FUSS & O'NEILL
1550 Main Street, Suite 400
Springfield, MA 01103
413.452.0445
www.fando.com

Little River Dam Removal and River Restoration

City of Haverhill

Haverhill, Massachusetts

April 8, 2026

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SECTION 00 11 13 - ADVERTISEMENT FOR BIDS

The City of Haverhill is requesting Bids for the construction of the following Project:

Little River Dam Removal and River Restoration

Bids for the project will be received electronically at www.projectdog.com (Project Code #873965) not later than **3:00 PM** local time on **May 13, 2026** at which time the bids will be opened publicly online. It is the sole responsibility of the bidder to ensure that the bid is submitted online prior to the bid opening time.

The project consists of removing the Little River Dam and restoring channel and floodplain through the former Little River Dam impoundment. Work items include excavation and off-site disposal of contaminated soil, excavation and on-site reuse of soil, excavation and off-site disposal of other soil, construction of channel bed and banks using bioengineering techniques, construction of rock weirs for fish passage, installation of bridge scour protection and stormwater outfall scour protection, construction of a retaining wall on the channel side of the former Stevens Mill building at the corner of Stevens Street and Winter Street, replacement and extension of an existing retaining wall, and restoration of the site with native seed and plantings. The project also includes as Add Alternates construction of several public amenities for improved river access, including a canoe/kayak launch, fishing platform, and access trails within Cashman Park, and a pocket park/overlook at Winter Street, as well as a pedestrian bridge across the river at Cashman Park and associated trail connecting the park to Stevens Street. All work under the contract is subject to the environmental permits issued for the project.

Bids will be received for a single prime Contract. Bids shall be on a unit price basis as indicated in the Bid Form and shall include both a Base Bid and Alternates as outlined in the Bid Form.

Bid Forms and Contract Documents shall be available online at www.projectdog.com at project code #873965 Please see the attached Projectdog E-Bidding Instructions to Bidders for additional details. Neither Owner nor Engineer will be responsible for full or partial sets of Bidding Documents, including Addenda if any, obtained from sources other than Projectdog, Inc.

All questions shall be directed in writing to the Engineer, Fuss & O'Neill, by email by **4:00 PM** local time on **April 30, 2026**. Questions should be sent to Claire Nauman: Claire.Nauman@fando.com.

A mandatory pre-bid conference will be held at **11:00 AM** local time on April 27, 2026. Bidders should meet at Cashman Park, 175 Hilldale Ave, Haverhill, MA, 01830.

This Project is subject to appropriation and availability of funds. Award of the Contract is contingent upon the City of Haverhill securing all necessary funding, including approval of a loan order and any required financing. The City reserves the right to reject any and all bids if sufficient funding is not obtained.

The project is subject to the City of Haverhill obtaining ownership or control of the dam associated with this project and securing the necessary permanent and temporary easements. Award of the Contract is contingent upon the City obtaining ownership or control of the dam and securing a permanent easement related to the proposed retaining wall and temporary easements for construction. The City reserves the right to reject any and all bids if the City does not own the dam and obtain the necessary easements.

Bid security shall be furnished in conformance with the Instructions to Bidders.

Minimum wage rates, as determined by the Executive Office of Labor and Workforce Development, Department of Labor Standards (DLS) under the provisions of M.G.L., Chapter 149, Section 26 to 27D, as amended, and/or the Davis-Bacon Act, apply to this project. It is the responsibility of the contractor, before bid opening, to request if necessary, any additional information on Prevailing Wage/Davis Bacon Wage Rates for those tradespeople who may be employed for the proposed work under this contract.

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Projectdog E-Bidding Instructions to Bidders

Bid Documents

Bid Forms and Contract Documents shall be available online at Projectdog.com. Documents are made available to all bidders in electronic form at no cost. Bidders desiring hard copies shall be solely responsible for all costs related to printing and shipping of hard copy documents. Neither Owner nor Architect/Engineer shall be responsible for full or partial sets of the Bidding Documents, including Addenda if any, obtained from sources other than Projectdog, Inc.

Receipt of Bids

This project is being Electronically Bid (E-Bid). All bids shall be submitted online at Projectdog.com. Hard copy bids will not be accepted by the Awarding Authority. Tutorials and Instructions are available online at Projectdog.com. For assistance, contact Projectdog, Inc. at 978.499.9014.

Preparation and Submission of Bids

Bid Forms will be posted online at Projectdog.com. All required Bid Forms must be completed and submitted in unrestricted PDF formatted files. The Bidder must fill-in all required fields and signatures either digitally or manually (print, fill-in, and scan to PDF).

The Bidder shall access the Projectdog.com E-Bidding System by entering the Project Code in the project locator box and then selecting “Sub E-Bid” or “GC E-Bid” from the project’s “Project Details” page. The Bidder must enter their bid price as a numeric, whole dollar value only with no punctuation. If no base bid price is applicable, Bidders are instructed to enter an amount of $1.00 (one dollar). **For GC E-Bids with Sub-Bids, General Contractors shall input the total Contract Price, i.e., the sum of all selected Sub-Bid amounts plus the amount for the work of the General Contractor.** The E-Bidding system automatically translates the numeric value into words and displays the bid price in both figures and words on the submitted bid form.

Bidders may upload (“Add File” or “Replace File”), review (“View File”), Save, submit (“Submit my E-Bid”), or retract (“Retract my E-Bid”) their E-Bid at any time prior to the designated deadline. The server clock is displayed on the project’s E-Bidding page and is the time of record. **Bidders must select “Submit my E-Bid” prior to the designated deadline to officially submit their E-Bid online.** Once submitted, an E-Bid cannot be edited. To modify a submitted E-Bid, Bidders must retract their submission, save any changes, and then submit the updated E-Bid. Upon submitting or retracting their E-Bid, Bidders will receive a convenience email for informational purposes only. Bidders shall contact Projectdog if the email is not received.

Bidders shall review their submitted E-Bid package by selecting “View My Bid Package” from the project’s E-Bidding page. Uploaded files may be reviewed individually by selecting “View File”. It

is also the Bidder's responsibility to ensure that their submitted bid is 100% true, complete, and accurate.

It is also the Bidder's responsibility to confirm online that their E-Bid package has been submitted successfully. Timely submission of an E-Bid shall be the full responsibility of the Bidder.

Alternates

Each Bidder shall acknowledge Alternates by entering the dollar amount and selecting the "Add" or "Subtract" radio button necessitated by each Alternate listed in the corresponding space on the project's E-Bidding page.

If an Alternate does not involve a change in dollar value, the Bidder shall so indicate by typing "0" for the dollar value of that Alternate and by selecting the "Add" radio button in the corresponding space on the project's E-Bidding page.

Bid Security

Bid Security in the form of a Bid Bond shall be submitted with your E-Bid online at Projectdog.com. In lieu of an insurance Bid Bond certificate, Bid Security in the form of cash, or a certified check, treasurer's, or cashier's check issued by a responsible bank or trust company and made payable to the Owner, with a completed Bid Deposit Affidavit must be received by the Owner before the bidding deadline. Visit the Downloads page at Projectdog.com to acquire a Bid Deposit Affidavit fill-in form.

Addenda

Addenda, if issued, will be posted to the Projectdog website and shall be accompanied by email notification to every individual or firm on record as having received the Bid Documents. Hard copies of addenda will not be mailed or faxed. It shall be the sole responsibility of the Contractor to ascertain and acknowledge "◉ Yes" to the existence of zero or all addenda within the E-Bidding System.

If a bid is submitted prior to an Addendum being issued, the Bidder will receive an email notification for informational purposes only. The Bidder must review the addendum, retract the bid, acknowledge all addenda, and re-submit the bid. If a Bidder fails to acknowledge all addenda their bid may be rejected by the Awarding Authority.

Withdrawal of Bids (Before the Bid Opening)

Any bid may be withdrawn (retracted) prior to the designated deadline by selecting "Retract My E-Bid" from the project's E-Bidding page. Upon retracting, the Bidder will receive a convenience email for informational purposes only. It is the Bidder's responsibility to review and confirm online that their bid has been retracted successfully.

Bid Opening

Once the bid deadline has closed the E-Bid links are no longer available. All E-Bids are compiled in real time upon bid close and published forthwith on the "Project Details" page titled as "List of Bids Received". Official bid tabulations are posted at the discretion of the Awarding Authority.

Projectdog, Inc

Supplemental Instructions to Bidders for Electronic Bid Projects (E-Bid)

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Attachment:

Bid Deposit Affidavit

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Sign Up

Every user of Projectdog.com has a unique username and password for their account. **MANDATORY: All users must keep usernames and passwords PRIVATE and SECURE. Do not share accounts.**

1. Go to **www.Projectdog.com**.
2. Select the "Sign Up" (Fig 1).
3. Complete all required form fields and press Submit. An automatic email will be sent to the registered email.
4. Select the confirmation link in the email to complete the registration.

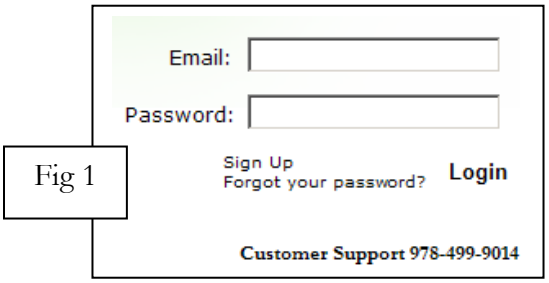

Fig 1

Login

1. Go to **www.Projectdog.com**.
2. Enter a registered email address and password (Fig 1).
3. Press Login.

Fig 2

Logoff

1. Hover over Home (Fig 2).
2. Select "Logoff".

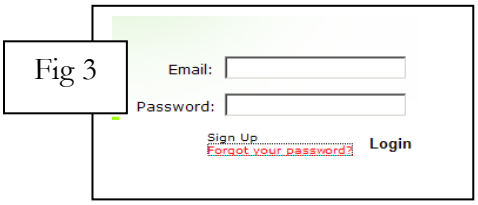

Fig 3

Forgotten Password

1. Select "Forgot your password?" (Fig 3).
2. Enter the e-mail address.
3. Select "Send Info". An automated e-mail will be sent with the password.

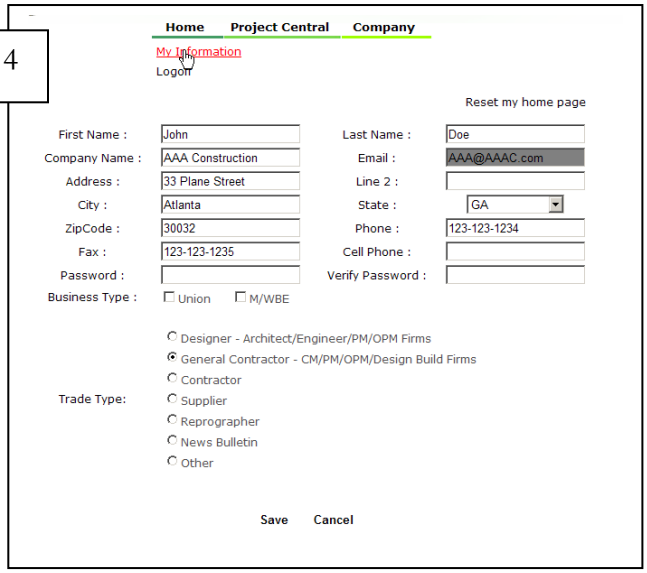

Fig 4

Account Information

View and edit user contact information. To change an email address, users must register a new account. Call Projectdog to have the old account removed.

1. Hover over Home (Fig 4).
2. Click "My Information".
3. Edit information as needed.
4. Click "Save" to finalize edits.

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Project Details

Utilize the search page (Fig 5) or enter a Project Code (Fig 6) to view a project's "Project Details" page (Fig 7).

Fig 5

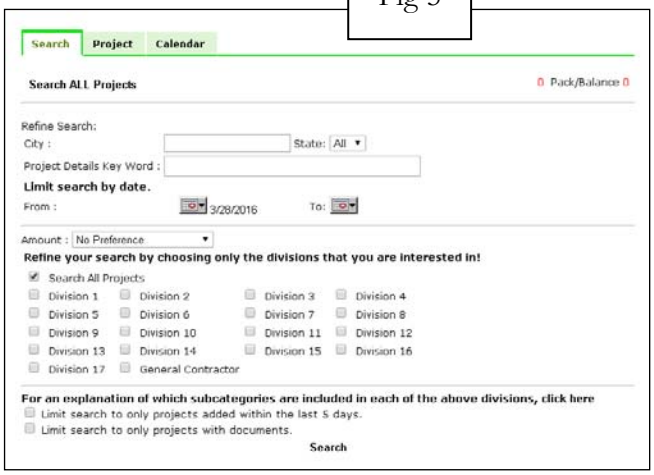
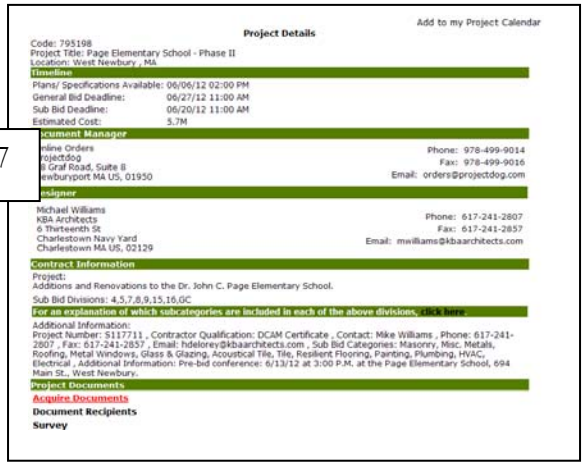


Fig 6

Fig 7



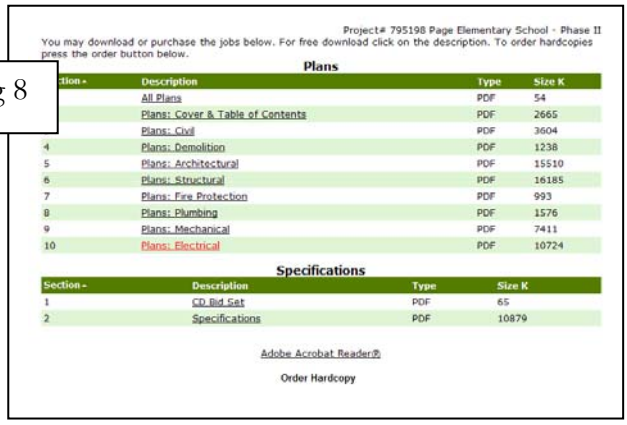
Acquire Documents

Download all project documents.

1. Click "Acquire Documents" link found on a project's "Project Details" page (Fig 7).
2. Respond to the Legal Notice after reviewing.
3. Click on any file description to open, review, or save a document (Fig 8).

   Users are automatically added to the project's "Document Recipients" list to receive update notifications upon viewing any document online.

Fig 8

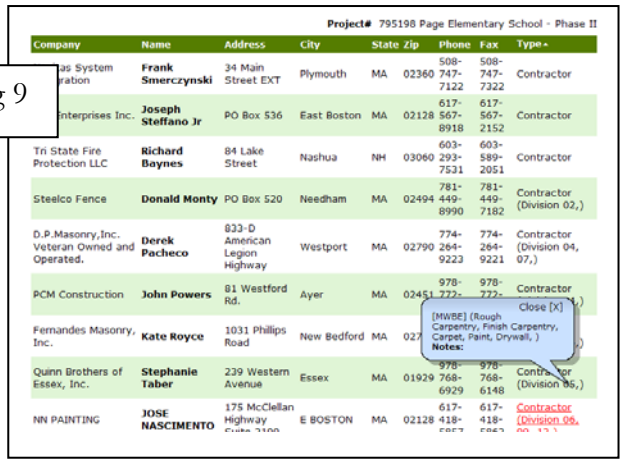


Document Recipients

Review all plan holders who have acquired documents.

1. Click "Document Recipients" link found on a project's "Project Details" page (Fig 7).
2. All potential bidders are listed and sorted by company type (Fig 9). Click on a column title to sort alphabetically.

Fig 9



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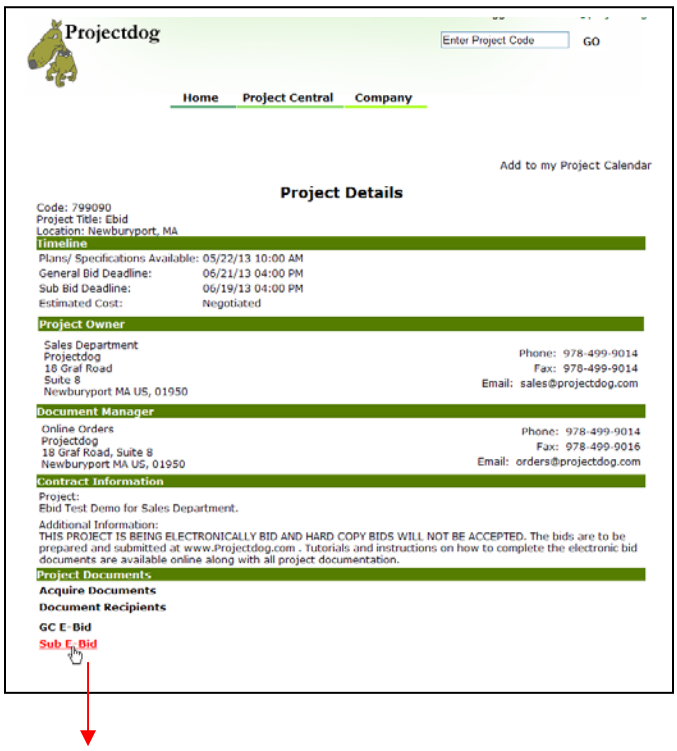
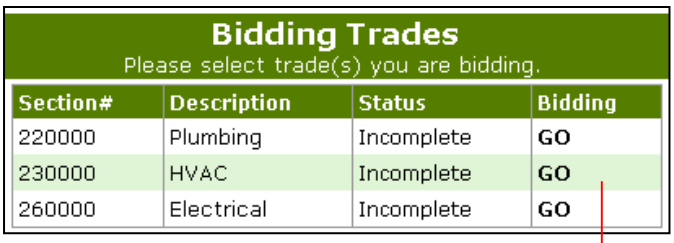
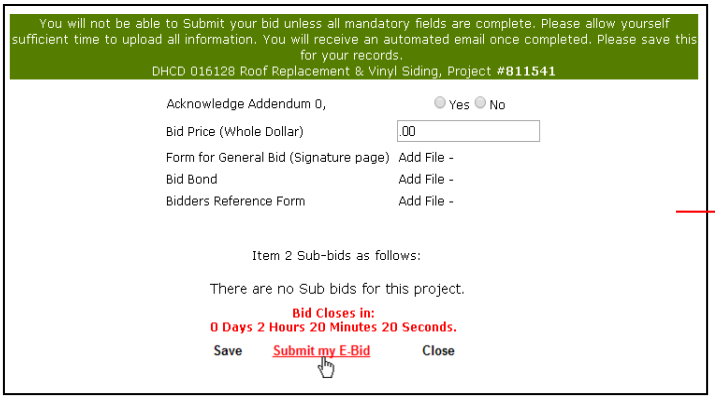
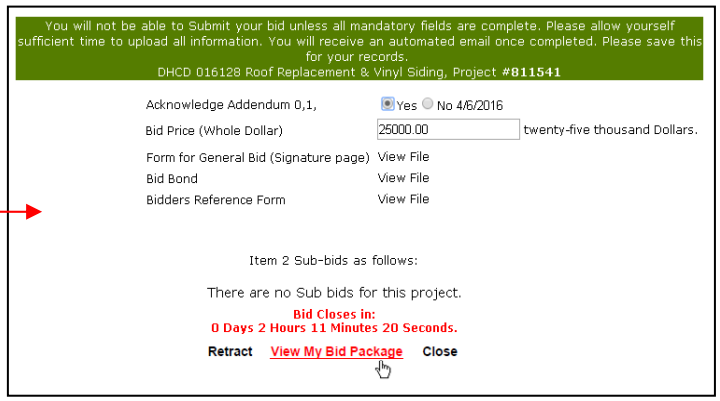
Electronic Bid (E-Bid)

This project is being **Electronically Bid** at www.Projectdog.com. Hard copy bids will not be accepted by the Awarding Authority. Go to www.Projectdog.com and Login with an existing account or click Sign Up to register for free. Enter a project code or search by keyword to access the "Project Details" page. Select "Acquire Documents" to download all bidding documents.









How to Submit an E-Bid

Complete and save all required forms as PDF files. Please be sure to sign all required signatures either digitally or manually.

1. Select the **GC E-Bid** or **Sub E-Bid** link located on the "Project Details" page.

   Subcontractors select a bidding trade;

   General Contractors will not be able to submit an E-Bid until the official sub bid tabulation is released by the Awarding Authority.

2. Answer / enter / upload all required areas. Enter all dollar value amounts as a whole dollar values only.

3. Select "Submit My E-Bid." Review the submitted bid package via the "View My Bid Package" link.

It's that simple!

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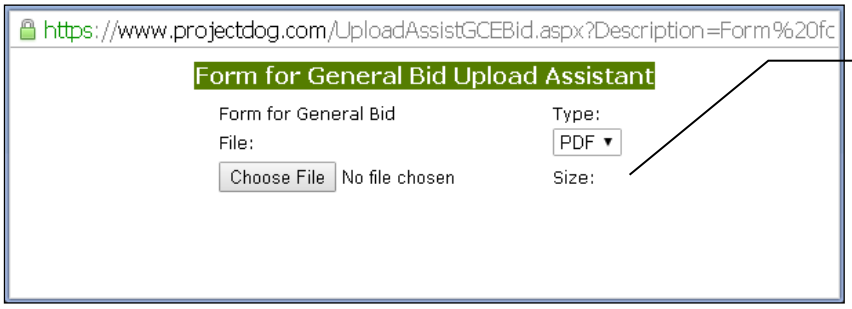
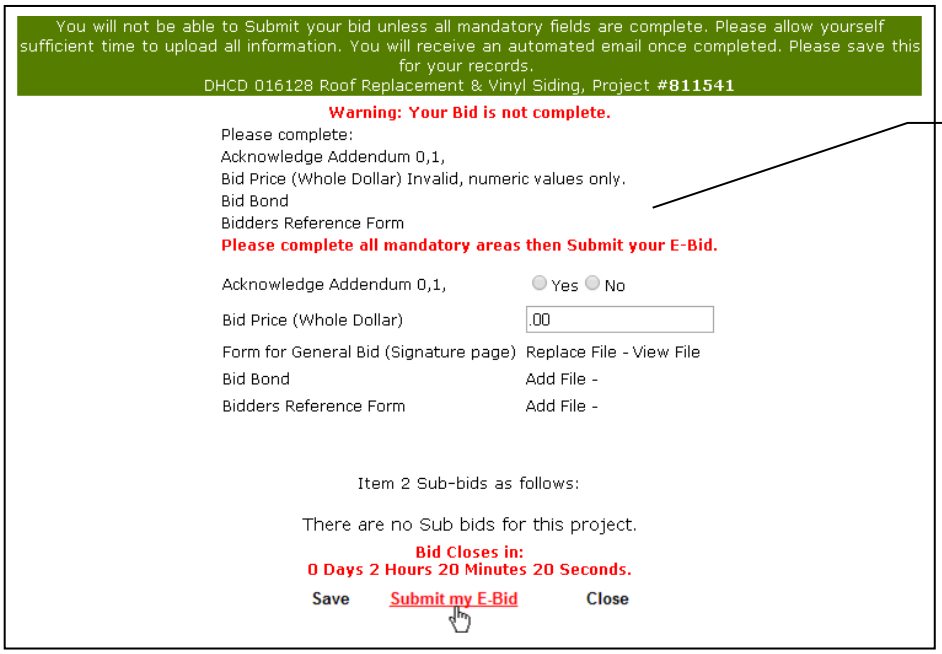


Add File

Click "Add File" on the E-Bid page to open the Upload Assistant window. Then click "Browse" or "Choose File" to upload a PDF file.



Warning

E-Bids cannot be submitted unless all areas are complete.

Save before adding files or closing the window or E-Bid data may need to be re-entered.

Projectdog.com server time is set to industry standards at time-a.nist.gov. Bidders are encouraged to update their computer clock.

Bidders may save, submit or modify an Electronic Bid (E-Bid) at any time prior to bid close. Once submitted, a bid cannot be edited. To modify a bid the bidder must retract the bid, make any necessary changes, and then submit the bid again. Upon submitting or retracting the bidder will receive a convenience email for informational purposes only. **Bidder shall contact Projectdog if an email is not received.**

It is the bidder's responsibility to review and confirm online that a bid has been submitted and/or retracted and that the bid is 100% true, complete and accurate. All bidders are required to review their submitted E-Bid via the "View My Bid Package" link.

If a bid is submitted prior to an addendum being issued the bidder will receive an automated email for informational purposes only stating the bidder must review the addendum, retract the bid, acknowledge all addenda, and submit the bid again. If a bidder fails to acknowledge addenda their bid may be rejected by the Awarding Authority.

Once the bid deadline has closed the E-Bid links are no longer available. All E-Bids are compiled in real time upon bid close and published forthwith on the "Project Details" page titled as "List of Bids Received". Official bid tabulations are posted at the discretion of the Awarding Authority.

For additional assistance, call Projectdog at (978) 499-9014 (M-F, 9AM-5PM).

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BID DEPOSIT AFFIDAVIT

This document is an affidavit form that is drafted to serve as a statement wherein the person (Bidder) who signs it swears under penalty of perjury that the facts and information that are identified in this affidavit are true.

In lieu of an insurance Bid Bond certificate, a hard copy of this completed Bid Deposit Affidavit AND the 5% Bid Deposit in the form of cash, certified check, treasurer's or cashier's check issued by a responsible bank or trust company MUST be received by the Awarding Authority PRIOR to the closing of the project's electronic bid.

BOTH the completed Bid Deposit Affidavit and the check (or cash) shall be enclosed in a sealed envelope with the following information plainly written on the outside:

> **DO NOT OPEN BEFORE:** *[indicate DATE and TIME of the bid opening]*
> ***Project Name -***
> ***Project Number -***
> ***Bidder's Name -***
> ***Business Address -***
> ***Phone Number -***

It is the Bidder's responsibility to ensure that this completed Bid Deposit Affidavit AND the check (or cash) are submitted as stated above AND received by the Awarding Authority prior to the closing of electronic bids. In addition, this completed Bid Deposit Affidavit must be uploaded with the electronic bid via the project's E-Bid Add File link "Bid Deposit (Bid Bond or Affidavit)" at www.Projectdog.com.

The Bidder understands and consents that any failure to do so whether his own or other fault may result in the rejection of said bid. The Bidder is solely responsible for the accuracy and value of the Bid Deposit. If the Bid Deposit is less than the required amount as outlined in the project specifications the bid may be rejected.

Bid Deposit amount enclosed: _____ ___ Certified check, Treasurer's or Cashier's check

___ Cash

Date: _____

Bidder's Name: _____

Address: _____

City, State, Zip: _____

Signature: _____

INSTRUCTIONS TO BIDDERS FOR CONSTRUCTION CONTRACT

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ARTICLE 1—DEFINED TERMS

1.01 Terms used in these Instructions to Bidders have the meanings indicated in the General Conditions and Supplementary Conditions. Additional terms used in these Instructions to Bidders have the meanings indicated below:

A. *Issuing Office*—The office from which the Bidding Documents are to be issued, and which registers plan holders.

B. *Successful Bidder* – The Bidder submitting a response Bid to whom the Owner (on the basis of Owner's evaluation as hereinafter provided) makes an award.

ARTICLE 2—BIDDING DOCUMENTS

2.01 Bidder shall obtain a complete set of Bidding Requirements and proposed Contract Documents (together, the Bidding Documents). See the Agreement for a list of the Contract Documents. It is Bidder's responsibility to determine that it is using a complete set of documents in the preparation of a Bid. Bidder assumes sole responsibility for errors or misinterpretations resulting from the use of incomplete documents, by Bidder itself or by its prospective Subcontractors and Suppliers.

2.02 Bidding Documents are made available for the sole purpose of obtaining Bids for completion of the Project and permission to download or distribution of the Bidding Documents does not confer a license or grant permission or authorization for any other use. Authorization to download documents, or other distribution, includes the right for plan holders to print documents solely for their use, and the use of their prospective Subcontractors and Suppliers, provided the plan holder pays all costs associated with printing or reproduction. Printed documents may not be re-sold under any circumstances.

2.03 Bidder may register as a plan holder and obtain complete sets of Bidding Documents, in the number and format stated in the Advertisement or invitation to bid, from the Issuing Office. Bidders may rely that sets of Bidding Documents obtained from the Issuing Office are complete, unless an omission is blatant. Registered plan holders will receive Addenda issued by Owner.

2.04 *Electronic Documents*

A. Bidding Documents will be made available to the Bidders as Electronic Documents in the manner specified.

1. Bidding Documents will be provided in Adobe PDF (Portable Document Format) (.pdf) that is readable by Adobe Acrobat Reader. It is the intent of the Engineer and Owner that such Electronic Documents are to be exactly representative of the paper copies of the documents. However, because the Owner and Engineer cannot totally control the transmission and receipt of Electronic Documents nor the Contractor's means of reproduction of such documents, the Owner and Engineer cannot and do not guarantee that Electronic Documents and reproductions prepared from those versions are identical in every manner to the paper copies.

B. Unless otherwise stated in the Bidding Documents, the Bidder may use and rely upon complete sets of Electronic Documents of the Bidding Documents, described in Paragraph 2.06.A above. However, Bidder assumes all risks associated with differences arising from transmission/receipt of Electronic Documents versions of Bidding Documents and reproductions prepared from those versions and, further, assumes all risks, costs, and responsibility associated with use of the

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Electronic Documents versions to derive information that is not explicitly contained in printed paper versions of the documents, and for Bidder's reliance upon such derived information.

ARTICLE 3—QUALIFICATIONS OF BIDDERS

3.01 Bidder must submit the qualifications statement (Section 00 45 13 "Bidder's Qualifications") and reference form (Section 00 45 14 "Bidder's Reference Form") demonstrating qualifications to do the work as part of their bid. Bidders must list a minimum of three and a maximum of five projects completed in the last 5 years and provide indicated information to demonstrate the Bidder's experience with projects similar in type and cost of construction. Include in the qualifications statement only projects that demonstrate experience in dam removal, river restoration and in-water work, with each project having a contract value equal to or greater than $1,000,000.

3.02 Bidder is to submit the following information with its Bid to demonstrate Bidder's qualifications to perform the Work:

A. Written evidence establishing its qualifications such as financial data, previous experience, and present commitments.

B. A written statement that Bidder is authorized to do business in the state where the Project is located, or a written certification that Bidder will obtain such authority prior to the Effective Date of the Contract.

C. Bidder's state or other contractor license number, if applicable.

D. Subcontractor and Supplier qualification information.

E. Other required information regarding qualifications.

3.03 A Bidder's failure to submit required qualification information within the times indicated may disqualify Bidder from receiving an award of the Contract.

3.04 No requirement in this Article 3 to submit information will prejudice the right of Owner to seek additional pertinent information regarding Bidder's qualifications.

3.05 Bidder is advised to carefully review those portions of the Bid Form requiring Bidder's representations and certifications.

ARTICLE 4—PRE-BID CONFERENCE

4.01 A mandatory pre-bid conference will be held at the time and location indicated in the Advertisement or invitation to bid. Representatives of Owner and Engineer will be present to discuss the Project. Proposals will not be accepted from Bidders who do not attend the conference. It is each Bidder's responsibility to sign in at the pre-bid conference to verify its participation. Bidders must sign in using the name of the organization that will be submitting a Bid. A list of qualified Bidders that attended the pre-bid conference and are eligible to submit a Bid for this Project will be issued in an Addendum.

4.02 Information presented at the pre-Bid conference does not alter the Contract Documents. Owner will issue Addenda to make any changes to the Contract Documents that result from discussions at the

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pre-Bid conference. Information presented, and statements made at the pre-bid conference will not be binding or legally effective unless incorporated in an Addendum.

ARTICLE 5—SITE AND OTHER AREAS; EXISTING SITE CONDITIONS; EXAMINATION OF SITE; OWNER'S SAFETY PROGRAM; OTHER WORK AT THE SITE

5.01 *Site and Other Areas*

A. The Site is identified in the Bidding Documents. By definition, the Site includes rights-of-way, easements, and other lands furnished by Owner for the use of the Contractor. Any additional lands required for temporary construction facilities, construction equipment, or storage of materials and equipment, and any access needed for such additional lands, are to be obtained and paid for by Contractor.

1. The City is in the process of obtaining temporary easements for access during construction at the convenience store property located at 93 Lafayette Square, as well as at the G&C Concrete facility on Stevens Street. The bidder should assume that access via these two properties will be available for use, as indicated on the design drawings.

2. Please note that the City is in the process of obtaining ownership of the dam and water rights, with an anticipated completion date of June 2026, and that any contract for the Work shall be contingent on the City securing such ownership and rights.

5.02 *Existing Site Conditions*

A. *Subsurface and Physical Conditions; Hazardous Environmental Conditions*

1. The Supplementary Conditions identify the following regarding existing conditions at or adjacent to the Site:

a. Those reports of explorations and tests of subsurface conditions at or adjacent to the Site that contain Technical Data.

b. Those drawings known to Owner of existing physical conditions at or adjacent to the Site, including those drawings depicting existing surface or subsurface structures at or adjacent to the Site (except Underground Facilities), that contain Technical Data.

c. Reports and drawings known to Owner relating to Hazardous Environmental Conditions that have been identified at or adjacent to the Site.

d. Technical Data contained in such reports and drawings.

2. Owner will make copies of reports and drawings referenced above available to any Bidder on request. These reports and drawings are not part of the Contract Documents, but the Technical Data contained therein upon whose accuracy Bidder is entitled to rely, as provided in the General Conditions, has been identified and established in the Supplementary Conditions. Bidder is responsible for any interpretation or conclusion Bidder draws from any Technical Data or any other data, interpretations, opinions, or information contained in such reports or shown or indicated in such drawings.

3. If the Supplementary Conditions do not identify Technical Data, the default definition of Technical Data set forth in Article 1 of the General Conditions will apply.

4. *Geotechnical Baseline Report/Geotechnical Data Report:* The Bidding Documents contain a Geotechnical Baseline Report (GBR) and Geotechnical Data Report (GDR).

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a. As set forth in the Supplementary Conditions, the GBR describes certain select subsurface conditions that are anticipated to be encountered by Contractor during construction in specified locations ("Baseline Conditions"). The GBR is a Contract Document.

b. The Baseline Conditions in the GBR are intended to reduce uncertainty and the degree of contingency in submitted Bids. However, Bidders cannot rely solely on the Baseline Conditions. Bids should be based on a comprehensive approach that includes an independent review and analysis of the GBR, all other Contract Documents, Technical Data, other available information, and observable surface conditions. Not all potential subsurface conditions are baselined.

c. Nothing in the GBR is intended to relieve Bidders of the responsibility to make their own determinations regarding construction costs, bidding strategies, and Bid prices, nor of the responsibility to select and be responsible for the means, methods, techniques, sequences, and procedures of construction, and for safety precautions and programs incident thereto.

d. As set forth in the Supplementary Conditions, the GDR is a Contract Document containing data prepared by or for the Owner in support of the GBR.

B. *Underground Facilities:* Underground Facilities are shown or indicated on the Drawings, pursuant to Paragraph 5.05 of the General Conditions, and not in the drawings referred to in Paragraph 5.02.A of these Instructions to Bidders. Information and data regarding the presence or location of Underground Facilities are not intended to be categorized, identified, or defined as Technical Data.

5.03 *Site Visit and Testing by Bidders*

A. Bidder is required to visit the Site and conduct a thorough visual examination of the Site and adjacent areas. During the visit the Bidder must not disturb any ongoing operations at the Site.

B. A Site visit is scheduled following the pre-bid conference. Maps to the Site will be available at the pre-Bid conference.

C. Bidders visiting the Site are required to arrange their own transportation to the Site.

D. Bidder is not required to conduct any subsurface testing, or exhaustive investigations of Site conditions.

E. On request, and to the extent Owner has control over the Site, and schedule permitting, the Owner will provide Bidder general access to the Site to conduct such additional examinations, investigations, explorations, tests, and studies as Bidder deems necessary for preparing and submitting a successful Bid. Owner will not have any obligation to grant such access if doing so is not practical because of existing operations, security or safety concerns, or restraints on Owner's authority regarding the Site. Bidder is responsible for establishing access needed to reach specific selected test sites.

F. Bidder must comply with all applicable Laws and Regulations regarding excavation and location of utilities, obtain all permits, and comply with all terms and conditions established by Owner or by property owners or other entities controlling the Site with respect to schedule, access, existing operations, security, liability insurance, and applicable safety programs.

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G. Bidder must fill all holes and clean up and restore the Site to its former condition upon completion of such explorations, investigations, tests, and studies.

5.04 *Owner's Safety Program*

A. Site visits and work at the Site may be governed by an Owner safety program. If an Owner safety program exists, it will be noted in the Supplementary Conditions.

5.05 *Other Work at the Site*

A. Reference is made to Article 8 of the Supplementary Conditions for the identification of the general nature of other work of which Owner is aware (if any) that is to be performed at the Site by Owner or others (such as utilities and other prime contractors) and relates to the Work contemplated by these Bidding Documents. If Owner is party to a written contract for such other work, then on request, Owner will provide to each Bidder access to examine such contracts (other than portions thereof related to price and other confidential matters), if any.

ARTICLE 6—BIDDER'S REPRESENTATIONS AND CERTIFICATIONS

6.01 *Express Representations and Certifications in Bid Form, Agreement*

A. The Bid Form that each Bidder will submit contains express representations regarding the Bidder's examination of Project documentation, Site visit, and preparation of the Bid, and certifications regarding lack of collusion or fraud in connection with the Bid. Bidder should review these representations and certifications, and assure that Bidder can make the representations and certifications in good faith, before executing and submitting its Bid.

B. If Bidder is awarded the Contract, Bidder (as Contractor) will make similar express representations and certifications when it executes the Agreement.

6.02 *It is the responsibility of each Bidder before submitting a Bid to:*

A. examine and carefully study the Bidding Documents, and any data and reference items identified in the Bidding Documents;

B. visit the site, conduct a thorough, alert visual examination of the site and adjacent areas, and become familiar with and satisfy itself as to the general, local, and site conditions that may affect cost, progress, and performance of the Work;

C. become familiar with and satisfy itself as to all Laws and Regulations that may affect cost, progress, and performance of the Work;

D. carefully study all: (1) reports of explorations and tests of subsurface conditions at or adjacent to the site and all drawings of physical conditions relating to existing surface or subsurface structures at the site that have been identified in the Supplementary Conditions, especially with respect to Technical Data in such reports and drawings.

E. consider the information known to Bidder itself; information commonly known to contractors doing business in the locality of the site; information and observations obtained from visits to the site; the Bidding Documents; and the site-related reports and drawings identified in the Bidding Documents, with respect to the effect of such information, observations, and documents on (1) the cost, progress, and performance of the Work; (2) the means, methods, techniques, sequences, and procedures of construction to be employed by Bidder; and (3) Bidder's safety precautions and programs;

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F. agree, based on the information and observations referred to in the preceding paragraph, that at the time of submitting its Bid no further examinations, investigations, explorations, tests, studies, or data are necessary for the determination of its Bid for performance of the Work at the price bid and within the times required, and in accordance with the other terms and conditions of the Bidding Documents;

G. become aware of the general nature of the work to be performed by Owner and others at the site that relates to the Work as indicated in the Bidding Documents;

H. promptly give Designer written notice of all conflicts, errors, ambiguities, or discrepancies that Bidder discovers in the Bidding Documents and confirm that the written resolution thereof by Designer is acceptable to Bidder;

I. determine that the Bidding Documents are generally sufficient to indicate and convey understanding of all terms and conditions for the performance and furnishing of the Work; and

J. agree that the submission of a Bid will constitute an incontrovertible representation by Bidder that Bidder has complied with every requirement of this Article, that without exception the Bid and all prices in the Bid are premised upon performing and furnishing the Work required by the Bidding Documents.

ARTICLE 7—INTERPRETATIONS AND ADDENDA

7.01 Owner on its own initiative may issue Addenda to clarify, correct, supplement, or change the Bidding Documents.

7.02 Bidder shall submit all questions about the meaning or intent of the Bidding Documents to Engineer in writing. Contact information and submittal procedures for such questions are as follows:

A. Via email to: Candice Constantine, PhD, PE, CConstantine@fando.com

7.03 Interpretations or clarifications considered necessary by Engineer in response to such questions will be issued by Addenda delivered to all registered plan holders. Questions received less than seven days prior to the date for opening of Bids may not be answered.

7.04 Only responses set forth in an Addendum will be binding. Oral and other interpretations or clarifications will be without legal effect. Responses to questions are not part of the Contract Documents unless set forth in an Addendum that expressly modifies or supplements the Contract Documents.

ARTICLE 8—BID SECURITY

8.01 A Bid must be accompanied by Bid security made payable to Owner in an amount of 5% percent of Bidder's maximum Bid price (determined by adding the base bid and all alternates) and in the form of a Bid bond issued by a surety meeting the requirements of Paragraph 6.01 of the General Conditions. Such Bid bond will be issued in the form included in the Bidding Documents.

8.02 The Bid security of the apparent Successful Bidder will be retained until Owner awards the contract to such Bidder, and such Bidder has executed the Contract, furnished the required Contract security, and met the other conditions of the Notice of Award, whereupon the Bid security will be released. If the Successful Bidder fails to execute and deliver the Contract and furnish the required Contract security within 15 days after the Notice of Award, Owner may consider Bidder to be in default, annul the Notice of Award, and the Bid security of that Bidder will be forfeited, in whole in the case of a penal

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sum bid bond, and to the extent of Owner's damages in the case of a damages-form bond. Such forfeiture will be Owner's exclusive remedy if Bidder defaults.

8.03 The Bid security of other Bidders that Owner believes to have a reasonable chance of receiving the award may be retained by Owner until the earlier of 7 days after the Effective Date of the Contract or 61 days after the Bid opening, whereupon Bid security furnished by such Bidders will be released.

8.04 Bid security of other Bidders that Owner believes do not have a reasonable chance of receiving the award will be released within 7 days after the Bid opening.

ARTICLE 9—CONTRACT TIMES

9.01 Bidder must set forth in the Bid the time by which Bidder must achieve Substantial Completion, subject to the restrictions established in Paragraph 13.07 of these Instructions. The Owner will take Bidder's time commitment regarding Substantial Completion into consideration during the evaluation of Bids, and it will be necessary for the apparent Successful Bidder to satisfy Owner that it will be able to achieve Substantial Completion within the time such Bidder has designated in the Bid. The Successful Bidder's time commitments will be entered into the Agreement or incorporated in the Agreement by reference to the specific terms of the Bid.

9.02 Provisions for liquidated damages, if any, for failure to timely attain a Milestone, Substantial Completion, or completion of the Work in readiness for final payment, are set forth in the Agreement.

ARTICLE 10—SUBSTITUTE AND "OR EQUAL" ITEMS

10.01 The Contract for the Work, as awarded, will be on the basis of materials and equipment specified or described in the Bidding Documents without consideration during the bidding and Contract award process of possible substitute or "or-equal" items. In cases in which the Contract allows the Contractor to request that Engineer authorize the use of a substitute or "or-equal" item of material or equipment, application for such acceptance may not be made to and will not be considered by Engineer until after the Effective Date of the Contract.

10.02 All prices that Bidder sets forth in its Bid will be based on the presumption that the Contractor will furnish the materials and equipment specified or described in the Bidding Documents, as supplemented by Addenda. Any assumptions regarding the possibility of post-Bid approvals of "or-equal" or substitution requests are made at Bidder's sole risk.

ARTICLE 11—SUBCONTRACTORS, SUPPLIERS, AND OTHERS

11.01 The apparent Successful Bidder, and any other Bidder so requested, must submit to Owner a list of any Subcontractors or Suppliers proposed for any portions of the Work within five days after Bid opening.

11.02 If requested by Owner, such list must be accompanied by an experience statement with pertinent information regarding similar projects and other evidence of qualification for each such Subcontractor or Supplier. If Owner or Engineer, after due investigation, has reasonable objection to any proposed Subcontractor or Supplier, Owner may, before the Notice of Award is given, request apparent Successful Bidder to submit an acceptable substitute, in which case apparent Successful Bidder will submit a substitute, Bidder's Bid price will be increased (or decreased) by the difference in cost

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occasioned by such substitution, and Owner may consider such price adjustment in evaluating Bids and making the Contract award.

11.03 If apparent Successful Bidder declines to make any such substitution, Owner may award the Contract to the next lowest Bidder that proposes to use acceptable Subcontractors and Suppliers. Declining to make requested substitutions will constitute grounds for forfeiture of the Bid security of any Bidder. Any Subcontractor or Supplier, so listed and against which Owner or Engineer makes no written objection prior to the giving of the Notice of Award will be deemed acceptable to Owner and Engineer subject to subsequent revocation of such acceptance as provided in Paragraph 7.07 of the General Conditions.

ARTICLE 12—PREPARATION OF BID

12.01 The Bid Form is included with the Bidding Documents.

A. All blanks on the Bid Form must be completed in ink and the Bid Form signed in ink. Erasures or alterations must be initialed in ink by the person signing the Bid Form. A Bid price must be indicated for each section, Bid item, alternate, adjustment unit price item, and unit price item listed therein.

B. If the Bid Form expressly indicates that submitting pricing on a specific alternate item is optional, and Bidder elects to not furnish pricing for such optional alternate item, then Bidder may enter the words "No Bid" or "Not Applicable."

12.02 If Bidder has obtained the Bidding Documents as Electronic Documents, then Bidder shall prepare its Bid on a paper copy of the Bid Form printed from the Electronic Documents version of the Bidding Documents. The printed copy of the Bid Form must be clearly legible, printed on 8½ inch by 11-inch paper and as closely identical in appearance to the Electronic Document version of the Bid Form as may be practical. The Owner reserves the right to accept Bid Forms which nominally vary in appearance from the original paper version of the Bid Form, providing that all required information and submittals are included with the Bid.

12.03 A Bid by a corporation must be executed in the corporate name by a corporate officer (whose title must appear under the signature), accompanied by evidence of authority to sign. The corporate address and state of incorporation must be shown.

12.04 A Bid by a partnership must be executed in the partnership name and signed by a partner (whose title must appear under the signature), accompanied by evidence of authority to sign. The official address of the partnership must be shown.

12.05 A Bid by a limited liability company must be executed in the name of the firm by a member or other authorized person and accompanied by evidence of authority to sign. The state of formation of the firm and the official address of the firm must be shown.

12.06 A Bid by an individual must show the Bidder's name and official address.

12.07 A Bid by a joint venture must be executed by an authorized representative of each joint venturer in the manner indicated on the Bid Form. The joint venture must have been formally established prior to submittal of a Bid, and the official address of the joint venture must be shown.

12.08 All names must be printed in ink below the signatures.

12.09 The Bid must contain an acknowledgment of receipt of all Addenda, the numbers of which must be filled in on the Bid Form.

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12.10 Postal and e-mail addresses and telephone number for communications regarding the Bid must be shown.

12.11 The Bid must contain evidence of Bidder's authority to do business in the state where the Project is located, or Bidder must certify in writing that it will obtain such authority within the time for acceptance of Bids and attach such certification to the Bid.

12.12 If Bidder is required to be licensed to submit a Bid or perform the Work in the state where the Project is located, the Bid must contain evidence of Bidder's licensure, or Bidder must certify in writing that it will obtain such licensure within the time for acceptance of Bids and attach such certification to the Bid. Bidder's state contractor license number, if any, must also be shown on the Bid Form.

ARTICLE 13—BASIS OF BID

13.01 *Base Bid with Alternates*

A. Bidders must submit a Bid for the base Bid and include a separate price for each alternate described in the Bidding Documents and as provided for in the Bid Form. Both the base Bid and alternates include lump sum and unit price items. The price for each alternate will be the amount added to or deleted from the base Bid if Owner selects the alternate.

1. The Base Bid includes construction of all dam removal and river restoration elements. An Add Alternate for scour protection under the MBTA bridge is contingent upon observed site conditions after drawdown of the impoundment. Bidders are requested to base pricing for these elements assuming a construction start date in late spring/early summer 2025.

2. Additional Add Alternates for construction of public amenities at Cashman Park, an overlook/pocket park at Winter Street, and a pedestrian bridge and walking trail to connect Cashman Park to Stevens Street via MBTA property east of Little River are contingent upon funding and, in the case of the bridge and trail, finalized lease agreements between MBTA and the City of Haverhill and may commence at a later date. Bidders are requested to base all unit pricing assuming that these Add Alternates would be built during the second season of construction, in Summer 2027.

13.02 *Unit Price*

A. Bidders must submit a Bid on a unit price basis for each item of Work listed in the unit price section of the Bid Form.

B. The "Bid Price" (sometimes referred to as the extended price) for each unit price Bid item will be the product of the "Estimated Quantity", which Owner or its representative has set forth in the Bid Form, for the item and the corresponding "Bid Unit Price" offered by the Bidder. The total of all unit price Bid items will be the sum of these "Bid Prices"; such total will be used by Owner for Bid comparison purposes. The final quantities and Contract Price will be determined in accordance with Paragraph 13.03 of the General Conditions.

C. Discrepancies between the multiplication of units of Work and unit prices will be resolved in favor of the unit prices. Discrepancies between the indicated sum of any column of figures and the correct sum thereof will be resolved in favor of the correct sum.

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ARTICLE 14—SUBMITTAL OF BID

14.01 The Bidding Documents include one separate unbound copy of the Bid Form, and, if required, the Bid Bond Form. The unbound copy of the Bid Form is to be completed and submitted with the Bid security and the other documents required to be submitted under the terms of Article 2 of the Bid Form.

14.02 A Bid must be received no later than the date and time prescribed and at the place indicated in the Advertisement or invitation to bid and must be enclosed in a plainly marked package with the Project title, and, if applicable, the designated portion of the Project for which the Bid is submitted, the name and address of Bidder, and must be accompanied by the Bid security and other required documents. If a Bid is sent by mail or other delivery system, the sealed envelope containing the Bid must be enclosed in a separate package plainly marked on the outside with the notation "BID ENCLOSED." A mailed Bid must be addressed to the location designated in the Advertisement.

14.03 Bids received after the date and time prescribed for the opening of bids, or not submitted at the correct location or in the designated manner, will not be accepted and will be returned to the Bidder unopened.

ARTICLE 15—MODIFICATION AND WITHDRAWAL OF BID

15.01 An unopened Bid may be withdrawn by an appropriate document duly executed in the same manner that a Bid must be executed and delivered to the place where Bids are to be submitted prior to the date and time for the opening of Bids. Upon receipt of such notice, the unopened Bid will be returned to the Bidder.

15.02 If a Bidder wishes to modify its Bid prior to Bid opening, Bidder must withdraw its initial Bid in the manner specified in Paragraph 15.01 and submit a new Bid prior to the date and time for the opening of Bids.

15.03 If within 24 hours after Bids are opened any Bidder files a duly signed written notice with Owner and promptly thereafter demonstrates to the reasonable satisfaction of Owner that there was a material and substantial mistake in the preparation of its Bid, the Bidder may withdraw its Bid, and the Bid security will be returned. Thereafter, if the Work is rebid, the Bidder will be disqualified from further bidding on the Work.

ARTICLE 16—OPENING OF BIDS

16.01 Bids will be opened at the time and place indicated in the advertisement or invitation to bid and, unless obviously non-responsive, read aloud publicly. An abstract of the amounts of the base Bids and major alternates, if any, will be made available to Bidders after the opening of Bids.

ARTICLE 17—BIDS TO REMAIN SUBJECT TO ACCEPTANCE

17.01 All Bids will remain subject to acceptance for the period of time stated in the Bid Form, but Owner may, in its sole discretion, release any Bid and return the Bid security prior to the end of this period.

ARTICLE 18—EVALUATION OF BIDS AND AWARD OF CONTRACT

18.01 Owner reserves the right to reject any or all Bids, including without limitation, nonconforming, nonresponsive, unbalanced, or conditional Bids. Owner also reserves the right to waive all minor Bid

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informalities not involving price, time, or changes in the Work. Owner will reject the Bid of any Bidder that Owner finds, after reasonable inquiry and evaluation, to not be responsible or qualified. If Bidder purports to add terms or conditions to its Bid, takes exception to any provision of the Bidding Documents, or attempts to alter the contents of the Contract Documents for purposes of the Bid, then the Owner may reject the Bid as nonresponsive; provided that Owner also reserves the right to waive all minor informalities not involving price, time, or changes in the Work.

18.02 If Owner awards the contract for the Work, such award will be to the responsible and qualified Bidder submitting the lowest responsive Bid.

18.03 *Evaluation of Bids*

A. In evaluating Bids, Owner will consider whether the Bids comply with the prescribed requirements, and such alternates, unit prices, and other data, as may be requested in the Bid Form or prior to the Notice of Award.

B. Based on the responsiveness, responsibility, and other factors set forth in these Instructions, the award may be made to Successful Bidder based on its base Bid and any combination of its additive alternate Bids for which Owner determines funds will be available at the time of award. The lowest responsive bid shall be the bid that allows the City to complete the most amount of base bid and alternate work within their budget.

C. For the determination of the apparent low Bidder when unit price bids are submitted, Bids will be compared on the basis of the total of the products of the estimated quantity of each item and unit price Bid for that item, together with any lump sum items.

18.04 In evaluating whether a Bidder is responsible, Owner will consider the qualifications of the Bidder and may consider the qualifications and experience of Subcontractors and Suppliers proposed for those portions of the Work for which the identity of Subcontractors and Suppliers must be submitted as provided in the Bidding Documents.

18.05 Owner may conduct such investigations as Owner deems necessary to establish the responsibility, qualifications, and financial ability of Bidders and any proposed Subcontractors or Suppliers.

18.06 This Project is subject to appropriation and availability of funds. Award of the Contract is contingent upon the City of Haverhill securing all necessary funding, including approval of a loan order and any

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required financing. The City reserves the right to reject any and all bids if sufficient funding is not obtained.

ARTICLE 19—PROJECT CONTINGENCIES

19.01 General: The project is subject to the satisfaction of the conditions set forth below. Notwithstanding any other provision of the Bidding Documents, the award of the Contract is expressly contingent upon fulfillment of these conditions.

19.02 Funding: The City must secure all necessary funding for the Project, including approval of a loan order and any required financing.

19.03 Property Interests (Dam Ownership and Easements): The City must obtain ownership of, or sufficient legal rights in, the dam associated with the Project, and must secure all permanent and temporary easements necessary for construction, access, and completion of the Work.

19.04 Owner's Rights: The City reserves the right, in its sole discretion, to delay award, cancel the solicitation, or reject any and all Bids if any of the above conditions are not satisfied.

19.05 No Damages for Non-Award: Bidders acknowledge that the City shall have no liability for any costs incurred in the preparation or submission of Bids, or for any other costs incurred in anticipation of award of the Contract, if the Project is delayed, modified, or canceled due to failure to satisfy these conditions.

ARTICLE 20—BONDS AND INSURANCE

20.01 Article 6 of the General Conditions, as may be modified by the Supplementary Conditions, sets forth Owner's requirements as to performance and payment bonds, other required bonds (if any), and insurance. When the Successful Bidder delivers the executed Agreement to Owner, it must be accompanied by required bonds and insurance documentation.

20.02 Article 8, Bid Security, of these Instructions, addresses any requirements for providing bid bonds as part of the bidding process.

ARTICLE 21—SIGNING OF AGREEMENT

21.01 When Owner issues a Notice of Award to the Successful Bidder, it will be accompanied by the unexecuted counterparts of the Agreement along with the other Contract Documents as identified in the Agreement. Within 15 days thereafter, Successful Bidder must execute and deliver the required number of counterparts of the Agreement and any bonds and insurance documentation required to be delivered by the Contract Documents to Owner. Within 10 days thereafter, Owner will deliver one fully executed counterpart of the Agreement to Successful Bidder, together with printed and electronic copies of the Contract Documents as stated in Paragraph 2.02 of the General Conditions.

ARTICLE 22—MINIMUM WAGE RATES

22.01 Minimum Wage Rates as determined by the Commissioner of Department of Workforce Development under the provision of the Massachusetts General Laws, Chapter 149, Sections 26 to 27D, as amended, apply to this project. It is the responsibility of the contractor, before bid opening, to request if

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necessary, any additional information on Minimum Wage Rates for those trades people who may be employed for the proposed work under this contract. See Attachment for Prevailing Wage Rates.

ARTICLE 23—SALES AND USE TAXES

23.01 Owner is exempt from Massachusetts state sales and use taxes on materials and equipment to be incorporated in the Work. Said taxes must not be included in the Bid. Refer to Paragraph SC-7.10 of the Supplementary Conditions for additional information.

ARTICLE 24—FEDERAL LAW REQUIREMENTS

24.01 The City anticipates that funding for some portion of the work may be made available through federal grant fund opportunities, and accordingly, certain federal requirements apply, including but not limited to the Davis-Bacon Act and corresponding Davis-Bacon wage determinations. Bidders should therefore assume that the requirements of federal law, as set forth in these Contract Documents, including Article 19 of the Supplemental Conditions, apply to this project.

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SECTION 00 41 12 - BID FORM

ARTICLE 1 – OWNER AND BIDDER

1.1 THIS BID IS SUBMITTED TO:

City of Haverhill

c/o Steven S. Bucuzzo

via www.projectdog.com

1.2 The undersigned Bidder proposes and agrees, if this Bid is accepted, to enter into an Agreement with Owner in the form included in the Bidding Documents to perform all Work as specified or indicated in the Bidding Documents for the prices and within the times indicated in this Bid and in accordance with the other terms and conditions of the Bidding Documents.

ARTICLE 2 – ATTACHMENTS TO THIS BID

2.1 The following documents are submitted with and made a condition of this Bid:

A. Required Bid security;

B. List of Proposed Subcontractors;

C. List of Proposed Suppliers;

D. Evidence of authority to do business in the state of the Project; or a written covenant to obtain such authority within the time for acceptance of Bids;

E. Contractor's license number as evidence of Bidder's State Contractor's License or a covenant by Bidder to obtain said license within the time for acceptance of Bids;

F. Required Bidder Qualification Statement with supporting data; and Completed Bid Schedule

G. Required Bidder's Reference Form

ARTICLE 3 – BASIS OF BID—LUMP SUM BID AND UNIT PRICES

3.1 Unit Price Bids

A. Bidder will perform the following Work at the indicated unit prices in the attached bid schedule.

B. Bidder acknowledges that:

1. each Bid Unit Price includes an amount considered by Bidder to be adequate to cover Contractor's overhead and profit for each separately identified item, and

2. estimated quantities are not guaranteed, and are solely for the purpose of comparison of Bids, and final payment for all Unit Price Work will be based on actual quantities, determined as provided in the Contract Documents.

ARTICLE 4 – TIME OF COMPLETION

4.1 Bidder agrees that the Work will be substantially complete and will be completed and ready for final payment in accordance with Paragraph 15.06 of the General Conditions on or before the dates or within the number of calendar days indicated in the Agreement.

4.2 Bidder accepts the provisions of the Agreement as to liquidated damages.

ARTICLE 5 – BIDDER'S ACKNOWLEDGEMENTS: ACCEPTANCE PERIOD, INSTRUCTIONS, AND RECEIPT OF ADDENDA

5.1 Bid Acceptance Period

A. This Bid will remain subject to acceptance for 60 days after the Bid opening, or for such longer period of time that Bidder may agree to in writing upon request of Owner.

5.2 Instructions to Bidders

A. Bidder accepts all of the terms and conditions of the Instructions to Bidders, including without limitation those dealing with the disposition of Bid security.

5.3 Receipt of Addenda

A. Bidder hereby acknowledges receipt of the following Addenda:

Addendum Number	Addendum Date

ARTICLE 6 – BIDDER'S REPRESENTATIONS AND CERTIFICATIONS

6.1 BIDDER'S REPRESENTATIONS

A. In submitting this Bid, Bidder represents the following:

1. Bidder has examined and carefully studied the Bidding Documents, including Addenda.
2. Bidder has visited the Site, conducted a thorough visual examination of the Site and adjacent areas, and become familiar with the general, local, and Site conditions that may affect cost, progress, and performance of the Work.
3. Bidder is familiar with all Laws and Regulations that may affect cost, progress, and performance of the Work.
4. Bidder has carefully studied the reports of explorations and tests of subsurface conditions at or adjacent to the Site and the drawings of physical conditions relating to existing surface or subsurface structures at the Site that have been identified in the Supplementary Conditions, with respect to the Technical Data in such reports and drawings.
5. Bidder has carefully studied the reports and drawings relating to Hazardous Environmental Conditions, if any, at or adjacent to the Site that have been identified in the Supplementary Conditions, with respect to Technical Data in such reports and drawings.
6. Bidder has considered the information known to Bidder itself; information commonly known to contractors doing business in the locality of the Site; information and observations obtained from visits to the Site; the Bidding Documents; and the Technical Data identified

in the Supplementary Conditions or by definition, with respect to the effect of such information, observations, and Technical Data on (a) the cost, progress, and performance of the Work; (b) the means, methods, techniques, sequences, and procedures of construction to be employed by Bidder, if selected as Contractor; and (c) Bidder's (Contractor's) safety precautions and programs.

7. Based on the information and observations referred to in the preceding paragraph, Bidder agrees that no further examinations, investigations, explorations, tests, studies, or data are necessary for the performance of the Work at the Contract Price, within the Contract Times, and in accordance with the other terms and conditions of the Contract.
8. Bidder is aware of the general nature of work to be performed by Owner and others at the Site that relates to the Work as indicated in the Bidding Documents.
9. Bidder has given Engineer written notice of all conflicts, errors, ambiguities, or discrepancies that Bidder has discovered in the Bidding Documents, and of discrepancies between Site conditions and the Contract Documents, and the written resolution thereof by Engineer is acceptable to Contractor.
10. The Bidding Documents are generally sufficient to indicate and convey understanding of all terms and conditions for performance and furnishing of the Work.
11. The submission of this Bid constitutes an incontrovertible representation by Bidder that without exception the Bid and all prices in the Bid are premised upon performing and furnishing the Work required by the Bidding Documents.

6.2 BIDDER'S CERTIFICATIONS

A. The Bidder certifies the following:

1. This Bid is genuine and not made in the interest of or on behalf of any undisclosed individual or entity and is not submitted in conformity with any collusive agreement or rules of any group, association, organization, or corporation.
2. Bidder has not directly or indirectly induced or solicited any other Bidder to submit a false or sham Bid.
3. Bidder has not solicited or induced any individual or entity to refrain from bidding.
4. Bidder has not engaged in corrupt, fraudulent, collusive, or coercive practices in competing for the Contract. For the purposes of this Paragraph 8.02.A:
    a. Corrupt practice means the offering, giving, receiving, or soliciting of anything of value likely to influence the action of a public official in the bidding process.
    b. Fraudulent practice means an intentional misrepresentation of facts made (a) to influence the bidding process to the detriment of Owner, (b) to establish bid prices at artificial non-competitive levels, or (c) to deprive Owner of the benefits of free and open competition.
    c. Collusive practice means a scheme or arrangement between two or more Bidders, with or without the knowledge of Owner, a purpose of which is to establish bid prices at artificial, non-competitive levels.

d. Coercive practice means harming or threatening to harm, directly or indirectly, persons or their property to influence their participation in the bidding process or affect the execution of the Contract.

BIDDER hereby submits this Bid as set forth above:

Bidder:

_____
(typed or printed name of organization)

By: _____
(individual's signature)

Name: _____
(typed or printed)

Title: _____
(typed or printed)

Date: _____
(typed or printed)

If Bidder is a corporation, a partnership, or a joint venture, attach evidence of authority to sign.

Attest: _____
(individual's signature)

Name: _____
(typed or printed)

Title: _____
(typed or printed)

Date: _____
(typed or printed)

Address for giving notices:

_____

_____

Bidder's Contact:

Name: _____
(typed or printed)

Title: _____
(typed or printed)

Phone: _____

Email: _____

Address:

_____

_____

_____

Bidder's Contractor License No.: (if applicable) _____

BID SCHEDULE

Amount shall be shown in both words and figures. In case of discrepancy, the amount shown in words will govern.

BASE BID

Item No.	Estimated Quantity	Item Description	Unit Price In Figures	Amount in Figures
1	1 LS	Mobilization		
		_____ Lump Sum	$_____	$_____
2	1 LS	General Requirements		
		_____ Lump Sum	$_____	$_____
3	1 LS	Demobilization		
		_____ Lump Sum	$_____	$_____
4	1 LS	Traffic Control and Protection of Public		
		_____ Lump Sum	$_____	$_____
5	3 AC	Site Clearing		
		_____ Acres	$_____	$_____
6	1 LS	Temporary Erosion and Sediment Control		
		_____ Lump Sum	$_____	$_____
7	1 LS	Control of Water		
		_____ Lump Sum	$_____	$_____

Item No.	Estimated Quantity	Item Description	Unit Price In Figures	Amount in Figures
8	1 LS	Demolition		
		_____ Lump Sum	$_____	$_____
9	1,160 CY	Excavation and Off-site Disposal of Contaminated Soils as Hazardous Waste		
		_____ Per Cubic Yard	$_____	$_____
10	1,920 CY	Excavation and Off-site Disposal of Contaminated Soils as Regulated Waste		
		_____ Per Cubic Yard	$_____	$_____
11	5,750 CY	Excavation and Reuse of Satisfactory Soils		
		_____ Per Cubic Yard	$_____	$_____
12	11,130 CY	Excavation and Off-site Disposal of Other Soils		
		_____ Per Cubic Yard	$_____	$_____
13	650 TON	Riprap Type A		
		_____ Per Ton	$_____	$_____
14	1,612 TON	Riprap Type B		
		_____ Per Ton	$_____	$_____

Item No.	Estimated Quantity	Item Description	Unit Price In Figures	Amount in Figures
15	179 TON	Riprap Type C		
		_____ Per Ton	$_____	$_____
16	271 TON	Riprap Type D		
		_____ Per Ton	$_____	$_____
17	9,660 TON	Streambed Material Type A		
		_____ Per Ton	$_____	$_____
18	80 TON	Streambed Material Type B		
		_____ Per Ton	$_____	$_____
19	220 EA	Weir Boulders		
		_____ Each	$_____	$_____
20	15 EA	Habitat Boulders		
		_____ Each	$_____	$_____
21	8,990 FF	Fabric Encapsulated Soil (FES) Lifts		
		_____ Per Face Foot	$_____	$_____

Item No.	Estimated Quantity	Item Description	Unit Price In Figures	Amount in Figures
22	5,580 SY	Surface Fabric Treatment		
		_____ Per Square Yard	$_____	$_____
23	50 EA	Logs with Rootwads		
		_____ Each	$_____	$_____
24	38 EA	Logs		
		_____ Each	$_____	$_____
25	38 EA	Logs for Timber Piles		
		_____ Each	$_____	$_____
26	1 LS	Concrete Retaining Wall A		
		_____ Lump Sum	$_____	$_____
27	6 LF	Decorative Metal Fence (5' ht.)		
		_____ Per Linear Foot	$_____	$_____
28	73 LF	Decorative Metal Fence (4' ht.)		
		_____ Per Linear Foot	$_____	$_____

Item No.	Estimated Quantity	Item Description	Unit Price In Figures	Amount in Figures
29	152 LF	Black Vinyl Coated Chain Link Fence (6' ht.) for Retaining Wall A		
		_____ Per Linear Foot	$_____	$_____
30	1 LS	Metal Guardrail		
		_____ Lump Sum	$_____	$_____
31	1 LS	Concrete Retaining Wall B		
		_____ Lump Sum	$_____	$_____
32	84 LF	Black Vinyl Coated Chain Link Fence (6' ht.) for Retaining Wall B		
		_____ Per Linear Foot	$_____	$_____
33	11 LF	24 Inch Reinforced Concrete Pipe		
		_____ Per Linear Foot	$_____	$_____
34	1 EA	24 Inch Reinforced Concrete Pipe Flared End		
		_____ Each	$_____	$_____
35	438 EA	Conservation Grade Trees		
		_____ Each	$_____	$_____

Item No.	Estimated Quantity	Item Description	Unit Price In Figures	Amount in Figures
36	840 EA	Conservation Grade Shrubs		
		_____ Each	$_____	$_____
37	84,460 EA	Tubelings		
		_____ Each	$_____	$_____
38	8.0 AC	Conservation Seed Mix		
		_____ Acres	$_____	$_____
39	0.6 AC	Upland/Park Seed Mix		
		_____ Acres	$_____	$_____
40	1 LS	Floating Safety Boom and Anchors		
		_____ Lump Sum	$_____	$_____
41	1 LS	Permanent Signs		
		_____ Lump Sum	$_____	$_____

BASE BID SUMMARY

TOTAL BASE BID $_____ __

Note: All Bid Alternates are add alternates that expand upon the work covered under the Base Bid.

BID ALTERNATE A. – Scour Protection Rip Rap Type A (MBTA Bridge)

Item No.	Estimated Quantity	Item Description	Unit Price In Figures	Amount in Figures
A1	394 TON	Scour Protection Riprap Type A (MBTA Bridge)		
		_____ Per Ton	$_____	$_____
		TOTAL BID ALTERNATE A.		$_____ __

BID ALTERNATE B. – MBTA Trail and Pedestrian Bridge

Item No.	Estimated Quantity	Item Description	Unit Price In Figures	Amount in Figures
B1	1 LS	Walkway Retaining Structure		
		_____ Lump Sum	$_____	$_____
B2	1 LS	Pedestrian Bridge		
		_____ Lump Sum	$_____	$_____
B3	9,860 SF	Asphalt Walking Trail		
		_____ Per Square Foot	$_____	$_____
B4	6,047 FF	Modular Concrete Block Wall		
		_____ Per Face Foot	$_____	$_____
B5	43 TON	Riprap Type C		
		_____ Per Ton	$_____	$_____
B6	100 LF	Decorative Metal Fence (3.5' ht.)		
		_____ Per Linear Foot	$_____	$_____
B7	1,724 LF	Black Vinyl Coated Chain Link Fence (6' ht.)		
		_____ Per Linear Foot	$_____	$_____

Item No.	Estimated Quantity	Item Description	Unit Price In Figures	Amount in Figures
B8	1 LS	Trail Crossing for Stormwater Outfall		
		_____ Lump Sum	$_____	$_____
B9	0.4 AC	Semi-Shade Seed Mix		
		_____ Acres	$_____	$_____

TOTAL BID ALTERNATE B. $_____

BID ALTERNATE C. – Winter Street Overlook/Pocket Park

Item No.	Estimated Quantity	Item Description	Unit Price In Figures	Amount in Figures
C1	1 LS	Overlook Plaza		
		_____ Lump Sum	$_____	$_____
C2	1 LS	Cement Concrete Sidewalk and Curbing		
		_____ Lump Sum	$_____	$_____
C3	1 LS	Timber Post Guardrail		
		_____ Lump Sum	$_____	$_____
C4	2 EA	Shade Tree 2-2.5" cal.		
		_____ Each	$_____	$_____

Item No.	Estimated Quantity	Item Description	Unit Price In Figures	Amount in Figures
C5	8 EA	Ornamental Tree 1-1.5" cal.		
		_____ Each	$_____	$_____
C6	53 EA	Shrubs 3 gal.		
		_____ Each	$_____	$_____
C7	1 LS	Perennials		
		_____ Lump Sum	$_____	$_____
C8	70 LF	Wood Guardrail		
		_____ Per Linear Foot	$_____	$_____

TOTAL BID ALTERNATE C. $_____

BID ALTERNATE D. – Cashman Park Improvements

Item No.	Estimated Quantity	Item Description	Unit Price In Figures	Amount in Figures
D1	1 LS	Kayak/Canoe Launch and Access Path		
		_____ Lump Sum	$_____	$_____
D2	1,795 SF	Reinforced Gravel Walkway		
		_____ Per Square Foot	$_____	$_____
D3	1 LS	Fishing Platform		
		_____ Lump Sum	$_____	$_____

Item No.	Estimated Quantity	Item Description	Unit Price In Figures	Amount in Figures
D4	25 EA	Shade Tree 2-2.5" cal.		
		_____ Each	$_____	$_____
D5	28 EA	Ornamental Tree 1-1.5" cal.		
		_____ Each	$_____	$_____
D6	47 EA	Shrubs 3 gal.		
		_____ Each	$_____	$_____
D7	1 LS	Perennials		
		_____ Lump Sum	$_____	$_____
D8	0.1 AC	Showy Wildflower Seed Mix		
		_____ Acres	$_____	$_____
D9	0.1 AC	Semi-Shade Seed Mix		
		_____ Acres	$_____	$_____

TOTAL BID ALTERNATE D. $_____

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BID BOND (PENAL SUM FORM)

Bidder	**Surety**
Name:	Name:
Address *(principal place of business)*:	Address *(principal place of business)*:
Owner	**Bid**
Name: **City of Haverhill**	Project *(name and location)*: **Little River Dam Removal and River Restoration, Haverhill, MA**
Address *(principal place of business)*: **4 Summer Street, Room 105 Haverhill, MA 01830**	Bid Due Date:
Bond	
Penal Sum:	
Date of Bond:	

Surety and Bidder, intending to be legally bound hereby, subject to the terms set forth in this Bid Bond, do each cause this Bid Bond to be duly executed by an authorized officer, agent, or representative.

Bidder	Surety
_____ *(Full formal name of Bidder)*	_____ *(Full formal name of Surety) (corporate seal)*
By: _____ *(Signature)*	By: _____ *(Signature) (Attach Power of Attorney)*
Name: _____ *(Printed or typed)*	Name: _____ *(Printed or typed)*
Title: _____	Title: _____
Attest: _____ *(Signature)*	Attest: _____ *(Signature)*
Name: _____ *(Printed or typed)*	Name: _____ *(Printed or typed)*
Title:	Title:

Notes: (1) Note: Addresses are to be used for giving any required notice. (2) Provide execution by any additional parties, such as joint venturers, if necessary.

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1. Bidder and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors, and assigns to pay to Owner upon default of Bidder the penal sum set forth on the face of this Bond. Payment of the penal sum is the extent of Bidder's and Surety's liability. Recovery of such penal sum under the terms of this Bond will be Owner's sole and exclusive remedy upon default of Bidder.
2. Default of Bidder occurs upon the failure of Bidder to deliver within the time required by the Bidding Documents (or any extension thereof agreed to in writing by Owner) the executed Agreement required by the Bidding Documents and any performance and payment bonds required by the Bidding Documents.
3. This obligation will be null and void if:
   3.1. Owner accepts Bidder's Bid and Bidder delivers within the time required by the Bidding Documents (or any extension thereof agreed to in writing by Owner) the executed Agreement required by the Bidding Documents and any performance and payment bonds required by the Bidding Documents, or
   3.2. All Bids are rejected by Owner, or
   3.3. Owner fails to issue a Notice of Award to Bidder within the time specified in the Bidding Documents (or any extension thereof agreed to in writing by Bidder and, if applicable, consented to by Surety when required by Paragraph 5 hereof).
4. Payment under this Bond will be due and payable upon default of Bidder and within 30 calendar days after receipt by Bidder and Surety of written notice of default from Owner, which notice will be given with reasonable promptness, identifying this Bond and the Project and including a statement of the amount due.
5. Surety waives notice of any and all defenses based on or arising out of any time extension to issue Notice of Award agreed to in writing by Owner and Bidder, provided that the total time for issuing Notice of Award including extensions does not in the aggregate exceed 120 days from the Bid due date without Surety's written consent.
6. No suit or action will be commenced under this Bond prior to 30 calendar days after the notice of default required in Paragraph 4 above is received by Bidder and Surety, and in no case later than one year after the Bid due date.
7. Any suit or action under this Bond will be commenced only in a court of competent jurisdiction located in the state in which the Project is located.
8. Notices required hereunder must be in writing and sent to Bidder and Surety at their respective addresses shown on the face of this Bond. Such notices may be sent by personal delivery, commercial courier, or by United States Postal Service registered or certified mail, return receipt requested, postage pre-paid, and will be deemed to be effective upon receipt by the party concerned.
9. Surety shall cause to be attached to this Bond a current and effective Power of Attorney evidencing the authority of the officer, agent, or representative who executed this Bond on behalf of Surety to execute, seal, and deliver such Bond and bind the Surety thereby.
10. This Bond is intended to conform to all applicable statutory requirements. Any applicable requirement of any applicable statute that has been omitted from this Bond will be deemed to be included herein as if set forth at length. If any provision of this Bond conflicts with any applicable statute, then the provision of said statute governs and the remainder of this Bond that is not in conflict therewith continues in full force and effect.
11. The term "Bid" as used herein includes a Bid, offer, or proposal as applicable.

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CERTIFICATE OF STATE TAX COMPLIANCE

Pursuant to Massachusetts General Laws, Chapter 62C, Section 49A

_____, authorized signatory for
name of signatory

_____, whose
name of contractor

principal place of business is at _____,

_____does hereby certify under the pains and penalties of perjury that

_____ has paid all
name of contractor

Massachusetts taxes and has complied with all laws of the Commonwealth of Massachusetts relating to taxes, reporting of employees and contractors, and withholding and remitting child support.

_____
Signature Date

_____
Print Name

_____
Federal Tax ID # or Social Security #

SECTION 00 45 13 – BIDDER'S QUALIFICATIONS

ARTICLE 1—GENERAL INFORMATION

1.1 Provide contact information for the Business:

Legal Name of Business:			
Corporate Office			
Name:		Phone number:	
Title:		Email address:	
Business address of corporate office:			
Local Office			
Name:		Phone number:	
Title:		Email address:	
Business address of local office:			

1.2 Provide information on the Business's organizational structure:

Form of Business:	☐ Sole Proprietorship ☐ Partnership ☐ Corporation		
☐ Limited Liability Company ☐ Joint Venture comprised of the following companies:			
	1.		
	2.		
	3.		
Provide a separate Qualification Statement for each Joint Venturer.			
Date Business was formed:		State in which Business was formed:	
Is this Business authorized to operate in the Project location?	☐ Yes ☐ No ☐ Pending		

1.3 Identify all businesses that own Business in whole or in part (25% or greater), or that are wholly or partly (25% or greater) owned by Business:

Name of business:		Affiliation:	
Address:			
Name of business:		Affiliation:	
Address:			
Name of business:		Affiliation:	
Address:			

1.4 Provide information regarding the Business's officers, partners, and limits of authority.

Name:		Title:	
Authorized to sign contracts: ☐ Yes ☐ No		Limit of Authority:	$
Name:		Title:	
Authorized to sign contracts: ☐ Yes ☐ No		Limit of Authority:	$
Name:		Title:	
Authorized to sign contracts: ☐ Yes ☐ No		Limit of Authority:	$
Name:		Title:	

ARTICLE 2—LICENSING

2.1 Provide information regarding licensure for Business:

Name of License:			
Licensing Agency:			
License No:		Expiration Date:	
Name of License:			
Licensing Agency:			
License No:		Expiration Date:	

ARTICLE 3—DIVERSE BUSINESS CERTIFICATIONS

3.1 Provide information regarding Business's Diverse Business Certification, if any. Provide evidence of current certification.

Certification	Certifying Agency	Certification Date
☐ Disadvantaged Business Enterprise		
☐ Minority Business Enterprise		
☐ Woman-Owned Business Enterprise		
☐ Small Business Enterprise		
☐ Disabled Business Enterprise		
☐ Veteran-Owned Business Enterprise		
☐ Service-Disabled Veteran-Owned Business		
☐ HUBZone Business (Historically Underutilized) Business		
☐ Other		
☐ None		

ARTICLE 4—SAFETY

4.1 Provide information regarding Business's safety organization and safety performance.

Name of Business's Safety Officer:		
Safety Certifications		
Certification Name	Issuing Agency	Expiration

4.2 Provide Worker's Compensation Insurance Experience Modification Rate (EMR), Total Recordable Frequency Rate (TRFR) for incidents, and Total Number of Recorded Manhours (MH) for the last 3 years and the EMR, TRFR, and MH history for the last 3 years of any proposed Subcontractor(s) that will provide Work valued at 10% or more of the Contract Price. Provide documentation of the EMR history for Business and Subcontractor(s).

Year									
Company	EMR	TRFR	MH	EMR	TRFR	MH	EMR	TRFR	MH

ARTICLE 5—FINANCIAL

5.1 Provide information regarding the Business's financial stability. Provide the most recent audited financial statement, and if such audited financial statement is not current, also provide the most current financial statement.

Financial Institution:		
Business address:		
Date of Business's most recent financial statement:		☐ Attached
Date of Business's most recent audited financial statement:		☐ Attached
Financial indicators from the most recent financial statement		
Contractor's Current Ratio (Current Assets ÷ Current Liabilities)		
Contractor's Quick Ratio ((Cash and Cash Equivalents + Accounts Receivable + Short Term Investments) ÷ Current Liabilities)		

ARTICLE 6—SURETY INFORMATION

6.1 Provide information regarding the surety company that will issue required bonds on behalf of the Business, including but not limited to performance and payment bonds.

Surety Name:			
Surety is a corporation organized and existing under the laws of the state of:			
Is surety authorized to provide surety bonds in the Project location?		☐ Yes ☐ No	
Is surety listed in "Companies Holding Certificates of Authority as Acceptable Sureties on Federal Bonds and as Acceptable Reinsuring Companies" published in Department Circular 570 (as amended) by the Bureau of the Fiscal Service, U.S. Department of the Treasury? ☐ Yes ☐ No			
Mailing Address (principal place of business):			
Physical Address (principal place of business):			
Phone (main):		Phone (claims):	

ARTICLE 7—INSURANCE

7.1 Provide information regarding Business's insurance company(s), including but not limited to its Commercial General Liability carrier. Provide information for each provider.

Name of insurance provider, and type of policy (CLE, auto, etc.):			
Insurance Provider		Type of Policy (Coverage Provided)	
Are providers licensed or authorized to issue policies in the Project location?			☐ Yes ☐ No
Does provider have an A.M. Best Rating of A-VII or better?			☐ Yes ☐ No
Mailing Address (principal place of business):			
Physical Address (principal place of business):			
Phone (main):		Phone (claims):	

ARTICLE 8—CONSTRUCTION EXPERIENCE

8.1 Provide information regarding the Business's previous contracting experience.

Years of experience with projects like the proposed project:				
As a general contractor:		As a joint venturer:		
Has Business, or a predecessor in interest, or an affiliate identified in Paragraph 1.03:				
Been disqualified as a bidder by any local, state, or federal agency within the last 5 years? ☐ Yes ☐ No				
Been barred from contracting by any local, state, or federal agency within the last 5 years? ☐ Yes ☐ No				
Been released from a bid in the past 5 years? ☐ Yes ☐ No				
Defaulted on a project or failed to complete any contract awarded to it? ☐ Yes ☐ No				
Refused to construct or refused to provide materials defined in the contract documents or in a change order? ☐ Yes ☐ No				
Been a party to any currently pending litigation or arbitration? ☐ Yes ☐ No				
Provide full details in a separate attachment if the response to any of these questions is Yes.				

ARTICLE 9—REQUIRED ATTACHMENTS

9.1 Provide the following information with the Statement of Qualifications:

A. If Business is a Joint Venture, separate Qualifications Statements for each Joint Venturer, as required in Paragraph 1.02.

B. Diverse Business Certifications if required by Paragraph 3.01.

C. Certification of Business's safety performance if required by Paragraph 4.02.

D. Financial statements as required by Paragraph 5.01.

E. Additional items as pertinent.

This Statement of Qualifications is offered by:

Business: _____
(typed or printed name of organization)

By: _____
(individual's signature)

Name: _____
(typed or printed)

Title: _____
(typed or printed)

Date: _____
(date signed)

(If Business is a corporation, a partnership, or a joint venture, attach evidence of authority to sign.)

Attest: _____
(individual's signature)

Name: _____
(typed or printed)

Title: _____
(typed or printed)

Address for giving notices:

_____

_____

_____

Designated Representative:

Name: _____
(typed or printed)

Title: _____
(typed or printed)

Address:

_____

_____

_____

Phone: _____

Email: _____

SECTION 00 45 14 – BIDDER'S REFERENCE FORM

Bidder's Name: _____

Project Title: **Little River Dam Removal and River Restoration**

The bidder must provide five (5) business references for similar projects performed & completed within the past five (5) years. Include dam removal work, as well as applicable ecological restoration and/or in-water work.

(1) Reference Name:_____ Contact: _____

Address:_____ Phone: ( ) _____

Contract Value: _____ Prime or Subcontractor: _____

Description and date(s) of work:

_____

_____

(2) Reference Name:_____ Contact: _____

Address:_____ Phone: ( ) _____

Contract Value: _____ Prime or Subcontractor: _____

Description and date(s) of work:

_____

_____

(3) Reference Name:_____ Contact: _____

Address:_____ Phone: ( ) _____

Contract Value: _____ Prime or Subcontractor: _____

Description and date(s) of work:

_____

_____

(4) Reference Name:_____ Contact: _____

Address:_____ Phone: ( ) _____

Contract Value: _____ Prime or Subcontractor: _____

Description and date(s) of work:

_____

_____

(5) Reference Name:_____ Contact: _____

Address:_____ Phone: ( ) _____

Contract Value: _____ Prime or Subcontractor: _____

Description and date(s) of work:

_____

_____

References will be contacted to confirm the bidder's skills, abilities and qualifications to faithfully perform the work specified. The Authority reserves the right to contact references not listed above. The Bidder will be given the opportunity to explain any unfavorable references received from such outreach.

SECTION 00330 - NON-COLLUSION AFFIDAVIT OF BIDDER

Commonwealth of: _____

County of: _____

_____; being first duly sworn, deposes and says that:

1) They are (owner, partner, officer, representative or agent) of _____, the Bidder that has submitted the attached Bid:

2) They are fully informed regarding the preparation and contents of the attached Bid and of all pertinent circumstances regarding such Bid:

3) Such Bid is genuine and is not a collusive or sham Bid:

4) Neither the said Bidder nor any of its officers, partners, owner, agents, representatives, employees or parties in interest, including this affiant, has in any way colluded, conspired, connived, or agreed, directly or indirectly with any other Bidder, firm or person to submit a collusive or sham Bid in connection with the Contract for which the attached Bid has been submitted or to refrain from bidding in connection with such Contract, or has in any manner, directly or indirectly, sought by agreement or collusion or communication or conference with any other Bidder, firm or person to fix the price or prices in the attached Bid or of any Bidder, or to fix any overhead, profit or cost element of the bid price or the bid price of any other Bidder or to secure through any collusion, conspiracy, connivance or unlawful agreement any advantage with the Owner or any person interested in the proposed Contract.

5) The price quoted in the attached Bid is fair and proper and is not tainted by collusion, conspiracy, connivance or unlawful agreement on the part of the Bidder or any of its agents, representatives, owners, employees, or parties in interest.

Signed: _____

Title: _____

Subscribed and sworn before me this _____ day of _____ , 20 _____ .

Notary Public: _____

My Commission expires: _____

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SECTION 00510 – NOTICE OF AWARD

Date of Issuance:

Owner:	City of Haverhill	Owner's Contract No.:	-
Designer:	Fuss & O'Neill, Inc.	Designer's Project No.:	20170390.U40
Project:	**Little River Dam Removal and River Restoration**	Contract Name:	-

Bidder:

Bidder's Address:

TO BIDDER:

You are notified that Owner has accepted your Bid dated [_____] for the above Contract, and that you are the Successful Bidder and are awarded a Contract for:

_____ .

[describe Work, alternates, or sections of Work awarded]

The Contract Price of the awarded Contract is: $_____ *[note if subject to unit prices, or cost-plus]*

[ ] unexecuted counterparts of the Agreement accompany this Notice of Award, and one copy of the Contract Documents accompanies this Notice of Award, or has been transmitted or made available to Bidder electronically. *[revise if multiple copies accompany the Notice of Award]*

☐ a set of the Drawings will be delivered separately from the other Contract Documents.

You must comply with the following conditions precedent within 15 days of the date of receipt of this Notice of Award:

1. Deliver to Owner [____]counterparts of the Agreement, fully executed by Bidder
2. Deliver with the executed Agreement(s) the Contract security *[e.g., performance and payment bonds]* and insurance documentation as specified in the Instructions to Bidders and General Conditions, Articles 2 and 6.
3. Other conditions precedent (if any):

Failure to comply with these conditions within the time specified will entitle Owner to consider you in default, annul this Notice of Award, and declare your Bid security forfeited.

Within ten days after you comply with the above conditions, Owner will return to you one fully executed counterpart of the Agreement, together with any additional copies of the Contract Documents as indicated in Paragraph 2.02 of the General Conditions.

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IN WITNESS WHEREOF, the parties have hereto and to two other identical instruments set their hands and seal the day first above written.

Approved as to Form:

_____

City Solicitor

_____

Witness

FOR THE CONTRACTOR:

By: _____

City of Haverhill:

_____

Melinda E. Barrett
Mayor

_____

Steven S. Bucuzzo
Purchasing Director

_____

Robert E. Ward
Public Works Director

Corporate Secretary:

_____

Certified as to Availability of Funding Pursuant to M.G.L.ch.44 §31(c):

_____

Angel Wills
Director of Finance & City Auditor

Copy: Fuss & O'Neill, Inc.

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AGREEMENT BETWEEN OWNER AND CONTRACTOR FOR CONSTRUCTION CONTRACT (STIPULATED PRICE)

This Agreement is by and between the **City of Haverhill** ("Owner") and **[name of contracting entity]** ("Contractor").

Terms used in this Agreement have the meanings stated in the General Conditions and the Supplementary Conditions.

Owner and Contractor hereby agree as follows:

ARTICLE 1—WORK

1.01 Contractor shall complete all Work as specified or indicated in the Contract Documents. The Work is generally described as follows: Selective demolition of the Little River Dam, dredging and disposal of contaminated sediments from within the Little River Dam impoundment, earthwork to reshape the Little River channel and banks from approximately the MBTA bridge to just south of Winter Street, and construction of community amenity/river access features at Cashman Park (fishing access, canoe/kayak launch, access trails) and Winter Street (overlook/pocket park). Installation of a pedestrian bridge and walking trail along the east side of Little River may be included as add-alternates.

1.02 The Owner is in the process of obtaining ownership of the dam and water rights, with an anticipated completion date of June 2026, and this agreement for the Work shall be contingent on the Owner securing such ownership and rights

ARTICLE 2—THE PROJECT

2.01 The Project, of which the Work under the Contract Documents is a part, is generally described as follows:

- Removal of the Little River Dam and existing impoundment to restore the natural flow of the river, restore land area along the river's edge, and provide flood protection.
- Restoration of the river corridor including installation of a nature-like fishway, installation of scour protection beneath the Winter Street and MBTA bridges, and native plantings.
- Construction of improved river access points at Cashman Park and a pocket park/overlook at Winter Street.

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ARTICLE 3—DESIGNER

3.01 The Owner has retained Fuss & O'Neill ("Designer" or "Engineer" or "Landscape Architect") to act as Owner's Representative, assume all duties and responsibilities of Engineer, and have the rights and authority assigned to Engineer in the Contract.

3.02 The part of the Project that pertains to the Work has been designed by Fuss & O'Neill.

ARTICLE 4—CONTRACT TIMES

4.01 *Time is of the Essence*

A. All time limits for Milestones, if any, Substantial Completion, and completion and readiness for final payment as stated in the Contract Documents are of the essence of the Contract.

4.02 *Contract Times: Dates*

A. Work under the Base Bid will be substantially completed by **November 30, 2027**, and completed and ready for final payment in accordance with Paragraph 15.06 of the General Conditions by **June 1, 2028**.

4.03 *Liquidated Damages*

A. Contractor and Owner recognize that time is of the essence as stated in Paragraph 4.01 above and that Owner will suffer financial and other losses if the Work is not completed and Milestones not achieved within the Contract Times, as duly modified. The parties also recognize the delays, expense, and difficulties involved in proving, in a legal or arbitration proceeding, the actual loss suffered by Owner if the Work is not completed on time. Accordingly, instead of requiring any such proof, Owner and Contractor agree that as liquidated damages for delay (but not as a penalty):

1. *Substantial Completion:* Contractor shall pay Owner $1,500.00 for each day that expires after the time (as duly adjusted pursuant to the Contract) specified above for Substantial Completion, until the Work is substantially complete.

2. *Completion of Remaining Work:* After Substantial Completion, if Contractor shall neglect, refuse, or fail to complete the remaining Work within the Contract Times (as duly adjusted pursuant to the Contract) for completion and readiness for final payment, Contractor shall pay Owner $1,500.00 for each day that expires after such time until the Work is completed and ready for final payment.

4. Liquidated damages for failing to timely attain Milestones, Substantial Completion, and final completion are not additive, and will not be imposed concurrently.

B. If Owner recovers liquidated damages for a delay in completion by Contractor, then such liquidated damages are Owner's sole and exclusive remedy for such delay, and Owner is precluded from recovering any other damages, whether actual, direct, excess, or consequential, for such delay, except for special damages (if any) specified in this Agreement.

4.04 *Special Damages*

A. Contractor shall reimburse Owner (1) for any fines or penalties imposed on Owner as a direct result of the Contractor's failure to attain Substantial Completion according to the Contract Times, and (2) for the actual costs reasonably incurred by Owner for engineering, construction observation, inspection, and administrative services needed after the time specified in

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Paragraph 4.02 for Substantial Completion (as duly adjusted pursuant to the Contract), until the Work is substantially complete.

B. After Contractor achieves Substantial Completion, if Contractor shall neglect, refuse, or fail to complete the remaining Work within the Contract Times, Contractor shall reimburse Owner for the actual costs reasonably incurred by Owner for engineering, construction observation, inspection, and administrative services needed after the time specified in Paragraph 4.02 for Work to be completed and ready for final payment (as duly adjusted pursuant to the Contract), until the Work is completed and ready for final payment.

C. The special damages imposed in this paragraph are supplemental to any liquidated damages for delayed completion established in this Agreement.

ARTICLE 5—CONTRACT PRICE

5.01 Owner shall pay Total of Lump Sum Amount and Unit Price Work (subject to final Unit Price adjustment):_____ , which include the base bid work and Add Alternates_____.

A. For all Work, at the prices stated in Contractor's Bid, attached hereto as an exhibit.

ARTICLE 6—PAYMENT PROCEDURES

6.01 *Submittal and Processing of Payments*

A. Contractor shall submit Applications for Payment in accordance with Article 15 of the General Conditions. Applications for Payment will be processed by Engineer as provided in the General Conditions.

6.02 *Progress Payments; Retainage*

A. Owner shall make progress payments on the basis of Contractor's Applications for Payment on or about the last day of each month during performance of the Work as provided in Paragraph 6.02.A.1 below, provided that such Applications for Payment have been submitted in a timely manner and otherwise meet the requirements of the Contract. All such payments will be measured by the Schedule of Values established as provided in the General Conditions (and in the case of Unit Price Work based on the number of units completed) or, in the event there is no Schedule of Values, as provided elsewhere in the Contract.

1. Prior to Substantial Completion, progress payments will be made in an amount equal to the percentage indicated below but, in each case, less the aggregate of payments previously made and less such amounts as Owner may withhold, including but not limited to liquidated damages, in accordance with the Contract.

a. 95 percent of the value of the Work completed (with the balance being retainage).

1) If 50 percent or more of the Work has been completed, as determined by Engineer, and if the character and progress of the Work have been satisfactory to Owner and Engineer, then as long as the character and progress of the Work remain satisfactory to Owner and Engineer, there will be no additional retainage; and

b. 95 percent of cost of materials and equipment not incorporated in the Work (with the balance being retainage).

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B. Upon Substantial Completion, Owner shall pay an amount sufficient to increase total payments to Contractor to 100 percent of the Work completed, less such amounts set off by Owner pursuant to Paragraph 15.01.E of the General Conditions, and less 200 percent of Engineer's estimate of the value of Work to be completed or corrected as shown on the punch list of items to be completed or corrected prior to final payment.

6.03 *Final Payment*

A. Upon final completion and acceptance of the Work, Owner shall pay the remainder of the Contract Price in accordance with Paragraph 15.06 of the General Conditions.

6.04 *Consent of Surety*

A. Owner will not make final payment, or return or release retainage at Substantial Completion or any other time, unless Contractor submits written consent of the surety to such payment, return, or release.

6.05 *Interest*

A. The Owner will generally pay monthly payment requisitions within 30 days; however, there are cases where it may take longer due to grant reimbursement timelines. In these cases, the Owner will not pay interest or late fees.

ARTICLE 7—CONTRACT DOCUMENTS

7.01 *Contents*

A. The Contract Documents consist of all of the following:

1. This Agreement.
2. Bonds:
    a. Performance bond (together with power of attorney).
    b. Payment bond (together with power of attorney).
3. General Conditions.
4. Supplementary Conditions.
5. Specifications as listed in the table of contents of the project manual (copy of list attached).
6. Drawings listed on the attached sheet index.
7. Addenda (numbers **[number]** to **[number]**, inclusive).
8. Exhibits to this Agreement (enumerated as follows):
    a. Contractor's Bid (pages ___ to ___, inclusive).
    b. All permits as listed in the table of contents of the project manual.
9. The following which may be delivered or issued on or after the Effective Date of the Contract and are not attached hereto:
    a. Notice to Proceed.
    b. Work Change Directives.
    c. Change Orders.

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d. Field Orders.

e. Warranty Bond, if any.

B. The Contract Documents listed in Paragraph 7.01.A are attached to this Agreement (except as expressly noted otherwise above).

C. There are no Contract Documents other than those listed above in this Article 7.

D. The Contract Documents may only be amended, modified, or supplemented as provided in the Contract.

ARTICLE 8—REPRESENTATIONS, CERTIFICATIONS, AND STIPULATIONS

8.01 *Contractor's Representations*

A. In order to induce Owner to enter into this Contract, Contractor makes the following representations:

1. Contractor has examined and carefully studied the Contract Documents, including Addenda.

2. Contractor has visited the Site, conducted a thorough visual examination of the Site and adjacent areas, and become familiar with the general, local, and Site conditions that may affect cost, progress, and performance of the Work.

3. Contractor is familiar with all Laws and Regulations that may affect cost, progress, and performance of the Work.

4. Contractor has carefully studied the reports of explorations and tests of subsurface conditions at or adjacent to the Site and the drawings of physical conditions relating to existing surface or subsurface structures at the Site that have been identified in the Supplementary Conditions, with respect to the Technical Data in such reports and drawings.

5. Contractor has carefully studied the reports and drawings relating to Hazardous Environmental Conditions, if any, at or adjacent to the Site that have been identified in the Supplementary Conditions, with respect to Technical Data in such reports and drawings.

6. Contractor has considered the information known to Contractor itself; information commonly known to contractors doing business in the locality of the Site; information and observations obtained from visits to the Site; the Contract Documents; and the Technical Data identified in the Supplementary Conditions or by definition, with respect to the effect of such information, observations, and Technical Data on (a) the cost, progress, and performance of the Work; (b) the means, methods, techniques, sequences, and procedures of construction to be employed by Contractor; and (c) Contractor's safety precautions and programs.

7. Based on the information and observations referred to in the preceding paragraph, Contractor agrees that no further examinations, investigations, explorations, tests, studies, or data are necessary for the performance of the Work at the Contract Price, within the Contract Times, and in accordance with the other terms and conditions of the Contract.

8. Contractor is aware of the general nature of work to be performed by Owner and others at the Site that relates to the Work as indicated in the Contract Documents.

9. Contractor has given Engineer written notice of all conflicts, errors, ambiguities, or discrepancies that Contractor has discovered in the Contract Documents, and of discrepancies between Site conditions and the Contract Documents, and the written resolution thereof by Engineer is acceptable to Contractor.

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10. The Contract Documents are generally sufficient to indicate and convey understanding of all terms and conditions for performance and furnishing of the Work.

11. Contractor's entry into this Contract constitutes an incontrovertible representation by Contractor that without exception all prices in the Agreement are premised upon performing and furnishing the Work required by the Contract Documents.

8.02 *Contractor's Certifications*

A. Contractor certifies that it has not engaged in corrupt, fraudulent, collusive, or coercive practices in competing for or in executing the Contract. For the purposes of this Paragraph 8.02:

1. "corrupt practice" means the offering, giving, receiving, or soliciting of anything of value likely to influence the action of a public official in the bidding process or in the Contract execution;

2. "fraudulent practice" means an intentional misrepresentation of facts made (a) to influence the bidding process or the execution of the Contract to the detriment of Owner, (b) to establish Bid or Contract prices at artificial non-competitive levels, or (c) to deprive Owner of the benefits of free and open competition;

3. "collusive practice" means a scheme or arrangement between two or more Bidders, with or without the knowledge of Owner, a purpose of which is to establish Bid prices at artificial, non-competitive levels; and

4. "coercive practice" means harming or threatening to harm, directly or indirectly, persons or their property to influence their participation in the bidding process or affect the execution of the Contract.

8.03 *Standard General Conditions*

A. Owner stipulates that if the General Conditions that are made a part of this Contract are EJCDC® C-700, Standard General Conditions for the Construction Contract (2018), published by the Engineers Joint Contract Documents Committee, and if Owner is the party that has furnished said General Conditions, then Owner has plainly shown all modifications to the standard wording of such published document to the Contractor, through a process such as highlighting or "track changes" (redline/strikeout), or in the Supplementary Conditions.

B. This Contract must include a certification of tax compliance by the Contractor, as required by Chapter 62C, Section 49A of the General Laws of Massachusetts (Requirement of Tax Compliance by All Contractors Providing Goods, Services, or Real Estate Space to the Commonwealth or Subdivision).

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This Agreement will be effective on **[indicate date on which Contract becomes effective]** (which is the Effective Date of the Contract).

Owner:

_____
(typed or printed name of organization)

Address for giving notices:

_____

_____

_____

Designated Representative:

Name: _____
(typed or printed)

Title: _____
(typed or printed)

Address:

_____

_____

_____

Phone: _____

Email: _____

Contractor:

_____
(typed or printed name of organization)

Address for giving notices:

_____

_____

_____

Designated Representative:

Name: _____
(typed or printed)

Title: _____
(typed or printed)

Address:

_____

_____

_____

Phone: _____

Email: _____

License No.: _____
(where applicable)

State: _____

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IN WITNESS WHEREOF, the parties have hereto and to two other identical instruments set their hands and seal the day first above written.

Approved as to Form:

_____

City Solicitor

_____

Witness

FOR THE CONTRACTOR:

By: _____

(If Contractor is a corporation, attach evidence of authority to sign.)

City of Haverhill:

_____

Melinda E. Barrett

Mayor

_____

Steven S. Bucuzzo

Purchasing Director

_____

Robert E. Ward

Public Works Director

Corporate Secretary:
§31(c):

_____

Certified as to Availability of Funding Pursuant to M.G.L.ch.44

_____

Angel Perkins
Director of Finance & City Auditor

Copy: Fuss & O'Neill, Inc.

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SECTION 00 55 00 - NOTICE TO PROCEED

Owner:	City of Haverhill	Owner's Contract No.:	
Contractor:		Contractor's Project No.:	
Designer:	Fuss & O'Neill, Inc.	Engineer's Project No.:	20170390.U40
Project:	Little River Dam Removal and River Restoration	Contract Name:	
		Effective Date of Contract:	

TO CONTRACTOR:

Owner hereby notifies Contractor that the Contract Times under the above Contract will commence to run on [_____, 20__]. *[see Paragraph 4.01 of the General Conditions]*

On that date, Contractor shall start performing its obligations under the Contract Documents. No Work shall be done at the Site prior to such date. In accordance with the Agreement, [the date of Substantial Completion is _____, and the date of readiness for final payment is_____] ***or*** [the number of days to achieve Substantial Completion is _____, and the number of days to achieve readiness for final payment is _____]

Before starting any Work at the Site, Contractor must comply with the following:

[Note any access limitations, security procedures, or other restrictions]

IN WITNESS WHEREOF, the parties have hereto and to two other identical instruments set their hands and seal the day first above written.

Approved as to Form:

_____

City Solicitor

_____

Witness

FOR THE CONTRACTOR:

By: _____

Corporate Secretary:

_____

City of Haverhill:

_____

Melinda E. Barrett
Mayor

_____

Steven S. Bucuzzo
Purchasing Director

_____

Robert E. Ward
Public Works Director

Certified as to Availability of Funding Pursuant to M.G.L.ch.44 §31(c):

_____

Angel Perkins
Director of Finance & City Auditor

Copy: Fuss & O'Neill, Inc.

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PERFORMANCE BOND

Contractor Name: **[Full formal name of Contractor]** Address *(principal place of business)*: **[Address of Contractor's principal place of business]**	**Surety** Name: **[Full formal name of Surety]** Address *(principal place of business)*: **[Address of Surety's principal place of business]**
Owner Name: **City of Haverhill** Mailing address *(principal place of business)*: **4 Summer Street, Room 105** **Haverhill, MA 01830**	**Contract** Description *(name and location)*: **Little River Dam Removal and River Restoration** Haverhill, MA Contract Price: **[Amount from Contract]** Effective Date of Contract: **[Date from Contract]**

Bond

Bond Amount: **[Amount]**

Date of Bond: **[Date]**

(Date of Bond cannot be earlier than Effective Date of Contract)

Modifications to this Bond form:

☐ None ☐ See Paragraph 16

Surety and Contractor, intending to be legally bound hereby, subject to the terms set forth in this Performance Bond, do each cause this Performance Bond to be duly executed by an authorized officer, agent, or representative.

Contractor as Principal	Surety
(Full formal name of Contractor)	*(Full formal name of Surety) (corporate seal)*
By: _____ *(Signature)*	By: _____ *(Signature)(Attach Power of Attorney)*
Name: _____ *(Printed or typed)*	Name: _____ *(Printed or typed)*
Title: _____	Title: _____
Attest: _____ *(Signature)*	Attest: _____ *(Signature)*
Name: _____ *(Printed or typed)*	Name: _____ *(Printed or typed)*
Title: _____	Title: _____

EJCDC® C-610, Performance Bond.
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Notes: (1) Provide supplemental execution by any additional parties, such as joint venturers. (2) Any singular reference to Contractor, Surety, Owner, or other party is considered plural where applicable.

1. The Contractor and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors, and assigns to the Owner for the performance of the Construction Contract, which is incorporated herein by reference.

2. If the Contractor performs the Construction Contract, the Surety and the Contractor shall have no obligation under this Bond, except when applicable to participate in a conference as provided in Paragraph 3.

3. If there is no Owner Default under the Construction Contract, the Surety's obligation under this Bond will arise after:

    3.1. The Owner first provides notice to the Contractor and the Surety that the Owner is considering declaring a Contractor Default. Such notice may indicate whether the Owner is requesting a conference among the Owner, Contractor, and Surety to discuss the Contractor's performance. If the Owner does not request a conference, the Surety may, within five (5) business days after receipt of the Owner's notice, request such a conference. If the Surety timely requests a conference, the Owner shall attend. Unless the Owner agrees otherwise, any conference requested under this Paragraph 3.1 will be held within ten (10) business days of the Surety's receipt of the Owner's notice. If the Owner, the Contractor, and the Surety agree, the Contractor shall be allowed a reasonable time to perform the Construction Contract, but such an agreement does not waive the Owner's right, if any, subsequently to declare a Contractor Default;

    3.2. The Owner declares a Contractor Default, terminates the Construction Contract and notifies the Surety; and

    3.3. The Owner has agreed to pay the Balance of the Contract Price in accordance with the terms of the Construction Contract to the Surety or to a contractor selected to perform the Construction Contract.

4. Failure on the part of the Owner to comply with the notice requirement in Paragraph 3.1 does not constitute a failure to comply with a condition precedent to the Surety's obligations, or release the Surety from its obligations, except to the extent the Surety demonstrates actual prejudice.

5. When the Owner has satisfied the conditions of Paragraph 3, the Surety shall promptly and at the Surety's expense take one of the following actions:

    5.1. Arrange for the Contractor, with the consent of the Owner, to perform and complete the Construction Contract;

    5.2. Undertake to perform and complete the Construction Contract itself, through its agents or independent contractors;

    5.3. Obtain bids or negotiated proposals from qualified contractors acceptable to the Owner for a contract for performance and completion of the Construction Contract, arrange for a contract to be prepared for execution by the Owner and a contractor selected with the Owners concurrence, to be secured with performance and payment bonds executed by a qualified surety equivalent to the bonds issued on the Construction Contract, and pay to the Owner the amount of damages as described in Paragraph 7 in excess of the Balance of the Contract Price incurred by the Owner as a result of the Contractor Default; or

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5.4. Waive its right to perform and complete, arrange for completion, or obtain a new contractor, and with reasonable promptness under the circumstances:

5.4.1 After investigation, determine the amount for which it may be liable to the Owner and, as soon as practicable after the amount is determined, make payment to the Owner; or

5.4.2 Deny liability in whole or in part and notify the Owner, citing the reasons for denial.

6. If the Surety does not proceed as provided in Paragraph 5 with reasonable promptness, the Surety shall be deemed to be in default on this Bond seven days after receipt of an additional written notice from the Owner to the Surety demanding that the Surety perform its obligations under this Bond, and the Owner shall be entitled to enforce any remedy available to the Owner. If the Surety proceeds as provided in Paragraph 5.4, and the Owner refuses the payment, or the Surety has denied liability, in whole or in part, without further notice, the Owner shall be entitled to enforce any remedy available to the Owner.

7. If the Surety elects to act under Paragraph 5.1, 5.2, or 5.3, then the responsibilities of the Surety to the Owner will not be greater than those of the Contractor under the Construction Contract, and the responsibilities of the Owner to the Surety will not be greater than those of the Owner under the Construction Contract. Subject to the commitment by the Owner to pay the Balance of the Contract Price, the Surety is obligated, without duplication for:

7.1. the responsibilities of the Contractor for correction of defective work and completion of the Construction Contract;

7.2. additional legal, design professional, and delay costs resulting from the Contractor's Default, and resulting from the actions or failure to act of the Surety under Paragraph 5; and

7.3. liquidated damages, or if no liquidated damages are specified in the Construction Contract, actual damages caused by delayed performance or non-performance of the Contractor.

8. If the Surety elects to act under Paragraph 5.1, 5.3, or 5.4, the Surety's liability is limited to the amount of this Bond.

9. The Surety shall not be liable to the Owner or others for obligations of the Contractor that are unrelated to the Construction Contract, and the Balance of the Contract Price will not be reduced or set off on account of any such unrelated obligations. No right of action will accrue on this Bond to any person or entity other than the Owner or its heirs, executors, administrators, successors, and assigns.

10. The Surety hereby waives notice of any change, including changes of time, to the Construction Contract or to related subcontracts, purchase orders, and other obligations.

11. Any proceeding, legal or equitable, under this Bond must be instituted in any court of competent jurisdiction in the location in which the work or part of the work is located and must be instituted within two years after a declaration of Contractor Default or within two years after the Contractor ceased working or within two years after the Surety refuses or fails to perform its obligations under this Bond, whichever occurs first. If the provisions of this paragraph are void or prohibited by law, the minimum periods of limitations available to sureties as a defense in the jurisdiction of the suit will be applicable.

12. Notice to the Surety, the Owner, or the Contractor must be mailed or delivered to the address shown on the page on which their signature appears.

13. When this Bond has been furnished to comply with a statutory or other legal requirement in the location where the construction was to be performed, any provision in this Bond conflicting with said statutory or legal requirement will be deemed deleted therefrom and provisions conforming to such statutory or other

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legal requirement will be deemed incorporated herein. When so furnished, the intent is that this Bond will be construed as a statutory bond and not as a common law bond.

14. Definitions

    14.1. *Balance of the Contract Price*—The total amount payable by the Owner to the Contractor under the Construction Contract after all proper adjustments have been made including allowance for the Contractor for any amounts received or to be received by the Owner in settlement of insurance or other claims for damages to which the Contractor is entitled, reduced by all valid and proper payments made to or on behalf of the Contractor under the Construction Contract.

    14.2. *Construction Contract*—The agreement between the Owner and Contractor identified on the cover page, including all Contract Documents and changes made to the agreement and the Contract Documents.

    14.3. *Contractor Default*—Failure of the Contractor, which has not been remedied or waived, to perform or otherwise to comply with a material term of the Construction Contract.

    14.4. *Owner Default*—Failure of the Owner, which has not been remedied or waived, to pay the Contractor as required under the Construction Contract or to perform and complete or comply with the other material terms of the Construction Contract.

    14.5. *Contract Documents*—All the documents that comprise the agreement between the Owner and Contractor.

15. If this Bond is issued for an agreement between a contractor and subcontractor, the term Contractor in this Bond will be deemed to be Subcontractor and the term Owner will be deemed to be Contractor.

16. Modifications to this Bond are as follows: **[Describe modification or enter "None"]**

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PAYMENT BOND

Contractor Name: **[Full formal name of Contractor]** Address *(principal place of business)*: **[Address of Contractor's principal place of business]**	**Surety** Name: **[Full formal name of Surety]** Address *(principal place of business)*: **[Address of Surety's principal place of business]**
Owner Name: **City of Haverhill** Mailing address *(principal place of business)*: **4 Summer Street, Room 105** **Haverhill, MA 01830**	**Contract** Description *(name and location)*: **Little River Dam Removal and River Restoration** Haverhill, MA Contract Price: **[Amount, from Contract]** Effective Date of Contract: **[Date, from Contract]**

Bond

Bond Amount: **[Amount]**

Date of Bond: **[Date]**

(Date of Bond cannot be earlier than Effective Date of Contract)

Modifications to this Bond form:

☐ None ☐ See Paragraph 18

Surety and Contractor, intending to be legally bound hereby, subject to the terms set forth in this Payment Bond, do each cause this Payment Bond to be duly executed by an authorized officer, agent, or representative.

Contractor as Principal	Surety
(Full formal name of Contractor)	*(Full formal name of Surety) (corporate seal)*
By: _____ *(Signature)*	By: _____ *(Signature)(Attach Power of Attorney)*
Name: _____ *(Printed or typed)*	Name: _____ *(Printed or typed)*
Title: _____	Title: _____
Attest: _____ *(Signature)*	Attest: _____ *(Signature)*
Name: _____ *(Printed or typed)*	Name: _____ *(Printed or typed)*
Title: _____	Title: _____

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Notes: (1) Provide supplemental execution by any additional parties, such as joint venturers. (2) Any singular reference to Contractor, Surety, Owner, or other party is considered plural where applicable.

1. The Contractor and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors, and assigns to the Owner to pay for labor, materials, and equipment furnished for use in the performance of the Construction Contract, which is incorporated herein by reference, subject to the following terms.

2. If the Contractor promptly makes payment of all sums due to Claimants, and defends, indemnifies, and holds harmless the Owner from claims, demands, liens, or suits by any person or entity seeking payment for labor, materials, or equipment furnished for use in the performance of the Construction Contract, then the Surety and the Contractor shall have no obligation under this Bond.

3. If there is no Owner Default under the Construction Contract, the Surety's obligation to the Owner under this Bond will arise after the Owner has promptly notified the Contractor and the Surety (at the address described in Paragraph 13) of claims, demands, liens, or suits against the Owner or the Owner's property by any person or entity seeking payment for labor, materials, or equipment furnished for use in the performance of the Construction Contract, and tendered defense of such claims, demands, liens, or suits to the Contractor and the Surety.

4. When the Owner has satisfied the conditions in Paragraph 3, the Surety shall promptly and at the Surety's expense defend, indemnify, and hold harmless the Owner against a duly tendered claim, demand, lien, or suit.

5. The Surety's obligations to a Claimant under this Bond will arise after the following:

    5.1. Claimants who do not have a direct contract with the Contractor

        5.1.1. have furnished a written notice of non-payment to the Contractor, stating with substantial accuracy the amount claimed and the name of the party to whom the materials were, or equipment was, furnished or supplied or for whom the labor was done or performed, within ninety (90) days after having last performed labor or last furnished materials or equipment included in the Claim; and

        5.1.2. have sent a Claim to the Surety (at the address described in Paragraph 13).

    5.2. Claimants who are employed by or have a direct contract with the Contractor have sent a Claim to the Surety (at the address described in Paragraph 13).

6. If a notice of non-payment required by Paragraph 5.1.1 is given by the Owner to the Contractor, that is sufficient to satisfy a Claimant's obligation to furnish a written notice of non-payment under Paragraph 5.1.1.

7. When a Claimant has satisfied the conditions of Paragraph 5.1 or 5.2, whichever is applicable, the Surety shall promptly and at the Surety's expense take the following actions:

    7.1. Send an answer to the Claimant, with a copy to the Owner, within sixty (60) days after receipt of the Claim, stating the amounts that are undisputed and the basis for challenging any amounts that are disputed; and

    7.2. Pay or arrange for payment of any undisputed amounts.

    7.3. The Surety's failure to discharge its obligations under Paragraph 7.1 or 7.2 will not be deemed to constitute a waiver of defenses the Surety or Contractor may have or acquire as to a Claim, except as to undisputed amounts for which the Surety and Claimant have reached agreement. If, however, the Surety fails to discharge its obligations under Paragraph 7.1 or 7.2, the Surety shall indemnify the

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Claimant for the reasonable attorney's fees the Claimant incurs thereafter to recover any sums found to be due and owing to the Claimant.

8. The Surety's total obligation will not exceed the amount of this Bond, plus the amount of reasonable attorney's fees provided under Paragraph 7.3, and the amount of this Bond will be credited for any payments made in good faith by the Surety.

9. Amounts owed by the Owner to the Contractor under the Construction Contract will be used for the performance of the Construction Contract and to satisfy claims, if any, under any construction performance bond. By the Contractor furnishing and the Owner accepting this Bond, they agree that all funds earned by the Contractor in the performance of the Construction Contract are dedicated to satisfying obligations of the Contractor and Surety under this Bond, subject to the Owner's priority to use the funds for the completion of the work.

10. The Surety shall not be liable to the Owner, Claimants, or others for obligations of the Contractor that are unrelated to the Construction Contract. The Owner shall not be liable for the payment of any costs or expenses of any Claimant under this Bond, and shall have under this Bond no obligation to make payments to or give notice on behalf of Claimants, or otherwise have any obligations to Claimants under this Bond.

11. The Surety hereby waives notice of any change, including changes of time, to the Construction Contract or to related subcontracts, purchase orders, and other obligations.

12. No suit or action will be commenced by a Claimant under this Bond other than in a court of competent jurisdiction in the state in which the project that is the subject of the Construction Contract is located or after the expiration of one year from the date (1) on which the Claimant sent a Claim to the Surety pursuant to Paragraph 5.1.2 or 5.2, or (2) on which the last labor or service was performed by anyone or the last materials or equipment were furnished by anyone under the Construction Contract, whichever of (1) or (2) first occurs. If the provisions of this paragraph are void or prohibited by law, the minimum period of limitation available to sureties as a defense in the jurisdiction of the suit will be applicable.

13. Notice and Claims to the Surety, the Owner, or the Contractor must be mailed or delivered to the address shown on the page on which their signature appears. Actual receipt of notice or Claims, however accomplished, will be sufficient compliance as of the date received.

14. When this Bond has been furnished to comply with a statutory or other legal requirement in the location where the construction was to be performed, any provision in this Bond conflicting with said statutory or legal requirement will be deemed deleted here from and provisions conforming to such statutory or other legal requirement will be deemed incorporated herein. When so furnished, the intent is that this Bond will be construed as a statutory bond and not as a common law bond.

15. Upon requests by any person or entity appearing to be a potential beneficiary of this Bond, the Contractor and Owner shall promptly furnish a copy of this Bond or shall permit a copy to be made.

16. Definitions

    16.1. *Claim*—A written statement by the Claimant including at a minimum:

        16.1.1. The name of the Claimant;

        16.1.2. The name of the person for whom the labor was done, or materials or equipment furnished;

        16.1.3. A copy of the agreement or purchase order pursuant to which labor, materials, or equipment was furnished for use in the performance of the Construction Contract;

        16.1.4. A brief description of the labor, materials, or equipment furnished;

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16.1.5. The date on which the Claimant last performed labor or last furnished materials or equipment for use in the performance of the Construction Contract;

16.1.6. The total amount earned by the Claimant for labor, materials, or equipment furnished as of the date of the Claim;

16.1.7. The total amount of previous payments received by the Claimant; and

16.1.8. The total amount due and unpaid to the Claimant for labor, materials, or equipment furnished as of the date of the Claim.

16.2. *Claimant*—An individual or entity having a direct contract with the Contractor or with a subcontractor of the Contractor to furnish labor, materials, or equipment for use in the performance of the Construction Contract. The term Claimant also includes any individual or entity that has rightfully asserted a claim under an applicable mechanic's lien or similar statute against the real property upon which the Project is located. The intent of this Bond is to include without limitation in the terms of "labor, materials, or equipment" that part of the water, gas, power, light, heat, oil, gasoline, telephone service, or rental equipment used in the Construction Contract, architectural and engineering services required for performance of the work of the Contractor and the Contractor's subcontractors, and all other items for which a mechanic's lien may be asserted in the jurisdiction where the labor, materials, or equipment were furnished.

16.3. *Construction Contract*—The agreement between the Owner and Contractor identified on the cover page, including all Contract Documents and all changes made to the agreement and the Contract Documents.

16.4. *Owner Default*—Failure of the Owner, which has not been remedied or waived, to pay the Contractor as required under the Construction Contract or to perform and complete or comply with the other material terms of the Construction Contract.

16.5. *Contract Documents*—All the documents that comprise the agreement between the Owner and Contractor.

17. If this Bond is issued for an agreement between a contractor and subcontractor, the term Contractor in this Bond will be deemed to be Subcontractor and the term Owner will be deemed to be Contractor.

18. Modifications to this Bond are as follows: **[Describe modification or enter "None"]**

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STANDARD GENERAL CONDITIONS OF THE CONSTRUCTION CONTRACT

Prepared By

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STANDARD GENERAL CONDITIONS OF THE CONSTRUCTION CONTRACT

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STANDARD GENERAL CONDITIONS OF THE CONSTRUCTION CONTRACT

ARTICLE 1—DEFINITIONS AND TERMINOLOGY

1.01 *Defined Terms*

A. Wherever used in the Bidding Requirements or Contract Documents, a term printed with initial capital letters, including the term's singular and plural forms, will have the meaning indicated in the definitions below. In addition to terms specifically defined, terms with initial capital letters in the Contract Documents include references to identified articles and paragraphs, and the titles of other documents or forms.

1. *Addenda*—Written or graphic instruments issued prior to the opening of Bids which clarify, correct, or change the Bidding Requirements or the proposed Contract Documents.

2. *Agreement*—The written instrument, executed by Owner and Contractor, that sets forth the Contract Price and Contract Times, identifies the parties and the Engineer, and designates the specific items that are Contract Documents.

3. *Application for Payment*—The document prepared by Contractor, in a form acceptable to Engineer, to request progress or final payments, and which is to be accompanied by such supporting documentation as is required by the Contract Documents.

4. *Bid*—The offer of a Bidder submitted on the prescribed form setting forth the prices for the Work to be performed.

5. *Bidder*—An individual or entity that submits a Bid to Owner.

6. *Bidding Documents*—The Bidding Requirements, the proposed Contract Documents, and all Addenda.

7. *Bidding Requirements*—The Advertisement or invitation to bid, Instructions to Bidders, Bid Bond or other Bid security, if any, the Bid Form, and the Bid with any attachments.

8. *Change Order*—A document which is signed by Contractor and Owner and authorizes an addition, deletion, or revision in the Work or an adjustment in the Contract Price or the Contract Times, or other revision to the Contract, issued on or after the Effective Date of the Contract.

9. *Change Proposal*—A written request by Contractor, duly submitted in compliance with the procedural requirements set forth herein, seeking an adjustment in Contract Price or Contract Times; contesting an initial decision by Engineer concerning the requirements of the Contract Documents or the acceptability of Work under the Contract Documents; challenging a set-off against payments due; or seeking other relief with respect to the terms of the Contract.

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10. *Claim*

    a. A demand or assertion by Owner directly to Contractor, duly submitted in compliance with the procedural requirements set forth herein, seeking an adjustment of Contract Price or Contract Times; contesting an initial decision by Engineer concerning the requirements of the Contract Documents or the acceptability of Work under the Contract Documents; contesting Engineer's decision regarding a Change Proposal; seeking resolution of a contractual issue that Engineer has declined to address; or seeking other relief with respect to the terms of the Contract.

    b. A demand or assertion by Contractor directly to Owner, duly submitted in compliance with the procedural requirements set forth herein, contesting Engineer's decision regarding a Change Proposal, or seeking resolution of a contractual issue that Engineer has declined to address.

    c. A demand or assertion by Owner or Contractor, duly submitted in compliance with the procedural requirements set forth herein, made pursuant to Paragraph 12.01.A.4, concerning disputes arising after Engineer has issued a recommendation of final payment.

    d. A demand for money or services by a third party is not a Claim.

11. *Constituent of Concern*—Asbestos, petroleum, radioactive materials, polychlorinated biphenyls (PCBs), lead-based paint (as defined by the HUD/EPA standard), hazardous waste, and any substance, product, waste, or other material of any nature whatsoever that is or becomes listed, regulated, or addressed pursuant to Laws and Regulations regulating, relating to, or imposing liability or standards of conduct concerning, any hazardous, toxic, or dangerous waste, substance, or material.

12. *Contract*—The entire and integrated written contract between Owner and Contractor concerning the Work.

13. *Contract Documents*—Those items so designated in the Agreement, and which together comprise the Contract.

14. *Contract Price*—The money that Owner has agreed to pay Contractor for completion of the Work in accordance with the Contract Documents.

15. *Contract Times*—The number of days or the dates by which Contractor shall: (a) achieve Milestones, if any; (b) achieve Substantial Completion; and (c) complete the Work.

16. *Contractor*—The individual or entity with which Owner has contracted for performance of the Work.

17. *Cost of the Work*—See Paragraph 13.01 for definition.

18. *Drawings*—The part of the Contract that graphically shows the scope, extent, and character of the Work to be performed by Contractor.

19. *Effective Date of the Contract*—The date, indicated in the Agreement, on which the Contract becomes effective.

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20. *Electronic Document*—Any Project-related correspondence, attachments to correspondence, data, documents, drawings, information, or graphics, including but not limited to Shop Drawings and other Submittals, that are in an electronic or digital format.

21. *Electronic Means*—Electronic mail (email), upload/download from a secure Project website, or other communications methods that allow: (a) the transmission or communication of Electronic Documents; (b) the documentation of transmissions, including sending and receipt; (c) printing of the transmitted Electronic Document by the recipient; (d) the storage and archiving of the Electronic Document by sender and recipient; and (e) the use by recipient of the Electronic Document for purposes permitted by this Contract. Electronic Means does not include the use of text messaging, or of Facebook, Twitter, Instagram, or similar social media services for transmission of Electronic Documents.

22. *Engineer*—The individual or entity named as such in the Agreement.

23. *Field Order*—A written order issued by Engineer which requires minor changes in the Work but does not change the Contract Price or the Contract Times.

24. *Hazardous Environmental Condition*—The presence at the Site of Constituents of Concern in such quantities or circumstances that may present a danger to persons or property exposed thereto.

    a. The presence at the Site of materials that are necessary for the execution of the Work, or that are to be incorporated into the Work, and that are controlled and contained pursuant to industry practices, Laws and Regulations, and the requirements of the Contract, is not a Hazardous Environmental Condition.

    b. The presence of Constituents of Concern that are to be removed or remediated as part of the Work is not a Hazardous Environmental Condition.

    c. The presence of Constituents of Concern as part of the routine, anticipated, and obvious working conditions at the Site, is not a Hazardous Environmental Condition.

25. *Laws and Regulations; Laws or Regulations*—Any and all applicable laws, statutes, rules, regulations, ordinances, codes, and binding decrees, resolutions, and orders of any and all governmental bodies, agencies, authorities, and courts having jurisdiction.

26. *Liens*—Charges, security interests, or encumbrances upon Contract-related funds, real property, or personal property.

27. *Milestone*—A principal event in the performance of the Work that the Contract requires Contractor to achieve by an intermediate completion date, or by a time prior to Substantial Completion of all the Work.

28. *Notice of Award*—The written notice by Owner to a Bidder of Owner's acceptance of the Bid.

29. *Notice to Proceed*—A written notice by Owner to Contractor fixing the date on which the Contract Times will commence to run and on which Contractor shall start to perform the Work.

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30. *Owner*—The individual or entity with which Contractor has contracted regarding the Work, and which has agreed to pay Contractor for the performance of the Work, pursuant to the terms of the Contract.

31. *Progress Schedule*—A schedule, prepared and maintained by Contractor, describing the sequence and duration of the activities comprising Contractor's plan to accomplish the Work within the Contract Times.

32. *Project*—The total undertaking to be accomplished for Owner by engineers, contractors, and others, including planning, study, design, construction, testing, commissioning, and start-up, and of which the Work to be performed under the Contract Documents is a part.

33. *Resident Project Representative*—The authorized representative of Engineer assigned to assist Engineer at the Site. As used herein, the term Resident Project Representative (RPR) includes any assistants or field staff of Resident Project Representative.

34. *Samples*—Physical examples of materials, equipment, or workmanship that are representative of some portion of the Work and that establish the standards by which such portion of the Work will be judged.

35. *Schedule of Submittals*—A schedule, prepared and maintained by Contractor, of required submittals and the time requirements for Engineer's review of the submittals.

36. *Schedule of Values*—A schedule, prepared and maintained by Contractor, allocating portions of the Contract Price to various portions of the Work and used as the basis for reviewing Contractor's Applications for Payment.

37. *Shop Drawings*—All drawings, diagrams, illustrations, schedules, and other data or information that are specifically prepared or assembled by or for Contractor and submitted by Contractor to illustrate some portion of the Work. Shop Drawings, whether approved or not, are not Drawings and are not Contract Documents.

38. *Site*—Lands or areas indicated in the Contract Documents as being furnished by Owner upon which the Work is to be performed, including rights-of-way and easements, and such other lands or areas furnished by Owner which are designated for the use of Contractor.

39. *Specifications*—The part of the Contract that consists of written requirements for materials, equipment, systems, standards, and workmanship as applied to the Work, and certain administrative requirements and procedural matters applicable to the Work.

40. *Subcontractor*—An individual or entity having a direct contract with Contractor or with any other Subcontractor for the performance of a part of the Work.

41. *Submittal*—A written or graphic document, prepared by or for Contractor, which the Contract Documents require Contractor to submit to Engineer, or that is indicated as a Submittal in the Schedule of Submittals accepted by Engineer. Submittals may include Shop Drawings and Samples; schedules; product data; Owner-delegated designs; sustainable design information; information on special procedures; testing plans; results of tests and evaluations, source quality-control testing and inspections, and field or Site quality-control testing and inspections; warranties and certifications; Suppliers'

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instructions and reports; records of delivery of spare parts and tools; operations and maintenance data; Project photographic documentation; record documents; and other such documents required by the Contract Documents. Submittals, whether or not approved or accepted by Engineer, are not Contract Documents. Change Proposals, Change Orders, Claims, notices, Applications for Payment, and requests for interpretation or clarification are not Submittals.

42. *Substantial Completion*—The time at which the Work (or a specified part thereof) has progressed to the point where, in the opinion of Engineer, the Work (or a specified part thereof) is sufficiently complete, in accordance with the Contract Documents, so that the Work (or a specified part thereof) can be utilized for the purposes for which it is intended. The terms "substantially complete" and "substantially completed" as applied to all or part of the Work refer to Substantial Completion of such Work.

43. *Successful Bidder*—The Bidder to which the Owner makes an award of contract.

44. *Supplementary Conditions*—The part of the Contract that amends or supplements these General Conditions.

45. *Supplier*—A manufacturer, fabricator, supplier, distributor, or vendor having a direct contract with Contractor or with any Subcontractor to furnish materials or equipment to be incorporated in the Work by Contractor or a Subcontractor.

46. *Technical Data*

    a. Those items expressly identified as Technical Data in the Supplementary Conditions, with respect to either (1) existing subsurface conditions at or adjacent to the Site, or existing physical conditions at or adjacent to the Site including existing surface or subsurface structures (except Underground Facilities) or (2) Hazardous Environmental Conditions at the Site.

    b. If no such express identifications of Technical Data have been made with respect to conditions at the Site, then Technical Data is defined, with respect to conditions at the Site under Paragraphs 5.03, 5.04, and 5.06, as the data contained in boring logs, recorded measurements of subsurface water levels, assessments of the condition of subsurface facilities, laboratory test results, and other factual, objective information regarding conditions at the Site that are set forth in any geotechnical, environmental, or other Site or facilities conditions report prepared for the Project and made available to Contractor.

    c. Information and data regarding the presence or location of Underground Facilities are not intended to be categorized, identified, or defined as Technical Data, and instead Underground Facilities are shown or indicated on the Drawings.

47. *Underground Facilities*—All active or not-in-service underground lines, pipelines, conduits, ducts, encasements, cables, wires, manholes, vaults, tanks, tunnels, or other such facilities or systems at the Site, including but not limited to those facilities or systems that produce, transmit, distribute, or convey telephone or other communications, cable television, fiber optic transmissions, power, electricity, light, heat, gases, oil, crude oil products, liquid petroleum products, water, steam, waste, wastewater, storm water,

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other liquids or chemicals, or traffic or other control systems. An abandoned facility or system is not an Underground Facility.

48. *Unit Price Work*—Work to be paid for on the basis of unit prices.

49. *Work*—The entire construction or the various separately identifiable parts thereof required to be provided under the Contract Documents. Work includes and is the result of performing or providing all labor, services, and documentation necessary to produce such construction; furnishing, installing, and incorporating all materials and equipment into such construction; and may include related services such as testing, start-up, and commissioning, all as required by the Contract Documents.

50. *Work Change Directive*—A written directive to Contractor issued on or after the Effective Date of the Contract, signed by Owner and recommended by Engineer, ordering an addition, deletion, or revision in the Work.

1.02 *Terminology*

A. The words and terms discussed in Paragraphs 1.02.B, C, D, and E are not defined terms that require initial capital letters, but, when used in the Bidding Requirements or Contract Documents, have the indicated meaning.

B. *Intent of Certain Terms or Adjectives*: The Contract Documents include the terms "as allowed," "as approved," "as ordered," "as directed" or terms of like effect or import to authorize an exercise of professional judgment by Engineer. In addition, the adjectives "reasonable," "suitable," "acceptable," "proper," "satisfactory," or adjectives of like effect or import are used to describe an action or determination of Engineer as to the Work. It is intended that such exercise of professional judgment, action, or determination will be solely to evaluate, in general, the Work for compliance with the information in the Contract Documents and with the design concept of the Project as a functioning whole as shown or indicated in the Contract Documents (unless there is a specific statement indicating otherwise). The use of any such term or adjective is not intended to and shall not be effective to assign to Engineer any duty or authority to supervise or direct the performance of the Work, or any duty or authority to undertake responsibility contrary to the provisions of Article 10 or any other provision of the Contract Documents.

C. *Day*: The word "day" means a calendar day of 24 hours measured from midnight to the next midnight.

D. *Defective*: The word "defective," when modifying the word "Work," refers to Work that is unsatisfactory, faulty, or deficient in that it:

1. does not conform to the Contract Documents;

2. does not meet the requirements of any applicable inspection, reference standard, test, or approval referred to in the Contract Documents; or

3. has been damaged prior to Engineer's recommendation of final payment (unless responsibility for the protection thereof has been assumed by Owner at Substantial Completion in accordance with Paragraph 15.03 or Paragraph 15.04).

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E. *Furnish, Install, Perform, Provide*

1. The word "furnish," when used in connection with services, materials, or equipment, means to supply and deliver said services, materials, or equipment to the Site (or some other specified location) ready for use or installation and in usable or operable condition.

2. The word "install," when used in connection with services, materials, or equipment, means to put into use or place in final position said services, materials, or equipment complete and ready for intended use.

3. The words "perform" or "provide," when used in connection with services, materials, or equipment, means to furnish and install said services, materials, or equipment complete and ready for intended use.

4. If the Contract Documents establish an obligation of Contractor with respect to specific services, materials, or equipment, but do not expressly use any of the four words "furnish," "install," "perform," or "provide," then Contractor shall furnish and install said services, materials, or equipment complete and ready for intended use.

F. *Contract Price or Contract Times*: References to a change in "Contract Price or Contract Times" or "Contract Times or Contract Price" or similar, indicate that such change applies to (1) Contract Price, (2) Contract Times, or (3) both Contract Price and Contract Times, as warranted, even if the term "or both" is not expressed.

G. Unless stated otherwise in the Contract Documents, words or phrases that have a well-known technical or construction industry or trade meaning are used in the Contract Documents in accordance with such recognized meaning.

ARTICLE 2—PRELIMINARY MATTERS

2.01 *Delivery of Performance and Payment Bonds; Evidence of Insurance*

A. *Performance and Payment Bonds*: When Contractor delivers the signed counterparts of the Agreement to Owner, Contractor shall also deliver to Owner the performance bond and payment bond (if the Contract requires Contractor to furnish such bonds).

B. *Evidence of Contractor's Insurance*: When Contractor delivers the signed counterparts of the Agreement to Owner, Contractor shall also deliver to Owner, with copies to each additional insured (as identified in the Contract), the certificates, endorsements, and other evidence of insurance required to be provided by Contractor in accordance with Article 6, except to the extent the Supplementary Conditions expressly establish other dates for delivery of specific insurance policies.

C. *Evidence of Owner's Insurance*: After receipt of the signed counterparts of the Agreement and all required bonds and insurance documentation, Owner shall promptly deliver to Contractor, with copies to each additional insured (as identified in the Contract), the certificates and other evidence of insurance required to be provided by Owner under Article 6.

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2.02 *Copies of Documents*

A. Owner shall furnish to Contractor four printed copies of the Contract (including one fully signed counterpart of the Agreement), and one copy in electronic portable document format (PDF). Additional printed copies will be furnished upon request at the cost of reproduction.

B. Owner shall maintain and safeguard at least one original printed record version of the Contract, including Drawings and Specifications signed and sealed by Engineer and other design professionals. Owner shall make such original printed record version of the Contract available to Contractor for review. Owner may delegate the responsibilities under this provision to Engineer.

2.03 *Before Starting Construction*

A. *Preliminary Schedules*: Within 10 days after the Effective Date of the Contract (or as otherwise required by the Contract Documents), Contractor shall submit to Engineer for timely review:

1. a preliminary Progress Schedule indicating the times (numbers of days or dates) for starting and completing the various stages of the Work, including any Milestones specified in the Contract;

2. a preliminary Schedule of Submittals; and

3. a preliminary Schedule of Values for all of the Work which includes quantities and prices of items which when added together equal the Contract Price and subdivides the Work into component parts in sufficient detail to serve as the basis for progress payments during performance of the Work. Such prices will include an appropriate amount of overhead and profit applicable to each item of Work.

2.04 *Preconstruction Conference; Designation of Authorized Representatives*

A. Before any Work at the Site is started, a conference attended by Owner, Contractor, Engineer, and others as appropriate will be held to establish a working understanding among the parties as to the Work, and to discuss the schedules referred to in Paragraph 2.03.A, procedures for handling Shop Drawings, Samples, and other Submittals, processing Applications for Payment, electronic or digital transmittals, and maintaining required records.

B. At this conference Owner and Contractor each shall designate, in writing, a specific individual to act as its authorized representative with respect to the services and responsibilities under the Contract. Such individuals shall have the authority to transmit and receive information, render decisions relative to the Contract, and otherwise act on behalf of each respective party.

2.05 *Acceptance of Schedules*

A. At least 10 days before submission of the first Application for Payment a conference, attended by Contractor, Engineer, and others as appropriate, will be held to review the schedules submitted in accordance with Paragraph 2.03.A. No progress payment will be made to Contractor until acceptable schedules are submitted to Engineer.

1. The Progress Schedule will be acceptable to Engineer if it provides an orderly progression of the Work to completion within the Contract Times. Such acceptance will not impose

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on Engineer responsibility for the Progress Schedule, for sequencing, scheduling, or progress of the Work, nor interfere with or relieve Contractor from Contractor's full responsibility therefor.

2. Contractor's Schedule of Submittals will be acceptable to Engineer if it provides a workable arrangement for reviewing and processing the required submittals.

3. Contractor's Schedule of Values will be acceptable to Engineer as to form and substance if it provides a reasonable allocation of the Contract Price to the component parts of the Work.

4. If a schedule is not acceptable, Contractor will have an additional 10 days to revise and resubmit the schedule.

2.06 *Electronic Transmittals*

A. Except as otherwise stated elsewhere in the Contract, the Owner, Engineer, and Contractor may send, and shall accept, Electronic Documents transmitted by Electronic Means.

B. If the Contract does not establish protocols for Electronic Means, then Owner, Engineer, and Contractor shall jointly develop such protocols.

C. Subject to any governing protocols for Electronic Means, when transmitting Electronic Documents by Electronic Means, the transmitting party makes no representations as to long-term compatibility, usability, or readability of the Electronic Documents resulting from the recipient's use of software application packages, operating systems, or computer hardware differing from those used in the drafting or transmittal of the Electronic Documents.

ARTICLE 3—CONTRACT DOCUMENTS: INTENT, REQUIREMENTS, REUSE

3.01 *Intent*

A. The Contract Documents are complementary; what is required by one Contract Document is as binding as if required by all.

B. It is the intent of the Contract Documents to describe a functionally complete Project (or part thereof) to be constructed in accordance with the Contract Documents.

C. Unless otherwise stated in the Contract Documents, if there is a discrepancy between the electronic versions of the Contract Documents (including any printed copies derived from such electronic versions) and the printed record version, the printed record version will govern.

D. The Contract supersedes prior negotiations, representations, and agreements, whether written or oral.

E. Engineer will issue clarifications and interpretations of the Contract Documents as provided herein.

F. Any provision or part of the Contract Documents held to be void or unenforceable under any Law or Regulation will be deemed stricken, and all remaining provisions will continue to be valid and binding upon Owner and Contractor, which agree that the Contract Documents will

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be reformed to replace such stricken provision or part thereof with a valid and enforceable provision that comes as close as possible to expressing the intention of the stricken provision.

G. Nothing in the Contract Documents creates:

1. any contractual relationship between Owner or Engineer and any Subcontractor, Supplier, or other individual or entity performing or furnishing any of the Work, for the benefit of such Subcontractor, Supplier, or other individual or entity; or

2. any obligation on the part of Owner or Engineer to pay or to see to the payment of any money due any such Subcontractor, Supplier, or other individual or entity, except as may otherwise be required by Laws and Regulations.

3.02 *Reference Standards*

A. *Standards Specifications, Codes, Laws and Regulations*

1. Reference in the Contract Documents to standard specifications, manuals, reference standards, or codes of any technical society, organization, or association, or to Laws or Regulations, whether such reference be specific or by implication, means the standard specification, manual, reference standard, code, or Laws or Regulations in effect at the time of opening of Bids (or on the Effective Date of the Contract if there were no Bids), except as may be otherwise specifically stated in the Contract Documents.

2. No provision of any such standard specification, manual, reference standard, or code, and no instruction of a Supplier, will be effective to change the duties or responsibilities of Owner, Contractor, or Engineer from those set forth in the part of the Contract Documents prepared by or for Engineer. No such provision or instruction shall be effective to assign to Owner or Engineer any duty or authority to supervise or direct the performance of the Work, or any duty or authority to undertake responsibility inconsistent with the provisions of the part of the Contract Documents prepared by or for Engineer.

3.03 *Reporting and Resolving Discrepancies*

A. *Reporting Discrepancies*

1. *Contractor's Verification of Figures and Field Measurements*: Before undertaking each part of the Work, Contractor shall carefully study the Contract Documents, and check and verify pertinent figures and dimensions therein, particularly with respect to applicable field measurements. Contractor shall promptly report in writing to Engineer any conflict, error, ambiguity, or discrepancy that Contractor discovers, or has actual knowledge of, and shall not proceed with any Work affected thereby until the conflict, error, ambiguity, or discrepancy is resolved by a clarification or interpretation by Engineer, or by an amendment or supplement to the Contract issued pursuant to Paragraph 11.01.

2. *Contractor's Review of Contract Documents*: If, before or during the performance of the Work, Contractor discovers any conflict, error, ambiguity, or discrepancy within the Contract Documents, or between the Contract Documents and (a) any applicable Law or Regulation, (b) actual field conditions, (c) any standard specification, manual, reference standard, or code, or (d) any instruction of any Supplier, then Contractor shall promptly

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report it to Engineer in writing. Contractor shall not proceed with the Work affected thereby (except in an emergency as required by Paragraph 7.15) until the conflict, error, ambiguity, or discrepancy is resolved, by a clarification or interpretation by Engineer, or by an amendment or supplement to the Contract issued pursuant to Paragraph 11.01.

3. Contractor shall not be liable to Owner or Engineer for failure to report any conflict, error, ambiguity, or discrepancy in the Contract Documents unless Contractor had actual knowledge thereof.

B. *Resolving Discrepancies*

1. Except as may be otherwise specifically stated in the Contract Documents, the provisions of the part of the Contract Documents prepared by or for Engineer take precedence in resolving any conflict, error, ambiguity, or discrepancy between such provisions of the Contract Documents and:

a. the provisions of any standard specification, manual, reference standard, or code, or the instruction of any Supplier (whether or not specifically incorporated by reference as a Contract Document); or

b. the provisions of any Laws or Regulations applicable to the performance of the Work (unless such an interpretation of the provisions of the Contract Documents would result in violation of such Law or Regulation).

3.04 *Requirements of the Contract Documents*

A. During the performance of the Work and until final payment, Contractor and Owner shall submit to the Engineer in writing all matters in question concerning the requirements of the Contract Documents (sometimes referred to as requests for information or interpretation—RFIs), or relating to the acceptability of the Work under the Contract Documents, as soon as possible after such matters arise. Engineer will be the initial interpreter of the requirements of the Contract Documents, and judge of the acceptability of the Work.

B. Engineer will, with reasonable promptness, render a written clarification, interpretation, or decision on the issue submitted, or initiate an amendment or supplement to the Contract Documents. Engineer's written clarification, interpretation, or decision will be final and binding on Contractor, unless it appeals by submitting a Change Proposal, and on Owner, unless it appeals by filing a Claim.

C. If a submitted matter in question concerns terms and conditions of the Contract Documents that do not involve (1) the performance or acceptability of the Work under the Contract Documents, (2) the design (as set forth in the Drawings, Specifications, or otherwise), or (3) other engineering or technical matters, then Engineer will promptly notify Owner and Contractor in writing that Engineer is unable to provide a decision or interpretation. If Owner and Contractor are unable to agree on resolution of such a matter in question, either party may pursue resolution as provided in Article 12.

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3.05 *Reuse of Documents*

A. Contractor and its Subcontractors and Suppliers shall not:

1. have or acquire any title to or ownership rights in any of the Drawings, Specifications, or other documents (or copies of any thereof) prepared by or bearing the seal of Engineer or its consultants, including electronic media versions, or reuse any such Drawings, Specifications, other documents, or copies thereof on extensions of the Project or any other project without written consent of Owner and Engineer and specific written verification or adaptation by Engineer; or

2. have or acquire any title or ownership rights in any other Contract Documents, reuse any such Contract Documents for any purpose without Owner's express written consent, or violate any copyrights pertaining to such Contract Documents.

B. The prohibitions of this Paragraph 3.05 will survive final payment, or termination of the Contract. Nothing herein precludes Contractor from retaining copies of the Contract Documents for record purposes.

ARTICLE 4—COMMENCEMENT AND PROGRESS OF THE WORK

4.01 *Commencement of Contract Times; Notice to Proceed*

A. The Contract Times will commence to run on the 30th day after the Effective Date of the Contract or, if a Notice to Proceed is given, on the day indicated in the Notice to Proceed. A Notice to Proceed may be given at any time within 30 days after the Effective Date of the Contract. In no event will the Contract Times commence to run later than the 60th day after the day of Bid opening or the 30th day after the Effective Date of the Contract, whichever date is earlier.

4.02 *Starting the Work*

A. Contractor shall start to perform the Work on the date when the Contract Times commence to run. No Work may be done at the Site prior to such date.

4.03 *Reference Points*

A. Owner shall provide engineering surveys to establish reference points for construction which in Engineer's judgment are necessary to enable Contractor to proceed with the Work. Contractor shall be responsible for laying out the Work, shall protect and preserve the established reference points and property monuments, and shall make no changes or relocations without the prior written approval of Owner. Contractor shall report to Engineer whenever any reference point or property monument is lost or destroyed or requires relocation because of necessary changes in grades or locations, and shall be responsible for the accurate replacement or relocation of such reference points or property monuments by professionally qualified personnel.

4.04 *Progress Schedule*

A. Contractor shall adhere to the Progress Schedule established in accordance with Paragraph 2.05 as it may be adjusted from time to time as provided below.

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1. Contractor shall submit to Engineer for acceptance (to the extent indicated in Paragraph 2.05) proposed adjustments in the Progress Schedule that will not result in changing the Contract Times.

2. Proposed adjustments in the Progress Schedule that will change the Contract Times must be submitted in accordance with the requirements of Article 11.

B. Contractor shall carry on the Work and adhere to the Progress Schedule during all disputes or disagreements with Owner. No Work will be delayed or postponed pending resolution of any disputes or disagreements, or during any appeal process, except as permitted by Paragraph 16.04, or as Owner and Contractor may otherwise agree in writing.

4.05 *Delays in Contractor's Progress*

A. If Owner, Engineer, or anyone for whom Owner is responsible, delays, disrupts, or interferes with the performance or progress of the Work, then Contractor shall be entitled to an equitable adjustment in Contract Price or Contract Times.

B. Contractor shall not be entitled to an adjustment in Contract Price or Contract Times for delay, disruption, or interference caused by or within the control of Contractor. Delay, disruption, and interference attributable to and within the control of a Subcontractor or Supplier shall be deemed to be within the control of Contractor.

C. If Contractor's performance or progress is delayed, disrupted, or interfered with by unanticipated causes not the fault of and beyond the control of Owner, Contractor, and those for which they are responsible, then Contractor shall be entitled to an equitable adjustment in Contract Times. Such an adjustment will be Contractor's sole and exclusive remedy for the delays, disruption, and interference described in this paragraph. Causes of delay, disruption, or interference that may give rise to an adjustment in Contract Times under this paragraph include but are not limited to the following:

1. Severe and unavoidable natural catastrophes such as fires, floods, epidemics, and earthquakes;

2. Abnormal weather conditions;

3. Acts or failures to act of third-party utility owners or other third-party entities (other than those third-party utility owners or other third-party entities performing other work at or adjacent to the Site as arranged by or under contract with Owner, as contemplated in Article 8); and

4. Acts of war or terrorism.

D. Contractor's entitlement to an adjustment of Contract Times or Contract Price is limited as follows:

1. Contractor's entitlement to an adjustment of the Contract Times is conditioned on the delay, disruption, or interference adversely affecting an activity on the critical path to completion of the Work, as of the time of the delay, disruption, or interference.

2. Contractor shall not be entitled to an adjustment in Contract Price for any delay, disruption, or interference if such delay is concurrent with a delay, disruption, or

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interference caused by or within the control of Contractor. Such a concurrent delay by Contractor shall not preclude an adjustment of Contract Times to which Contractor is otherwise entitled.

3. Adjustments of Contract Times or Contract Price are subject to the provisions of Article 11.

E. Each Contractor request or Change Proposal seeking an increase in Contract Times or Contract Price must be supplemented by supporting data that sets forth in detail the following:

1. The circumstances that form the basis for the requested adjustment;

2. The date upon which each cause of delay, disruption, or interference began to affect the progress of the Work;

3. The date upon which each cause of delay, disruption, or interference ceased to affect the progress of the Work;

4. The number of days' increase in Contract Times claimed as a consequence of each such cause of delay, disruption, or interference; and

5. The impact on Contract Price, in accordance with the provisions of Paragraph 11.07.

Contractor shall also furnish such additional supporting documentation as Owner or Engineer may require including, where appropriate, a revised progress schedule indicating all the activities affected by the delay, disruption, or interference, and an explanation of the effect of the delay, disruption, or interference on the critical path to completion of the Work.

F. Delays, disruption, and interference to the performance or progress of the Work resulting from the existence of a differing subsurface or physical condition, an Underground Facility that was not shown or indicated by the Contract Documents, or not shown or indicated with reasonable accuracy, and those resulting from Hazardous Environmental Conditions, are governed by Article 5, together with the provisions of Paragraphs 4.05.D and 4.05.E.

G. Paragraph 8.03 addresses delays, disruption, and interference to the performance or progress of the Work resulting from the performance of certain other work at or adjacent to the Site.

ARTICLE 5—SITE; SUBSURFACE AND PHYSICAL CONDITIONS; HAZARDOUS ENVIRONMENTAL CONDITIONS

5.01 *Availability of Lands*

A. Owner shall furnish the Site. Owner shall notify Contractor in writing of any encumbrances or restrictions not of general application but specifically related to use of the Site with which Contractor must comply in performing the Work.

B. Upon reasonable written request, Owner shall furnish Contractor with a current statement of record legal title and legal description of the lands upon which permanent improvements are to be made and Owner's interest therein as necessary for giving notice of or filing a mechanic's or construction lien against such lands in accordance with applicable Laws and Regulations.

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C. Contractor shall provide for all additional lands and access thereto that may be required for temporary construction facilities or storage of materials and equipment.

5.02 *Use of Site and Other Areas*

A. *Limitation on Use of Site and Other Areas*

1. Contractor shall confine construction equipment, temporary construction facilities, the storage of materials and equipment, and the operations of workers to the Site, adjacent areas that Contractor has arranged to use through construction easements or otherwise, and other adjacent areas permitted by Laws and Regulations, and shall not unreasonably encumber the Site and such other adjacent areas with construction equipment or other materials or equipment. Contractor shall assume full responsibility for (a) damage to the Site; (b) damage to any such other adjacent areas used for Contractor's operations; (c) damage to any other adjacent land or areas, or to improvements, structures, utilities, or similar facilities located at such adjacent lands or areas; and (d) for injuries and losses sustained by the owners or occupants of any such land or areas; provided that such damage or injuries result from the performance of the Work or from other actions or conduct of the Contractor or those for which Contractor is responsible.

2. If a damage or injury claim is made by the owner or occupant of any such land or area because of the performance of the Work, or because of other actions or conduct of the Contractor or those for which Contractor is responsible, Contractor shall (a) take immediate corrective or remedial action as required by Paragraph 7.13, or otherwise; (b) promptly attempt to settle the claim as to all parties through negotiations with such owner or occupant, or otherwise resolve the claim by arbitration or other dispute resolution proceeding, or in a court of competent jurisdiction; and (c) to the fullest extent permitted by Laws and Regulations, indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them, from and against any such claim, and against all costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to any claim or action, legal or equitable, brought by any such owner or occupant against Owner, Engineer, or any other party indemnified hereunder to the extent caused directly or indirectly, in whole or in part by, or based upon, Contractor's performance of the Work, or because of other actions or conduct of the Contractor or those for which Contractor is responsible.

B. *Removal of Debris During Performance of the Work*: During the progress of the Work the Contractor shall keep the Site and other adjacent areas free from accumulations of waste materials, rubbish, and other debris. Removal and disposal of such waste materials, rubbish, and other debris will conform to applicable Laws and Regulations.

C. *Cleaning*: Prior to Substantial Completion of the Work Contractor shall clean the Site and the Work and make it ready for utilization by Owner. At the completion of the Work Contractor shall remove from the Site and adjacent areas all tools, appliances, construction equipment and machinery, and surplus materials and shall restore to original condition all property not designated for alteration by the Contract Documents.

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D. *Loading of Structures*: Contractor shall not load nor permit any part of any structure to be loaded in any manner that will endanger the structure, nor shall Contractor subject any part of the Work or adjacent structures or land to stresses or pressures that will endanger them.

5.03 *Subsurface and Physical Conditions*

A. *Reports and Drawings*: The Supplementary Conditions identify:

1. Those reports of explorations and tests of subsurface conditions at or adjacent to the Site that contain Technical Data;

2. Those drawings of existing physical conditions at or adjacent to the Site, including those drawings depicting existing surface or subsurface structures at or adjacent to the Site (except Underground Facilities), that contain Technical Data; and

3. Technical Data contained in such reports and drawings.

B. *Underground Facilities*: Underground Facilities are shown or indicated on the Drawings, pursuant to Paragraph 5.05, and not in the drawings referred to in Paragraph 5.03.A. Information and data regarding the presence or location of Underground Facilities are not intended to be categorized, identified, or defined as Technical Data.

C. *Reliance by Contractor on Technical Data*: Contractor may rely upon the accuracy of the Technical Data expressly identified in the Supplementary Conditions with respect to such reports and drawings, but such reports and drawings are not Contract Documents. If no such express identification has been made, then Contractor may rely upon the accuracy of the Technical Data as defined in Paragraph 1.01.A.46.b.

D. *Limitations of Other Data and Documents*: Except for such reliance on Technical Data, Contractor may not rely upon or make any claim against Owner or Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors, with respect to:

1. the completeness of such reports and drawings for Contractor's purposes, including, but not limited to, any aspects of the means, methods, techniques, sequences, and procedures of construction to be employed by Contractor, and safety precautions and programs incident thereto;

2. other data, interpretations, opinions, and information contained in such reports or shown or indicated in such drawings;

3. the contents of other Site-related documents made available to Contractor, such as record drawings from other projects at or adjacent to the Site, or Owner's archival documents concerning the Site; or

4. any Contractor interpretation of or conclusion drawn from any Technical Data or any such other data, interpretations, opinions, or information.

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5.04 *Differing Subsurface or Physical Conditions*

A. *Notice by Contractor*: If Contractor believes that any subsurface or physical condition that is uncovered or revealed at the Site:

1. is of such a nature as to establish that any Technical Data on which Contractor is entitled to rely as provided in Paragraph 5.03 is materially inaccurate;

2. is of such a nature as to require a change in the Drawings or Specifications;

3. differs materially from that shown or indicated in the Contract Documents; or

4. is of an unusual nature, and differs materially from conditions ordinarily encountered and generally recognized as inherent in work of the character provided for in the Contract Documents;

then Contractor shall, promptly after becoming aware thereof and before further disturbing the subsurface or physical conditions or performing any Work in connection therewith (except in an emergency as required by Paragraph 7.15), notify Owner and Engineer in writing about such condition. Contractor shall not further disturb such condition or perform any Work in connection therewith (except with respect to an emergency) until receipt of a written statement permitting Contractor to do so.

B. *Engineer's Review*: After receipt of written notice as required by the preceding paragraph, Engineer will promptly review the subsurface or physical condition in question; determine whether it is necessary for Owner to obtain additional exploration or tests with respect to the condition; conclude whether the condition falls within any one or more of the differing site condition categories in Paragraph 5.04.A; obtain any pertinent cost or schedule information from Contractor; prepare recommendations to Owner regarding the Contractor's resumption of Work in connection with the subsurface or physical condition in question and the need for any change in the Drawings or Specifications; and advise Owner in writing of Engineer's findings, conclusions, and recommendations.

C. *Owner's Statement to Contractor Regarding Site Condition*: After receipt of Engineer's written findings, conclusions, and recommendations, Owner shall issue a written statement to Contractor (with a copy to Engineer) regarding the subsurface or physical condition in question, addressing the resumption of Work in connection with such condition, indicating whether any change in the Drawings or Specifications will be made, and adopting or rejecting Engineer's written findings, conclusions, and recommendations, in whole or in part.

D. *Early Resumption of Work*: If at any time Engineer determines that Work in connection with the subsurface or physical condition in question may resume prior to completion of Engineer's review or Owner's issuance of its statement to Contractor, because the condition in question has been adequately documented, and analyzed on a preliminary basis, then the Engineer may at its discretion instruct Contractor to resume such Work.

E. *Possible Price and Times Adjustments*

1. Contractor shall be entitled to an equitable adjustment in Contract Price or Contract Times, to the extent that the existence of a differing subsurface or physical condition, or any related delay, disruption, or interference, causes an increase or decrease in

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Contractor's cost of, or time required for, performance of the Work; subject, however, to the following:

a. Such condition must fall within any one or more of the categories described in Paragraph 5.04.A;

b. With respect to Work that is paid for on a unit price basis, any adjustment in Contract Price will be subject to the provisions of Paragraph 13.03; and,

c. Contractor's entitlement to an adjustment of the Contract Times is subject to the provisions of Paragraphs 4.05.D and 4.05.E.

2. Contractor shall not be entitled to any adjustment in the Contract Price or Contract Times with respect to a subsurface or physical condition if:

a. Contractor knew of the existence of such condition at the time Contractor made a commitment to Owner with respect to Contract Price and Contract Times by the submission of a Bid or becoming bound under a negotiated contract, or otherwise;

b. The existence of such condition reasonably could have been discovered or revealed as a result of any examination, investigation, exploration, test, or study of the Site and contiguous areas expressly required by the Bidding Requirements or Contract Documents to be conducted by or for Contractor prior to Contractor's making such commitment; or

c. Contractor failed to give the written notice required by Paragraph 5.04.A.

3. If Owner and Contractor agree regarding Contractor's entitlement to and the amount or extent of any adjustment in the Contract Price or Contract Times, then any such adjustment will be set forth in a Change Order.

4. Contractor may submit a Change Proposal regarding its entitlement to or the amount or extent of any adjustment in the Contract Price or Contract Times, no later than 30 days after Owner's issuance of the Owner's written statement to Contractor regarding the subsurface or physical condition in question.

F. *Underground Facilities; Hazardous Environmental Conditions*: Paragraph 5.05 governs rights and responsibilities regarding the presence or location of Underground Facilities. Paragraph 5.06 governs rights and responsibilities regarding Hazardous Environmental Conditions. The provisions of Paragraphs 5.03 and 5.04 are not applicable to the presence or location of Underground Facilities, or to Hazardous Environmental Conditions.

5.05 *Underground Facilities*

A. *Contractor's Responsibilities*: Unless it is otherwise expressly provided in the Supplementary Conditions, the cost of all of the following are included in the Contract Price, and Contractor shall have full responsibility for:

1. reviewing and checking all information and data regarding existing Underground Facilities at the Site;

2. complying with applicable state and local utility damage prevention Laws and Regulations;

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3. verifying the actual location of those Underground Facilities shown or indicated in the Contract Documents as being within the area affected by the Work, by exposing such Underground Facilities during the course of construction;

4. coordination of the Work with the owners (including Owner) of such Underground Facilities, during construction; and

5. the safety and protection of all existing Underground Facilities at the Site, and repairing any damage thereto resulting from the Work.

B. *Notice by Contractor*: If Contractor believes that an Underground Facility that is uncovered or revealed at the Site was not shown or indicated on the Drawings, or was not shown or indicated on the Drawings with reasonable accuracy, then Contractor shall, promptly after becoming aware thereof and before further disturbing conditions affected thereby or performing any Work in connection therewith (except in an emergency as required by Paragraph 7.15), notify Owner and Engineer in writing regarding such Underground Facility.

C. *Engineer's Review*: Engineer will:

1. promptly review the Underground Facility and conclude whether such Underground Facility was not shown or indicated on the Drawings, or was not shown or indicated with reasonable accuracy;

2. identify and communicate with the owner of the Underground Facility; prepare recommendations to Owner (and if necessary issue any preliminary instructions to Contractor) regarding the Contractor's resumption of Work in connection with the Underground Facility in question;

3. obtain any pertinent cost or schedule information from Contractor; determine the extent, if any, to which a change is required in the Drawings or Specifications to reflect and document the consequences of the existence or location of the Underground Facility; and

4. advise Owner in writing of Engineer's findings, conclusions, and recommendations.

During such time, Contractor shall be responsible for the safety and protection of such Underground Facility.

D. *Owner's Statement to Contractor Regarding Underground Facility*: After receipt of Engineer's written findings, conclusions, and recommendations, Owner shall issue a written statement to Contractor (with a copy to Engineer) regarding the Underground Facility in question addressing the resumption of Work in connection with such Underground Facility, indicating whether any change in the Drawings or Specifications will be made, and adopting or rejecting Engineer's written findings, conclusions, and recommendations in whole or in part.

E. *Early Resumption of Work*: If at any time Engineer determines that Work in connection with the Underground Facility may resume prior to completion of Engineer's review or Owner's issuance of its statement to Contractor, because the Underground Facility in question and conditions affected by its presence have been adequately documented, and analyzed on a preliminary basis, then the Engineer may at its discretion instruct Contractor to resume such Work.

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F. *Possible Price and Times Adjustments*

1. Contractor shall be entitled to an equitable adjustment in the Contract Price or Contract Times, to the extent that any existing Underground Facility at the Site that was not shown or indicated on the Drawings, or was not shown or indicated with reasonable accuracy, or any related delay, disruption, or interference, causes an increase or decrease in Contractor's cost of, or time required for, performance of the Work; subject, however, to the following:

   a. With respect to Work that is paid for on a unit price basis, any adjustment in Contract Price will be subject to the provisions of Paragraph 13.03;

   b. Contractor's entitlement to an adjustment of the Contract Times is subject to the provisions of Paragraphs 4.05.D and 4.05.E; and

   c. Contractor gave the notice required in Paragraph 5.05.B.

2. If Owner and Contractor agree regarding Contractor's entitlement to and the amount or extent of any adjustment in the Contract Price or Contract Times, then any such adjustment will be set forth in a Change Order.

3. Contractor may submit a Change Proposal regarding its entitlement to or the amount or extent of any adjustment in the Contract Price or Contract Times, no later than 30 days after Owner's issuance of the Owner's written statement to Contractor regarding the Underground Facility in question.

4. The information and data shown or indicated on the Drawings with respect to existing Underground Facilities at the Site is based on information and data (a) furnished by the owners of such Underground Facilities, or by others, (b) obtained from available records, or (c) gathered in an investigation conducted in accordance with the current edition of ASCE 38, Standard Guideline for the Collection and Depiction of Existing Subsurface Utility Data, by the American Society of Civil Engineers. If such information or data is incorrect or incomplete, Contractor's remedies are limited to those set forth in this Paragraph 5.05.F.

5.06 *Hazardous Environmental Conditions at Site*

A. *Reports and Drawings*: The Supplementary Conditions identify:

1. those reports known to Owner relating to Hazardous Environmental Conditions that have been identified at or adjacent to the Site;

2. drawings known to Owner relating to Hazardous Environmental Conditions that have been identified at or adjacent to the Site; and

3. Technical Data contained in such reports and drawings.

B. *Reliance by Contractor on Technical Data Authorized*: Contractor may rely upon the accuracy of the Technical Data expressly identified in the Supplementary Conditions with respect to such reports and drawings, but such reports and drawings are not Contract Documents. If no such express identification has been made, then Contractor may rely on the accuracy of the Technical Data as defined in Paragraph 1.01.A.46.b. Except for such reliance on Technical

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Data, Contractor may not rely upon or make any claim against Owner or Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors, with respect to:

1. the completeness of such reports and drawings for Contractor's purposes, including, but not limited to, any aspects of the means, methods, techniques, sequences and procedures of construction to be employed by Contractor, and safety precautions and programs incident thereto;
2. other data, interpretations, opinions, and information contained in such reports or shown or indicated in such drawings; or
3. any Contractor interpretation of or conclusion drawn from any Technical Data or any such other data, interpretations, opinions or information.

C. Contractor shall not be responsible for removing or remediating any Hazardous Environmental Condition encountered, uncovered, or revealed at the Site unless such removal or remediation is expressly identified in the Contract Documents to be within the scope of the Work.

D. Contractor shall be responsible for controlling, containing, and duly removing all Constituents of Concern brought to the Site by Contractor, Subcontractors, Suppliers, or anyone else for whom Contractor is responsible, and for any associated costs; and for the costs of removing and remediating any Hazardous Environmental Condition created by the presence of any such Constituents of Concern.

E. If Contractor encounters, uncovers, or reveals a Hazardous Environmental Condition whose removal or remediation is not expressly identified in the Contract Documents as being within the scope of the Work, or if Contractor or anyone for whom Contractor is responsible creates a Hazardous Environmental Condition, then Contractor shall immediately: (1) secure or otherwise isolate such condition; (2) stop all Work in connection with such condition and in any area affected thereby (except in an emergency as required by Paragraph 7.15); and (3) notify Owner and Engineer (and promptly thereafter confirm such notice in writing). Owner shall promptly consult with Engineer concerning the necessity for Owner to retain a qualified expert to evaluate such condition or take corrective action, if any. Promptly after consulting with Engineer, Owner shall take such actions as are necessary to permit Owner to timely obtain required permits and provide Contractor the written notice required by Paragraph 5.06.F. If Contractor or anyone for whom Contractor is responsible created the Hazardous Environmental Condition in question, then Owner may remove and remediate the Hazardous Environmental Condition, and impose a set-off against payments to account for the associated costs.

F. Contractor shall not resume Work in connection with such Hazardous Environmental Condition or in any affected area until after Owner has obtained any required permits related thereto, and delivered written notice to Contractor either (1) specifying that such condition and any affected area is or has been rendered safe for the resumption of Work, or (2) specifying any special conditions under which such Work may be resumed safely.

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G. If Owner and Contractor cannot agree as to entitlement to or on the amount or extent, if any, of any adjustment in Contract Price or Contract Times, as a result of such Work stoppage, such special conditions under which Work is agreed to be resumed by Contractor, or any costs or expenses incurred in response to the Hazardous Environmental Condition, then within 30 days of Owner's written notice regarding the resumption of Work, Contractor may submit a Change Proposal, or Owner may impose a set-off. Entitlement to any such adjustment is subject to the provisions of Paragraphs 4.05.D, 4.05.E, 11.07, and 11.08.

H. If, after receipt of such written notice, Contractor does not agree to resume such Work based on a reasonable belief it is unsafe, or does not agree to resume such Work under such special conditions, then Owner may order the portion of the Work that is in the area affected by such condition to be deleted from the Work, following the contractual change procedures in Article 11. Owner may have such deleted portion of the Work performed by Owner's own forces or others in accordance with Article 8.

I. To the fullest extent permitted by Laws and Regulations, Owner shall indemnify and hold harmless Contractor, Subcontractors, and Engineer, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals, and all court, arbitration, or other dispute resolution costs) arising out of or relating to a Hazardous Environmental Condition, provided that such Hazardous Environmental Condition (1) was not shown or indicated in the Drawings, Specifications, or other Contract Documents, identified as Technical Data entitled to limited reliance pursuant to Paragraph 5.06.B, or identified in the Contract Documents to be included within the scope of the Work, and (2) was not created by Contractor or by anyone for whom Contractor is responsible. Nothing in this Paragraph 5.06.I obligates Owner to indemnify any individual or entity from and against the consequences of that individual's or entity's own negligence.

J. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to the failure to control, contain, or remove a Constituent of Concern brought to the Site by Contractor or by anyone for whom Contractor is responsible, or to a Hazardous Environmental Condition created by Contractor or by anyone for whom Contractor is responsible. Nothing in this Paragraph 5.06.J obligates Contractor to indemnify any individual or entity from and against the consequences of that individual's or entity's own negligence.

K. The provisions of Paragraphs 5.03, 5.04, and 5.05 do not apply to the presence of Constituents of Concern or to a Hazardous Environmental Condition uncovered or revealed at the Site.

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ARTICLE 6—BONDS AND INSURANCE

6.01 *Performance, Payment, and Other Bonds*

A. Contractor shall furnish a performance bond and a payment bond, each in an amount at least equal to the Contract Price, as security for the faithful performance and payment of Contractor's obligations under the Contract. These bonds must remain in effect until one year after the date when final payment becomes due or until completion of the correction period specified in Paragraph 15.08, whichever is later, except as provided otherwise by Laws or Regulations, the terms of a prescribed bond form, the Supplementary Conditions, or other provisions of the Contract.

B. Contractor shall also furnish such other bonds (if any) as are required by the Supplementary Conditions or other provisions of the Contract.

C. All bonds must be in the form included in the Bidding Documents or otherwise specified by Owner prior to execution of the Contract, except as provided otherwise by Laws or Regulations, and must be issued and signed by a surety named in "Companies Holding Certificates of Authority as Acceptable Sureties on Federal Bonds and as Acceptable Reinsuring Companies" as published in Department Circular 570 (as amended and supplemented) by the Bureau of the Fiscal Service, U.S. Department of the Treasury. A bond signed by an agent or attorney-in-fact must be accompanied by a certified copy of that individual's authority to bind the surety. The evidence of authority must show that it is effective on the date the agent or attorney-in-fact signed the accompanying bond.

D. Contractor shall obtain the required bonds from surety companies that are duly licensed or authorized, in the state or jurisdiction in which the Project is located, to issue bonds in the required amounts.

E. If the surety on a bond furnished by Contractor is declared bankrupt or becomes insolvent, or the surety ceases to meet the requirements above, then Contractor shall promptly notify Owner and Engineer in writing and shall, within 20 days after the event giving rise to such notification, provide another bond and surety, both of which must comply with the bond and surety requirements above.

F. If Contractor has failed to obtain a required bond, Owner may exclude the Contractor from the Site and exercise Owner's termination rights under Article 16.

G. Upon request to Owner from any Subcontractor, Supplier, or other person or entity claiming to have furnished labor, services, materials, or equipment used in the performance of the Work, Owner shall provide a copy of the payment bond to such person or entity.

H. Upon request to Contractor from any Subcontractor, Supplier, or other person or entity claiming to have furnished labor, services, materials, or equipment used in the performance of the Work, Contractor shall provide a copy of the payment bond to such person or entity.

6.02 *Insurance—General Provisions*

A. Owner and Contractor shall obtain and maintain insurance as required in this article and in the Supplementary Conditions.

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B. All insurance required by the Contract to be purchased and maintained by Owner or Contractor shall be obtained from insurance companies that are duly licensed or authorized in the state or jurisdiction in which the Project is located to issue insurance policies for the required limits and coverages. Unless a different standard is indicated in the Supplementary Conditions, all companies that provide insurance policies required under this Contract shall have an A.M. Best rating of A-VII or better.

C. Alternative forms of insurance coverage, including but not limited to self-insurance and "Occupational Accident and Excess Employer's Indemnity Policies," are not sufficient to meet the insurance requirements of this Contract, unless expressly allowed in the Supplementary Conditions.

D. Contractor shall deliver to Owner, with copies to each additional insured identified in the Contract, certificates of insurance and endorsements establishing that Contractor has obtained and is maintaining the policies and coverages required by the Contract. Upon request by Owner or any other insured, Contractor shall also furnish other evidence of such required insurance, including but not limited to copies of policies, documentation of applicable self-insured retentions (if allowed) and deductibles, full disclosure of all relevant exclusions, and evidence of insurance required to be purchased and maintained by Subcontractors or Suppliers. In any documentation furnished under this provision, Contractor, Subcontractors, and Suppliers may block out (redact) (1) any confidential premium or pricing information and (2) any wording specific to a project or jurisdiction other than those applicable to this Contract.

E. Owner shall deliver to Contractor, with copies to each additional insured identified in the Contract, certificates of insurance and endorsements establishing that Owner has obtained and is maintaining the policies and coverages required of Owner by the Contract (if any). Upon request by Contractor or any other insured, Owner shall also provide other evidence of such required insurance (if any), including but not limited to copies of policies, documentation of applicable self-insured retentions (if allowed) and deductibles, and full disclosure of all relevant exclusions. In any documentation furnished under this provision, Owner may block out (redact) (1) any confidential premium or pricing information and (2) any wording specific to a project or jurisdiction other than those relevant to this Contract.

F. Failure of Owner or Contractor to demand such certificates or other evidence of the other party's full compliance with these insurance requirements, or failure of Owner or Contractor to identify a deficiency in compliance from the evidence provided, will not be construed as a waiver of the other party's obligation to obtain and maintain such insurance.

G. In addition to the liability insurance required to be provided by Contractor, the Owner, at Owner's option, may purchase and maintain Owner's own liability insurance. Owner's liability policies, if any, operate separately and independently from policies required to be provided by Contractor, and Contractor cannot rely upon Owner's liability policies for any of Contractor's obligations to the Owner, Engineer, or third parties.

H. Contractor shall require:

1. Subcontractors to purchase and maintain worker's compensation, commercial general liability, and other insurance that is appropriate for their participation in the Project, and

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to name as additional insureds Owner and Engineer (and any other individuals or entities identified in the Supplementary Conditions as additional insureds on Contractor's liability policies) on each Subcontractor's commercial general liability insurance policy; and

2. Suppliers to purchase and maintain insurance that is appropriate for their participation in the Project.

I. If either party does not purchase or maintain the insurance required of such party by the Contract, such party shall notify the other party in writing of such failure to purchase prior to the start of the Work, or of such failure to maintain prior to any change in the required coverage.

J. If Contractor has failed to obtain and maintain required insurance, Contractor's entitlement to enter or remain at the Site will end immediately, and Owner may impose an appropriate set-off against payment for any associated costs (including but not limited to the cost of purchasing necessary insurance coverage), and exercise Owner's termination rights under Article 16.

K. Without prejudice to any other right or remedy, if a party has failed to obtain required insurance, the other party may elect (but is in no way obligated) to obtain equivalent insurance to protect such other party's interests at the expense of the party who was required to provide such coverage, and the Contract Price will be adjusted accordingly.

L. Owner does not represent that insurance coverage and limits established in this Contract necessarily will be adequate to protect Contractor or Contractor's interests. Contractor is responsible for determining whether such coverage and limits are adequate to protect its interests, and for obtaining and maintaining any additional insurance that Contractor deems necessary.

M. The insurance and insurance limits required herein will not be deemed as a limitation on Contractor's liability, or that of its Subcontractors or Suppliers, under the indemnities granted to Owner and other individuals and entities in the Contract or otherwise.

N. All the policies of insurance required to be purchased and maintained under this Contract will contain a provision or endorsement that the coverage afforded will not be canceled, or renewal refused, until at least 10 days prior written notice has been given to the purchasing policyholder. Within three days of receipt of any such written notice, the purchasing policyholder shall provide a copy of the notice to each other insured and Engineer.

6.03 *Contractor's Insurance*

A. *Required Insurance*: Contractor shall purchase and maintain Worker's Compensation, Commercial General Liability, and other insurance pursuant to the specific requirements of the Supplementary Conditions.

B. *General Provisions*: The policies of insurance required by this Paragraph 6.03 as supplemented must:

1. include at least the specific coverages required;

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2. be written for not less than the limits provided, or those required by Laws or Regulations, whichever is greater;

3. remain in effect at least until the Work is complete (as set forth in Paragraph 15.06.D), and longer if expressly required elsewhere in this Contract, and at all times thereafter when Contractor may be correcting, removing, or replacing defective Work as a warranty or correction obligation, or otherwise, or returning to the Site to conduct other tasks arising from the Contract;

4. apply with respect to the performance of the Work, whether such performance is by Contractor, any Subcontractor or Supplier, or by anyone directly or indirectly employed by any of them to perform any of the Work, or by anyone for whose acts any of them may be liable; and

5. include all necessary endorsements to support the stated requirements.

C. *Additional Insureds*: The Contractor's commercial general liability, automobile liability, employer's liability, umbrella or excess, pollution liability, and unmanned aerial vehicle liability policies, if required by this Contract, must:

1. include and list as additional insureds Owner and Engineer, and any individuals or entities identified as additional insureds in the Supplementary Conditions;

2. include coverage for the respective officers, directors, members, partners, employees, and consultants of all such additional insureds;

3. afford primary coverage to these additional insureds for all claims covered thereby (including as applicable those arising from both ongoing and completed operations);

4. not seek contribution from insurance maintained by the additional insured; and

5. as to commercial general liability insurance, apply to additional insureds with respect to liability caused in whole or in part by Contractor's acts or omissions, or the acts and omissions of those working on Contractor's behalf, in the performance of Contractor's operations.

6.04 *Builder's Risk and Other Property Insurance*

A. *Builder's Risk*: Unless otherwise provided in the Supplementary Conditions, Contractor shall purchase and maintain builder's risk insurance upon the Work on a completed value basis, in the amount of the Work's full insurable replacement cost (subject to such deductible amounts as may be provided in the Supplementary Conditions or required by Laws and Regulations). The specific requirements applicable to the builder's risk insurance are set forth in the Supplementary Conditions.

B. *Property Insurance for Facilities of Owner Where Work Will Occur*: Owner is responsible for obtaining and maintaining property insurance covering each existing structure, building, or facility in which any part of the Work will occur, or to which any part of the Work will attach or be adjoined. Such property insurance will be written on a special perils (all-risk) form, on a replacement cost basis, providing coverage consistent with that required for the builder's risk

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insurance, and will be maintained until the Work is complete, as set forth in Paragraph 15.06.D.

C. *Property Insurance for Substantially Complete Facilities*: Promptly after Substantial Completion, and before actual occupancy or use of the substantially completed Work, Owner will obtain property insurance for such substantially completed Work, and maintain such property insurance at least until the Work is complete, as set forth in Paragraph 15.06.D. Such property insurance will be written on a special perils (all-risk) form, on a replacement cost basis, and provide coverage consistent with that required for the builder's risk insurance. The builder's risk insurance may terminate upon written confirmation of Owner's procurement of such property insurance.

D. *Partial Occupancy or Use by Owner*: If Owner will occupy or use a portion or portions of the Work prior to Substantial Completion of all the Work, as provided in Paragraph 15.04, then Owner (directly, if it is the purchaser of the builder's risk policy, or through Contractor) will provide advance notice of such occupancy or use to the builder's risk insurer, and obtain an endorsement consenting to the continuation of coverage prior to commencing such partial occupancy or use.

E. *Insurance of Other Property; Additional Insurance*: If the express insurance provisions of the Contract do not require or address the insurance of a property item or interest, then the entity or individual owning such property item will be responsible for insuring it. If Contractor elects to obtain other special insurance to be included in or supplement the builder's risk or property insurance policies provided under this Paragraph 6.04, it may do so at Contractor's expense.

6.05 *Property Losses; Subrogation*

A. The builder's risk insurance policy purchased and maintained in accordance with Paragraph 6.04 (or an installation floater policy if authorized by the Supplementary Conditions), will contain provisions to the effect that in the event of payment of any loss or damage the insurer will have no rights of recovery against any insureds thereunder, or against Engineer or its consultants, or their officers, directors, members, partners, employees, agents, consultants, or subcontractors.

1. Owner and Contractor waive all rights against each other and the respective officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, for all losses and damages caused by, arising out of, or resulting from any of the perils, risks, or causes of loss covered by such policies and any other property insurance applicable to the Work; and, in addition, waive all such rights against Engineer, its consultants, all individuals or entities identified in the Supplementary Conditions as builder's risk or installation floater insureds, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, under such policies for losses and damages so caused.

2. None of the above waivers extends to the rights that any party making such waiver may have to the proceeds of insurance held by Owner or Contractor as trustee or fiduciary, or otherwise payable under any policy so issued.

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B. Any property insurance policy maintained by Owner covering any loss, damage, or consequential loss to Owner's existing structures, buildings, or facilities in which any part of the Work will occur, or to which any part of the Work will attach or adjoin; to adjacent structures, buildings, or facilities of Owner; or to part or all of the completed or substantially completed Work, during partial occupancy or use pursuant to Paragraph 15.04, after Substantial Completion pursuant to Paragraph 15.03, or after final payment pursuant to Paragraph 15.06, will contain provisions to the effect that in the event of payment of any loss or damage the insurer will have no rights of recovery against any insureds thereunder, or against Contractor, Subcontractors, or Engineer, or the officers, directors, members, partners, employees, agents, consultants, or subcontractors of each and any of them, and that the insured is allowed to waive the insurer's rights of subrogation in a written contract executed prior to the loss, damage, or consequential loss.

1. Owner waives all rights against Contractor, Subcontractors, and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them, for all losses and damages caused by, arising out of, or resulting from fire or any of the perils, risks, or causes of loss covered by such policies.

C. The waivers in this Paragraph 6.05 include the waiver of rights due to business interruption, loss of use, or other consequential loss extending beyond direct physical loss or damage to Owner's property or the Work caused by, arising out of, or resulting from fire or other insured peril, risk, or cause of loss.

D. Contractor shall be responsible for assuring that each Subcontract contains provisions whereby the Subcontractor waives all rights against Owner, Contractor, all individuals or entities identified in the Supplementary Conditions as insureds, the Engineer and its consultants, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, for all losses and damages caused by, arising out of, relating to, or resulting from fire or other peril, risk, or cause of loss covered by builder's risk insurance, installation floater, and any other property insurance applicable to the Work.

6.06 *Receipt and Application of Property Insurance Proceeds*

A. Any insured loss under the builder's risk and other policies of property insurance required by Paragraph 6.04 will be adjusted and settled with the named insured that purchased the policy. Such named insured shall act as fiduciary for the other insureds, and give notice to such other insureds that adjustment and settlement of a claim is in progress. Any other insured may state its position regarding a claim for insured loss in writing within 15 days after notice of such claim.

B. Proceeds for such insured losses may be made payable by the insurer either jointly to multiple insureds, or to the named insured that purchased the policy in its own right and as fiduciary for other insureds, subject to the requirements of any applicable mortgage clause. A named insured receiving insurance proceeds under the builder's risk and other policies of insurance required by Paragraph 6.04 shall maintain such proceeds in a segregated account, and distribute such proceeds in accordance with such agreement as the parties in interest may

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reach, or as otherwise required under the dispute resolution provisions of this Contract or applicable Laws and Regulations.

C. If no other special agreement is reached, Contractor shall repair or replace the damaged Work, using allocated insurance proceeds.

ARTICLE 7—CONTRACTOR'S RESPONSIBILITIES

7.01 *Contractor's Means and Methods of Construction*

A. Contractor shall be solely responsible for the means, methods, techniques, sequences, and procedures of construction.

B. If the Contract Documents note, or Contractor determines, that professional engineering or other design services are needed to carry out Contractor's responsibilities for construction means, methods, techniques, sequences, and procedures, or for Site safety, then Contractor shall cause such services to be provided by a properly licensed design professional, at Contractor's expense. Such services are not Owner-delegated professional design services under this Contract, and neither Owner nor Engineer has any responsibility with respect to (1) Contractor's determination of the need for such services, (2) the qualifications or licensing of the design professionals retained or employed by Contractor, (3) the performance of such services, or (4) any errors, omissions, or defects in such services.

7.02 *Supervision and Superintendence*

A. Contractor shall supervise, inspect, and direct the Work competently and efficiently, devoting such attention thereto and applying such skills and expertise as may be necessary to perform the Work in accordance with the Contract Documents.

B. At all times during the progress of the Work, Contractor shall assign a competent resident superintendent who will not be replaced without written notice to Owner and Engineer except under extraordinary circumstances.

7.03 *Labor; Working Hours*

A. Contractor shall provide competent, suitably qualified personnel to survey and lay out the Work and perform construction as required by the Contract Documents. Contractor shall maintain good discipline and order at the Site.

B. Contractor shall be fully responsible to Owner and Engineer for all acts and omissions of Contractor's employees; of Suppliers and Subcontractors, and their employees; and of any other individuals or entities performing or furnishing any of the Work, just as Contractor is responsible for Contractor's own acts and omissions.

C. Except as otherwise required for the safety or protection of persons or the Work or property at the Site or adjacent thereto, and except as otherwise stated in the Contract Documents, all Work at the Site will be performed during regular working hours, Monday through Friday. Contractor will not perform Work on a Saturday, Sunday, or any legal holiday. Contractor may perform Work outside regular working hours or on Saturdays, Sundays, or legal holidays only with Owner's written consent, which will not be unreasonably withheld.

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7.04 *Services, Materials, and Equipment*

A. Unless otherwise specified in the Contract Documents, Contractor shall provide and assume full responsibility for all services, materials, equipment, labor, transportation, construction equipment and machinery, tools, appliances, fuel, power, light, heat, telephone, water, sanitary facilities, temporary facilities, and all other facilities and incidentals necessary for the performance, testing, start up, and completion of the Work, whether or not such items are specifically called for in the Contract Documents.

B. All materials and equipment incorporated into the Work must be new and of good quality, except as otherwise provided in the Contract Documents. All special warranties and guarantees required by the Specifications will expressly run to the benefit of Owner. If required by Engineer, Contractor shall furnish satisfactory evidence (including reports of required tests) as to the source, kind, and quality of materials and equipment.

C. All materials and equipment must be stored, applied, installed, connected, erected, protected, used, cleaned, and conditioned in accordance with instructions of the applicable Supplier, except as otherwise may be provided in the Contract Documents.

7.05 *"Or Equals"*

A. *Contractor's Request; Governing Criteria*: Whenever an item of equipment or material is specified or described in the Contract Documents by using the names of one or more proprietary items or specific Suppliers, the Contract Price has been based upon Contractor furnishing such item as specified. The specification or description of such an item is intended to establish the type, function, appearance, and quality required. Unless the specification or description contains or is followed by words reading that no like, equivalent, or "or equal" item is permitted, Contractor may request that Engineer authorize the use of other items of equipment or material, or items from other proposed Suppliers, under the circumstances described below.

1. If Engineer in its sole discretion determines that an item of equipment or material proposed by Contractor is functionally equal to that named and sufficiently similar so that no change in related Work will be required, Engineer will deem it an "or equal" item. For the purposes of this paragraph, a proposed item of equipment or material will be considered functionally equal to an item so named if:

a. in the exercise of reasonable judgment Engineer determines that the proposed item:

1) is at least equal in materials of construction, quality, durability, appearance, strength, and design characteristics;

2) will reliably perform at least equally well the function and achieve the results imposed by the design concept of the completed Project as a functioning whole;

3) has a proven record of performance and availability of responsive service; and

4) is not objectionable to Owner.

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b. Contractor certifies that, if the proposed item is approved and incorporated into the Work:

1) there will be no increase in cost to the Owner or increase in Contract Times; and

2) the item will conform substantially to the detailed requirements of the item named in the Contract Documents.

B. *Contractor's Expense*: Contractor shall provide all data in support of any proposed "or equal" item at Contractor's expense.

C. *Engineer's Evaluation and Determination*: Engineer will be allowed a reasonable time to evaluate each "or-equal" request. Engineer may require Contractor to furnish additional data about the proposed "or-equal" item. Engineer will be the sole judge of acceptability. No "or-equal" item will be ordered, furnished, installed, or utilized until Engineer's review is complete and Engineer determines that the proposed item is an "or-equal," which will be evidenced by an approved Shop Drawing or other written communication. Engineer will advise Contractor in writing of any negative determination.

D. *Effect of Engineer's Determination*: Neither approval nor denial of an "or-equal" request will result in any change in Contract Price. The Engineer's denial of an "or-equal" request will be final and binding, and may not be reversed through an appeal under any provision of the Contract.

E. *Treatment as a Substitution Request*: If Engineer determines that an item of equipment or material proposed by Contractor does not qualify as an "or-equal" item, Contractor may request that Engineer consider the item a proposed substitute pursuant to Paragraph 7.06.

7.06 *Substitutes*

A. *Contractor's Request; Governing Criteria*: Unless the specification or description of an item of equipment or material required to be furnished under the Contract Documents contains or is followed by words reading that no substitution is permitted, Contractor may request that Engineer authorize the use of other items of equipment or material under the circumstances described below. To the extent possible such requests must be made before commencement of related construction at the Site.

1. Contractor shall submit sufficient information as provided below to allow Engineer to determine if the item of material or equipment proposed is functionally equivalent to that named and an acceptable substitute therefor. Engineer will not accept requests for review of proposed substitute items of equipment or material from anyone other than Contractor.

2. The requirements for review by Engineer will be as set forth in Paragraph 7.06.B, as supplemented by the Specifications, and as Engineer may decide is appropriate under the circumstances.

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3. Contractor shall make written application to Engineer for review of a proposed substitute item of equipment or material that Contractor seeks to furnish or use. The application:
    a. will certify that the proposed substitute item will:
        1) perform adequately the functions and achieve the results called for by the general design;
        2) be similar in substance to the item specified; and
        3) be suited to the same use as the item specified.
    b. will state:
        1) the extent, if any, to which the use of the proposed substitute item will necessitate a change in Contract Times;
        2) whether use of the proposed substitute item in the Work will require a change in any of the Contract Documents (or in the provisions of any other direct contract with Owner for other work on the Project) to adapt the design to the proposed substitute item; and
        3) whether incorporation or use of the proposed substitute item in connection with the Work is subject to payment of any license fee or royalty.
    c. will identify:
        1) all variations of the proposed substitute item from the item specified; and
        2) available engineering, sales, maintenance, repair, and replacement services.
    d. will contain an itemized estimate of all costs or credits that will result directly or indirectly from use of such substitute item, including but not limited to changes in Contract Price, shared savings, costs of redesign, and claims of other contractors affected by any resulting change.

B. *Engineer's Evaluation and Determination*: Engineer will be allowed a reasonable time to evaluate each substitute request, and to obtain comments and direction from Owner. Engineer may require Contractor to furnish additional data about the proposed substitute item. Engineer will be the sole judge of acceptability. No substitute will be ordered, furnished, installed, or utilized until Engineer's review is complete and Engineer determines that the proposed item is an acceptable substitute. Engineer's determination will be evidenced by a Field Order or a proposed Change Order accounting for the substitution itself and all related impacts, including changes in Contract Price or Contract Times. Engineer will advise Contractor in writing of any negative determination.

C. *Special Guarantee*: Owner may require Contractor to furnish at Contractor's expense a special performance guarantee or other surety with respect to any substitute.

D. *Reimbursement of Engineer's Cost*: Engineer will record Engineer's costs in evaluating a substitute proposed or submitted by Contractor. Whether or not Engineer approves a substitute so proposed or submitted by Contractor, Contractor shall reimburse Owner for the reasonable charges of Engineer for evaluating each such proposed substitute. Contractor shall

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also reimburse Owner for the reasonable charges of Engineer for making changes in the Contract Documents (or in the provisions of any other direct contract with Owner) resulting from the acceptance of each proposed substitute.

E. *Contractor's Expense*: Contractor shall provide all data in support of any proposed substitute at Contractor's expense.

F. *Effect of Engineer's Determination*: If Engineer approves the substitution request, Contractor shall execute the proposed Change Order and proceed with the substitution. The Engineer's denial of a substitution request will be final and binding, and may not be reversed through an appeal under any provision of the Contract. Contractor may challenge the scope of reimbursement costs imposed under Paragraph 7.06.D, by timely submittal of a Change Proposal.

7.07 *Concerning Subcontractors and Suppliers*

A. Contractor may retain Subcontractors and Suppliers for the performance of parts of the Work. Such Subcontractors and Suppliers must be acceptable to Owner. The Contractor's retention of a Subcontractor or Supplier for the performance of parts of the Work will not relieve Contractor's obligation to Owner to perform and complete the Work in accordance with the Contract Documents.

B. Contractor shall retain specific Subcontractors and Suppliers for the performance of designated parts of the Work if required by the Contract to do so.

C. Subsequent to the submittal of Contractor's Bid or final negotiation of the terms of the Contract, Owner may not require Contractor to retain any Subcontractor or Supplier to furnish or perform any of the Work against which Contractor has reasonable objection.

D. Prior to entry into any binding subcontract or purchase order, Contractor shall submit to Owner the identity of the proposed Subcontractor or Supplier (unless Owner has already deemed such proposed Subcontractor or Supplier acceptable during the bidding process or otherwise). Such proposed Subcontractor or Supplier shall be deemed acceptable to Owner unless Owner raises a substantive, reasonable objection within 5 days.

E. Owner may require the replacement of any Subcontractor or Supplier. Owner also may require Contractor to retain specific replacements; provided, however, that Owner may not require a replacement to which Contractor has a reasonable objection. If Contractor has submitted the identity of certain Subcontractors or Suppliers for acceptance by Owner, and Owner has accepted it (either in writing or by failing to make written objection thereto), then Owner may subsequently revoke the acceptance of any such Subcontractor or Supplier so identified solely on the basis of substantive, reasonable objection after due investigation. Contractor shall submit an acceptable replacement for the rejected Subcontractor or Supplier.

F. If Owner requires the replacement of any Subcontractor or Supplier retained by Contractor to perform any part of the Work, then Contractor shall be entitled to an adjustment in Contract Price or Contract Times, with respect to the replacement; and Contractor shall initiate a Change Proposal for such adjustment within 30 days of Owner's requirement of replacement.

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G. No acceptance by Owner of any such Subcontractor or Supplier, whether initially or as a replacement, will constitute a waiver of the right of Owner to the completion of the Work in accordance with the Contract Documents.

H. On a monthly basis, Contractor shall submit to Engineer a complete list of all Subcontractors and Suppliers having a direct contract with Contractor, and of all other Subcontractors and Suppliers known to Contractor at the time of submittal.

I. Contractor shall be solely responsible for scheduling and coordinating the work of Subcontractors and Suppliers.

J. The divisions and sections of the Specifications and the identifications of any Drawings do not control Contractor in dividing the Work among Subcontractors or Suppliers, or in delineating the Work to be performed by any specific trade.

K. All Work performed for Contractor by a Subcontractor or Supplier must be pursuant to an appropriate contractual agreement that specifically binds the Subcontractor or Supplier to the applicable terms and conditions of the Contract for the benefit of Owner and Engineer.

L. Owner may furnish to any Subcontractor or Supplier, to the extent practicable, information about amounts paid to Contractor for Work performed for Contractor by the Subcontractor or Supplier.

M. Contractor shall restrict all Subcontractors and Suppliers from communicating with Engineer or Owner, except through Contractor or in case of an emergency, or as otherwise expressly allowed in this Contract.

7.08 *Patent Fees and Royalties*

A. Contractor shall pay all license fees and royalties and assume all costs incident to the use in the performance of the Work or the incorporation in the Work of any invention, design, process, product, or device which is the subject of patent rights or copyrights held by others. If an invention, design, process, product, or device is specified in the Contract Documents for use in the performance of the Work and if, to the actual knowledge of Owner or Engineer, its use is subject to patent rights or copyrights calling for the payment of any license fee or royalty to others, the existence of such rights will be disclosed in the Contract Documents.

B. To the fullest extent permitted by Laws and Regulations, Owner shall indemnify and hold harmless Contractor, and its officers, directors, members, partners, employees, agents, consultants, and subcontractors, from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals, and all court or arbitration or other dispute resolution costs) arising out of or relating to any infringement of patent rights or copyrights incident to the use in the performance of the Work or resulting from the incorporation in the Work of any invention, design, process, product, or device specified in the Contract Documents, but not identified as being subject to payment of any license fee or royalty to others required by patent rights or copyrights.

C. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees,

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agents, consultants and subcontractors of each and any of them, from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to any infringement of patent rights or copyrights incident to the use in the performance of the Work or resulting from the incorporation in the Work of any invention, design, process, product, or device not specified in the Contract Documents.

7.09 *Permits*

A. Unless otherwise provided in the Contract Documents, Contractor shall obtain and pay for all construction permits, licenses, and certificates of occupancy. Owner shall assist Contractor, when necessary, in obtaining such permits and licenses. Contractor shall pay all governmental charges and inspection fees necessary for the prosecution of the Work which are applicable at the time of the submission of Contractor's Bid (or when Contractor became bound under a negotiated contract). Owner shall pay all charges of utility owners for connections for providing permanent service to the Work.

7.10 *Taxes*

A. Contractor shall pay all sales, consumer, use, and other similar taxes required to be paid by Contractor in accordance with the Laws and Regulations of the place of the Project which are applicable during the performance of the Work.

7.11 *Laws and Regulations*

A. Contractor shall give all notices required by and shall comply with all Laws and Regulations applicable to the performance of the Work. Neither Owner nor Engineer shall be responsible for monitoring Contractor's compliance with any Laws or Regulations.

B. If Contractor performs any Work or takes any other action knowing or having reason to know that it is contrary to Laws or Regulations, Contractor shall bear all resulting costs and losses, and shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such Work or other action. It is not Contractor's responsibility to make certain that the Work described in the Contract Documents is in accordance with Laws and Regulations, but this does not relieve Contractor of its obligations under Paragraph 3.03.

C. Owner or Contractor may give written notice to the other party of any changes after the submission of Contractor's Bid (or after the date when Contractor became bound under a negotiated contract) in Laws or Regulations having an effect on the cost or time of performance of the Work, including but not limited to changes in Laws or Regulations having an effect on procuring permits and on sales, use, value-added, consumption, and other similar taxes. If Owner and Contractor are unable to agree on entitlement to or on the amount or extent, if any, of any adjustment in Contract Price or Contract Times resulting from such

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changes, then within 30 days of such written notice Contractor may submit a Change Proposal, or Owner may initiate a Claim.

7.12 *Record Documents*

A. Contractor shall maintain in a safe place at the Site one printed record copy of all Drawings, Specifications, Addenda, Change Orders, Work Change Directives, Field Orders, written interpretations and clarifications, and approved Shop Drawings. Contractor shall keep such record documents in good order and annotate them to show changes made during construction. These record documents, together with all approved Samples, will be available to Engineer for reference. Upon completion of the Work, Contractor shall deliver these record documents to Engineer.

7.13 *Safety and Protection*

A. Contractor shall be solely responsible for initiating, maintaining, and supervising all safety precautions and programs in connection with the Work. Such responsibility does not relieve Subcontractors of their responsibility for the safety of persons or property in the performance of their work, nor for compliance with applicable safety Laws and Regulations.

B. Contractor shall designate a qualified and experienced safety representative whose duties and responsibilities are the prevention of Work-related accidents and the maintenance and supervision of safety precautions and programs.

C. Contractor shall take all necessary precautions for the safety of, and shall provide the necessary protection to prevent damage, injury, or loss to:

1. all persons on the Site or who may be affected by the Work;

2. all the Work and materials and equipment to be incorporated therein, whether in storage on or off the Site; and

3. other property at the Site or adjacent thereto, including trees, shrubs, lawns, walks, pavements, roadways, structures, other work in progress, utilities, and Underground Facilities not designated for removal, relocation, or replacement in the course of construction.

D. All damage, injury, or loss to any property referred to in Paragraph 7.13.C.2 or 7.13.C.3 caused, directly or indirectly, in whole or in part, by Contractor, any Subcontractor, Supplier, or any other individual or entity directly or indirectly employed by any of them to perform any of the Work, or anyone for whose acts any of them may be liable, shall be remedied by Contractor at its expense (except damage or loss attributable to the fault of Drawings or Specifications or to the acts or omissions of Owner or Engineer or anyone employed by any of them, or anyone for whose acts any of them may be liable, and not attributable, directly or indirectly, in whole or in part, to the fault or negligence of Contractor or any Subcontractor, Supplier, or other individual or entity directly or indirectly employed by any of them).

E. Contractor shall comply with all applicable Laws and Regulations relating to the safety of persons or property, or to the protection of persons or property from damage, injury, or loss; and shall erect and maintain all necessary safeguards for such safety and protection.

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F. Contractor shall notify Owner; the owners of adjacent property; the owners of Underground Facilities and other utilities (if the identity of such owners is known to Contractor); and other contractors and utility owners performing work at or adjacent to the Site, in writing, when Contractor knows that prosecution of the Work may affect them, and shall cooperate with them in the protection, removal, relocation, and replacement of their property or work in progress.

G. Contractor shall comply with the applicable requirements of Owner's safety programs, if any. Any Owner's safety programs that are applicable to the Work are identified or included in the Supplementary Conditions or Specifications.

H. Contractor shall inform Owner and Engineer of the specific requirements of Contractor's safety program with which Owner's and Engineer's employees and representatives must comply while at the Site.

I. Contractor's duties and responsibilities for safety and protection will continue until all the Work is completed, Engineer has issued a written notice to Owner and Contractor in accordance with Paragraph 15.06.C that the Work is acceptable, and Contractor has left the Site (except as otherwise expressly provided in connection with Substantial Completion).

J. Contractor's duties and responsibilities for safety and protection will resume whenever Contractor or any Subcontractor or Supplier returns to the Site to fulfill warranty or correction obligations, or to conduct other tasks arising from the Contract Documents.

7.14 *Hazard Communication Programs*

A. Contractor shall be responsible for coordinating any exchange of safety data sheets (formerly known as material safety data sheets) or other hazard communication information required to be made available to or exchanged between or among employers at the Site in accordance with Laws or Regulations.

7.15 *Emergencies*

A. In emergencies affecting the safety or protection of persons or the Work or property at the Site or adjacent thereto, Contractor is obligated to act to prevent damage, injury, or loss. Contractor shall give Engineer prompt written notice if Contractor believes that any significant changes in the Work or variations from the Contract Documents have been caused by an emergency, or are required as a result of Contractor's response to an emergency. If Engineer determines that a change in the Contract Documents is required because of an emergency or Contractor's response, a Work Change Directive or Change Order will be issued.

7.16 *Submittals*

A. *Shop Drawing and Sample Requirements*

1. Before submitting a Shop Drawing or Sample, Contractor shall:

a. review and coordinate the Shop Drawing or Sample with other Shop Drawings and Samples and with the requirements of the Work and the Contract Documents;

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b. determine and verify:

1) all field measurements, quantities, dimensions, specified performance and design criteria, installation requirements, materials, catalog numbers, and similar information with respect to the Submittal;

2) the suitability of all materials and equipment offered with respect to the indicated application, fabrication, shipping, handling, storage, assembly, and installation pertaining to the performance of the Work; and

3) all information relative to Contractor's responsibilities for means, methods, techniques, sequences, and procedures of construction, and safety precautions and programs incident thereto;

c. confirm that the Submittal is complete with respect to all related data included in the Submittal.

2. Each Shop Drawing or Sample must bear a stamp or specific written certification that Contractor has satisfied Contractor's obligations under the Contract Documents with respect to Contractor's review of that Submittal, and that Contractor approves the Submittal.

3. With each Shop Drawing or Sample, Contractor shall give Engineer specific written notice of any variations that the Submittal may have from the requirements of the Contract Documents. This notice must be set forth in a written communication separate from the Submittal; and, in addition, in the case of a Shop Drawing by a specific notation made on the Shop Drawing itself.

B. *Submittal Procedures for Shop Drawings and Samples*: Contractor shall label and submit Shop Drawings and Samples to Engineer for review and approval in accordance with the accepted Schedule of Submittals.

1. *Shop Drawings*

a. Contractor shall submit the number of copies required in the Specifications.

b. Data shown on the Shop Drawings must be complete with respect to quantities, dimensions, specified performance and design criteria, materials, and similar data to show Engineer the services, materials, and equipment Contractor proposes to provide, and to enable Engineer to review the information for the limited purposes required by Paragraph 7.16.C.

2. *Samples*

a. Contractor shall submit the number of Samples required in the Specifications.

b. Contractor shall clearly identify each Sample as to material, Supplier, pertinent data such as catalog numbers, the use for which intended and other data as Engineer may require to enable Engineer to review the Submittal for the limited purposes required by Paragraph 7.16.C.

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3. Where a Shop Drawing or Sample is required by the Contract Documents or the Schedule of Submittals, any related Work performed prior to Engineer's review and approval of the pertinent submittal will be at the sole expense and responsibility of Contractor.

C. *Engineer's Review of Shop Drawings and Samples*

1. Engineer will provide timely review of Shop Drawings and Samples in accordance with the accepted Schedule of Submittals. Engineer's review and approval will be only to determine if the items covered by the Submittals will, after installation or incorporation in the Work, comply with the requirements of the Contract Documents, and be compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents.

2. Engineer's review and approval will not extend to means, methods, techniques, sequences, or procedures of construction, or to safety precautions or programs incident thereto.

3. Engineer's review and approval of a separate item as such will not indicate approval of the assembly in which the item functions.

4. Engineer's review and approval of a Shop Drawing or Sample will not relieve Contractor from responsibility for any variation from the requirements of the Contract Documents unless Contractor has complied with the requirements of Paragraph 7.16.A.3 and Engineer has given written approval of each such variation by specific written notation thereof incorporated in or accompanying the Shop Drawing or Sample. Engineer will document any such approved variation from the requirements of the Contract Documents in a Field Order or other appropriate Contract modification.

5. Engineer's review and approval of a Shop Drawing or Sample will not relieve Contractor from responsibility for complying with the requirements of Paragraphs 7.16.A and B.

6. Engineer's review and approval of a Shop Drawing or Sample, or of a variation from the requirements of the Contract Documents, will not, under any circumstances, change the Contract Times or Contract Price, unless such changes are included in a Change Order.

7. Neither Engineer's receipt, review, acceptance, or approval of a Shop Drawing or Sample will result in such item becoming a Contract Document.

8. Contractor shall perform the Work in compliance with the requirements and commitments set forth in approved Shop Drawings and Samples, subject to the provisions of Paragraph 7.16.C.4.

D. *Resubmittal Procedures for Shop Drawings and Samples*

1. Contractor shall make corrections required by Engineer and shall return the required number of corrected copies of Shop Drawings and submit, as required, new Samples for review and approval. Contractor shall direct specific attention in writing to revisions other than the corrections called for by Engineer on previous Submittals.

2. Contractor shall furnish required Shop Drawing and Sample submittals with sufficient information and accuracy to obtain required approval of an item with no more than two

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resubmittals. Engineer will record Engineer's time for reviewing a third or subsequent resubmittal of a Shop Drawing or Sample, and Contractor shall be responsible for Engineer's charges to Owner for such time. Owner may impose a set-off against payments due Contractor to secure reimbursement for such charges.

3. If Contractor requests a change of a previously approved Shop Drawing or Sample, Contractor shall be responsible for Engineer's charges to Owner for its review time, and Owner may impose a set-off against payments due Contractor to secure reimbursement for such charges, unless the need for such change is beyond the control of Contractor.

E. *Submittals Other than Shop Drawings, Samples, and Owner-Delegated Designs*

1. The following provisions apply to all Submittals other than Shop Drawings, Samples, and Owner-delegated designs:

a. Contractor shall submit all such Submittals to the Engineer in accordance with the Schedule of Submittals and pursuant to the applicable terms of the Contract Documents.

b. Engineer will provide timely review of all such Submittals in accordance with the Schedule of Submittals and return such Submittals with a notation of either Accepted or Not Accepted. Any such Submittal that is not returned within the time established in the Schedule of Submittals will be deemed accepted.

c. Engineer's review will be only to determine if the Submittal is acceptable under the requirements of the Contract Documents as to general form and content of the Submittal.

d. If any such Submittal is not accepted, Contractor shall confer with Engineer regarding the reason for the non-acceptance, and resubmit an acceptable document.

2. Procedures for the submittal and acceptance of the Progress Schedule, the Schedule of Submittals, and the Schedule of Values are set forth in Paragraphs 2.03. 2.04, and 2.05.

F. Owner-delegated Designs: Submittals pursuant to Owner-delegated designs are governed by the provisions of Paragraph 7.19.

7.17 *Contractor's General Warranty and Guarantee*

A. Contractor warrants and guarantees to Owner that all Work will be in accordance with the Contract Documents and will not be defective. Engineer is entitled to rely on Contractor's warranty and guarantee.

B. Owner's rights under this warranty and guarantee are in addition to, and are not limited by, Owner's rights under the correction period provisions of Paragraph 15.08. The time in which Owner may enforce its warranty and guarantee rights under this Paragraph 7.17 is limited only by applicable Laws and Regulations restricting actions to enforce such rights; provided, however, that after the end of the correction period under Paragraph 15.08:

1. Owner shall give Contractor written notice of any defective Work within 60 days of the discovery that such Work is defective; and

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2. Such notice will be deemed the start of an event giving rise to a Claim under Paragraph 12.01.B, such that any related Claim must be brought within 30 days of the notice.

C. Contractor's warranty and guarantee hereunder excludes defects or damage caused by:

1. abuse, or improper modification, maintenance, or operation, by persons other than Contractor, Subcontractors, Suppliers, or any other individual or entity for whom Contractor is responsible; or

2. normal wear and tear under normal usage.

D. Contractor's obligation to perform and complete the Work in accordance with the Contract Documents is absolute. None of the following will constitute an acceptance of Work that is not in accordance with the Contract Documents, a release of Contractor's obligation to perform the Work in accordance with the Contract Documents, or a release of Owner's warranty and guarantee rights under this Paragraph 7.17:

1. Observations by Engineer;

2. Recommendation by Engineer or payment by Owner of any progress or final payment;

3. The issuance of a certificate of Substantial Completion by Engineer or any payment related thereto by Owner;

4. Use or occupancy of the Work or any part thereof by Owner;

5. Any review and approval of a Shop Drawing or Sample submittal;

6. The issuance of a notice of acceptability by Engineer;

7. The end of the correction period established in Paragraph 15.08;

8. Any inspection, test, or approval by others; or

9. Any correction of defective Work by Owner.

E. If the Contract requires the Contractor to accept the assignment of a contract entered into by Owner, then the specific warranties, guarantees, and correction obligations contained in the assigned contract will govern with respect to Contractor's performance obligations to Owner for the Work described in the assigned contract.

7.18 *Indemnification*

A. To the fullest extent permitted by Laws and Regulations, and in addition to any other obligations of Contractor under the Contract or otherwise, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them, from losses, damages, costs, and judgments (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals, and all court or arbitration or other dispute resolution costs) arising from third-party claims or actions relating to or resulting from the performance or furnishing of the Work, provided that any such claim, action, loss, cost, judgment or damage is attributable to bodily injury, sickness, disease, or death, or to damage to or destruction of tangible property (other than the Work itself), including the loss of use

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resulting therefrom, but only to the extent caused by any negligent act or omission of Contractor, any Subcontractor, any Supplier, or any individual or entity directly or indirectly employed by any of them to perform any of the Work, or anyone for whose acts any of them may be liable.

B. In any and all claims against Owner or Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors, by any employee (or the survivor or personal representative of such employee) of Contractor, any Subcontractor, any Supplier, or any individual or entity directly or indirectly employed by any of them to perform any of the Work, or anyone for whose acts any of them may be liable, the indemnification obligation under Paragraph 7.18.A will not be limited in any way by any limitation on the amount or type of damages, compensation, or benefits payable by or for Contractor or any such Subcontractor, Supplier, or other individual or entity under workers' compensation acts, disability benefit acts, or other employee benefit acts.

7.19 *Delegation of Professional Design Services*

A. Owner may require Contractor to provide professional design services for a portion of the Work by express delegation in the Contract Documents. Such delegation will specify the performance and design criteria that such services must satisfy, and the Submittals that Contractor must furnish to Engineer with respect to the Owner-delegated design.

B. Contractor shall cause such Owner-delegated professional design services to be provided pursuant to the professional standard of care by a properly licensed design professional, whose signature and seal must appear on all drawings, calculations, specifications, certifications, and Submittals prepared by such design professional. Such design professional must issue all certifications of design required by Laws and Regulations.

C. If a Shop Drawing or other Submittal related to the Owner-delegated design is prepared by Contractor, a Subcontractor, or others for submittal to Engineer, then such Shop Drawing or other Submittal must bear the written approval of Contractor's design professional when submitted by Contractor to Engineer.

D. Owner and Engineer shall be entitled to rely upon the adequacy, accuracy, and completeness of the services, certifications, and approvals performed or provided by the design professionals retained or employed by Contractor under an Owner-delegated design, subject to the professional standard of care and the performance and design criteria stated in the Contract Documents.

E. Pursuant to this Paragraph 7.19, Engineer's review, approval, and other determinations regarding design drawings, calculations, specifications, certifications, and other Submittals furnished by Contractor pursuant to an Owner-delegated design will be only for the following limited purposes:

1. Checking for conformance with the requirements of this Paragraph 7.19;

2. Confirming that Contractor (through its design professionals) has used the performance and design criteria specified in the Contract Documents; and

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3. Establishing that the design furnished by Contractor is consistent with the design concept expressed in the Contract Documents.

F. Contractor shall not be responsible for the adequacy of performance or design criteria specified by Owner or Engineer.

G. Contractor is not required to provide professional services in violation of applicable Laws and Regulations.

ARTICLE 8—OTHER WORK AT THE SITE

8.01 *Other Work*

A. In addition to and apart from the Work under the Contract Documents, the Owner may perform other work at or adjacent to the Site. Such other work may be performed by Owner's employees, or through contracts between the Owner and third parties. Owner may also arrange to have third-party utility owners perform work on their utilities and facilities at or adjacent to the Site.

B. If Owner performs other work at or adjacent to the Site with Owner's employees, or through contracts for such other work, then Owner shall give Contractor written notice thereof prior to starting any such other work. If Owner has advance information regarding the start of any third-party utility work that Owner has arranged to take place at or adjacent to the Site, Owner shall provide such information to Contractor.

C. Contractor shall afford proper and safe access to the Site to each contractor that performs such other work, each utility owner performing other work, and Owner, if Owner is performing other work with Owner's employees, and provide a reasonable opportunity for the introduction and storage of materials and equipment and the execution of such other work.

D. Contractor shall do all cutting, fitting, and patching of the Work that may be required to properly connect or otherwise make its several parts come together and properly integrate with such other work. Contractor shall not endanger any work of others by cutting, excavating, or otherwise altering such work; provided, however, that Contractor may cut or alter others' work with the written consent of Engineer and the others whose work will be affected.

E. If the proper execution or results of any part of Contractor's Work depends upon work performed by others, Contractor shall inspect such other work and promptly report to Engineer in writing any delays, defects, or deficiencies in such other work that render it unavailable or unsuitable for the proper execution and results of Contractor's Work. Contractor's failure to so report will constitute an acceptance of such other work as fit and proper for integration with Contractor's Work except for latent defects and deficiencies in such other work.

F. The provisions of this article are not applicable to work that is performed by third-party utilities or other third-party entities without a contract with Owner, or that is performed without having been arranged by Owner. If such work occurs, then any related delay,

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disruption, or interference incurred by Contractor is governed by the provisions of Paragraph 4.05.C.3.

8.02 *Coordination*

A. If Owner intends to contract with others for the performance of other work at or adjacent to the Site, to perform other work at or adjacent to the Site with Owner's employees, or to arrange to have utility owners perform work at or adjacent to the Site, the following will be set forth in the Supplementary Conditions or provided to Contractor prior to the start of any such other work:

1. The identity of the individual or entity that will have authority and responsibility for coordination of the activities among the various contractors;

2. An itemization of the specific matters to be covered by such authority and responsibility; and

3. The extent of such authority and responsibilities.

B. Unless otherwise provided in the Supplementary Conditions, Owner shall have sole authority and responsibility for such coordination.

8.03 *Legal Relationships*

A. If, in the course of performing other work for Owner at or adjacent to the Site, the Owner's employees, any other contractor working for Owner, or any utility owner that Owner has arranged to perform work, causes damage to the Work or to the property of Contractor or its Subcontractors, or delays, disrupts, interferes with, or increases the scope or cost of the performance of the Work, through actions or inaction, then Contractor shall be entitled to an equitable adjustment in the Contract Price or the Contract Times. Contractor must submit any Change Proposal seeking an equitable adjustment in the Contract Price or the Contract Times under this paragraph within 30 days of the damaging, delaying, disrupting, or interfering event. The entitlement to, and extent of, any such equitable adjustment will take into account information (if any) regarding such other work that was provided to Contractor in the Contract Documents prior to the submittal of the Bid or the final negotiation of the terms of the Contract, and any remedies available to Contractor under Laws or Regulations concerning utility action or inaction. When applicable, any such equitable adjustment in Contract Price will be conditioned on Contractor assigning to Owner all Contractor's rights against such other contractor or utility owner with respect to the damage, delay, disruption, or interference that is the subject of the adjustment. Contractor's entitlement to an adjustment of the Contract Times or Contract Price is subject to the provisions of Paragraphs 4.05.D and 4.05.E.

B. Contractor shall take reasonable and customary measures to avoid damaging, delaying, disrupting, or interfering with the work of Owner, any other contractor, or any utility owner performing other work at or adjacent to the Site.

1. If Contractor fails to take such measures and as a result damages, delays, disrupts, or interferes with the work of any such other contractor or utility owner, then Owner may impose a set-off against payments due Contractor, and assign to such other contractor or

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utility owner the Owner's contractual rights against Contractor with respect to the breach of the obligations set forth in this Paragraph 8.03.B.

2. When Owner is performing other work at or adjacent to the Site with Owner's employees, Contractor shall be liable to Owner for damage to such other work, and for the reasonable direct delay, disruption, and interference costs incurred by Owner as a result of Contractor's failure to take reasonable and customary measures with respect to Owner's other work. In response to such damage, delay, disruption, or interference, Owner may impose a set-off against payments due Contractor.

C. If Contractor damages, delays, disrupts, or interferes with the work of any other contractor, or any utility owner performing other work at or adjacent to the Site, through Contractor's failure to take reasonable and customary measures to avoid such impacts, or if any claim arising out of Contractor's actions, inactions, or negligence in performance of the Work at or adjacent to the Site is made by any such other contractor or utility owner against Contractor, Owner, or Engineer, then Contractor shall (1) promptly attempt to settle the claim as to all parties through negotiations with such other contractor or utility owner, or otherwise resolve the claim by arbitration or other dispute resolution proceeding or at law, and (2) indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them from and against any such claims, and against all costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such damage, delay, disruption, or interference.

ARTICLE 9—OWNER'S RESPONSIBILITIES

9.01 *Communications to Contractor*

A. Except as otherwise provided in these General Conditions, Owner shall issue all communications to Contractor through Engineer.

9.02 *Replacement of Engineer*

A. Owner may at its discretion appoint an engineer to replace Engineer, provided Contractor makes no reasonable objection to the replacement engineer. The replacement engineer's status under the Contract Documents will be that of the former Engineer.

9.03 *Furnish Data*

A. Owner shall promptly furnish the data required of Owner under the Contract Documents.

9.04 *Pay When Due*

A. Owner shall make payments to Contractor when they are due as provided in the Agreement.

9.05 *Lands and Easements; Reports, Tests, and Drawings*

A. Owner's duties with respect to providing lands and easements are set forth in Paragraph 5.01.

B. Owner's duties with respect to providing engineering surveys to establish reference points are set forth in Paragraph 4.03.

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C. Article 5 refers to Owner's identifying and making available to Contractor copies of reports of explorations and tests of conditions at the Site, and drawings of physical conditions relating to existing surface or subsurface structures at the Site.

9.06 *Insurance*

A. Owner's responsibilities, if any, with respect to purchasing and maintaining liability and property insurance are set forth in Article 6.

9.07 *Change Orders*

A. Owner's responsibilities with respect to Change Orders are set forth in Article 11.

9.08 *Inspections, Tests, and Approvals*

A. Owner's responsibility with respect to certain inspections, tests, and approvals is set forth in Paragraph 14.02.B.

9.09 *Limitations on Owner's Responsibilities*

A. The Owner shall not supervise, direct, or have control or authority over, nor be responsible for, Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work. Owner will not be responsible for Contractor's failure to perform the Work in accordance with the Contract Documents.

9.10 *Undisclosed Hazardous Environmental Condition*

A. Owner's responsibility in respect to an undisclosed Hazardous Environmental Condition is set forth in Paragraph 5.06.

9.11 *Evidence of Financial Arrangements*

A. Upon request of Contractor, Owner shall furnish Contractor reasonable evidence that financial arrangements have been made to satisfy Owner's obligations under the Contract (including obligations under proposed changes in the Work).

9.12 *Safety Programs*

A. While at the Site, Owner's employees and representatives shall comply with the specific applicable requirements of Contractor's safety programs of which Owner has been informed.

B. Owner shall furnish copies of any applicable Owner safety programs to Contractor.

ARTICLE 10—ENGINEER'S STATUS DURING CONSTRUCTION

10.01 *Owner's Representative*

A. Engineer will be Owner's representative during the construction period. The duties and responsibilities and the limitations of authority of Engineer as Owner's representative during construction are set forth in the Contract.

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10.02 *Visits to Site*

A. Engineer will make visits to the Site at intervals appropriate to the various stages of construction as Engineer deems necessary in order to observe, as an experienced and qualified design professional, the progress that has been made and the quality of the various aspects of Contractor's executed Work. Based on information obtained during such visits and observations, Engineer, for the benefit of Owner, will determine, in general, if the Work is proceeding in accordance with the Contract Documents. Engineer will not be required to make exhaustive or continuous inspections on the Site to check the quality or quantity of the Work. Engineer's efforts will be directed toward providing for Owner a greater degree of confidence that the completed Work will conform generally to the Contract Documents. On the basis of such visits and observations, Engineer will keep Owner informed of the progress of the Work and will endeavor to guard Owner against defective Work.

B. Engineer's visits and observations are subject to all the limitations on Engineer's authority and responsibility set forth in Paragraph 10.07. Particularly, but without limitation, during or as a result of Engineer's visits or observations of Contractor's Work, Engineer will not supervise, direct, control, or have authority over or be responsible for Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work.

10.03 *Resident Project Representative*

A. If Owner and Engineer have agreed that Engineer will furnish a Resident Project Representative to represent Engineer at the Site and assist Engineer in observing the progress and quality of the Work, then the authority and responsibilities of any such Resident Project Representative will be as provided in the Supplementary Conditions, and limitations on the responsibilities thereof will be as provided in the Supplementary Conditions and in Paragraph 10.07.

B. If Owner designates an individual or entity who is not Engineer's consultant, agent, or employee to represent Owner at the Site, then the responsibilities and authority of such individual or entity will be as provided in the Supplementary Conditions.

10.04 *Engineer's Authority*

A. Engineer has the authority to reject Work in accordance with Article 14.

B. Engineer's authority as to Submittals is set forth in Paragraph 7.16.

C. Engineer's authority as to design drawings, calculations, specifications, certifications and other Submittals from Contractor in response to Owner's delegation (if any) to Contractor of professional design services, is set forth in Paragraph 7.19.

D. Engineer's authority as to changes in the Work is set forth in Article 11.

E. Engineer's authority as to Applications for Payment is set forth in Article 15.

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10.05 *Determinations for Unit Price Work*

A. Engineer will determine the actual quantities and classifications of Unit Price Work performed by Contractor as set forth in Paragraph 13.03.

10.06 *Decisions on Requirements of Contract Documents and Acceptability of Work*

A. Engineer will render decisions regarding the requirements of the Contract Documents, and judge the acceptability of the Work, pursuant to the specific procedures set forth herein for initial interpretations, Change Proposals, and acceptance of the Work. In rendering such decisions and judgments, Engineer will not show partiality to Owner or Contractor, and will not be liable to Owner, Contractor, or others in connection with any proceedings, interpretations, decisions, or judgments conducted or rendered in good faith.

10.07 *Limitations on Engineer's Authority and Responsibilities*

A. Neither Engineer's authority or responsibility under this Article 10 or under any other provision of the Contract, nor any decision made by Engineer in good faith either to exercise or not exercise such authority or responsibility or the undertaking, exercise, or performance of any authority or responsibility by Engineer, will create, impose, or give rise to any duty in contract, tort, or otherwise owed by Engineer to Contractor, any Subcontractor, any Supplier, any other individual or entity, or to any surety for or employee or agent of any of them.

B. Engineer will not supervise, direct, control, or have authority over or be responsible for Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work. Engineer will not be responsible for Contractor's failure to perform the Work in accordance with the Contract Documents.

C. Engineer will not be responsible for the acts or omissions of Contractor or of any Subcontractor, any Supplier, or of any other individual or entity performing any of the Work.

D. Engineer's review of the final Application for Payment and accompanying documentation, and all maintenance and operating instructions, schedules, guarantees, bonds, certificates of inspection, tests and approvals, and other documentation required to be delivered by Contractor under Paragraph 15.06.A, will only be to determine generally that their content complies with the requirements of, and in the case of certificates of inspections, tests, and approvals, that the results certified indicate compliance with the Contract Documents.

E. The limitations upon authority and responsibility set forth in this Paragraph 10.07 also apply to the Resident Project Representative, if any.

10.08 *Compliance with Safety Program*

A. While at the Site, Engineer's employees and representatives will comply with the specific applicable requirements of Owner's and Contractor's safety programs of which Engineer has been informed.

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ARTICLE 11—CHANGES TO THE CONTRACT

11.01 *Amending and Supplementing the Contract*

A. The Contract may be amended or supplemented by a Change Order, a Work Change Directive, or a Field Order.

B. If an amendment or supplement to the Contract includes a change in the Contract Price or the Contract Times, such amendment or supplement must be set forth in a Change Order.

C. All changes to the Contract that involve (1) the performance or acceptability of the Work, (2) the design (as set forth in the Drawings, Specifications, or otherwise), or (3) other engineering or technical matters, must be supported by Engineer's recommendation. Owner and Contractor may amend other terms and conditions of the Contract without the recommendation of the Engineer.

11.02 *Change Orders*

A. Owner and Contractor shall execute appropriate Change Orders covering:

1. Changes in Contract Price or Contract Times which are agreed to by the parties, including any undisputed sum or amount of time for Work actually performed in accordance with a Work Change Directive;

2. Changes in Contract Price resulting from an Owner set-off, unless Contractor has duly contested such set-off;

3. Changes in the Work which are: (a) ordered by Owner pursuant to Paragraph 11.05, (b) required because of Owner's acceptance of defective Work under Paragraph 14.04 or Owner's correction of defective Work under Paragraph 14.07, or (c) agreed to by the parties, subject to the need for Engineer's recommendation if the change in the Work involves the design (as set forth in the Drawings, Specifications, or otherwise) or other engineering or technical matters; and

4. Changes that embody the substance of any final and binding results under: Paragraph 11.03.B, resolving the impact of a Work Change Directive; Paragraph 11.09, concerning Change Proposals; Article 12, Claims; Paragraph 13.02.D, final adjustments resulting from allowances; Paragraph 13.03.D, final adjustments relating to determination of quantities for Unit Price Work; and similar provisions.

B. If Owner or Contractor refuses to execute a Change Order that is required to be executed under the terms of Paragraph 11.02.A, it will be deemed to be of full force and effect, as if fully executed.

11.03 *Work Change Directives*

A. A Work Change Directive will not change the Contract Price or the Contract Times but is evidence that the parties expect that the modification ordered or documented by a Work Change Directive will be incorporated in a subsequently issued Change Order, following negotiations by the parties as to the Work Change Directive's effect, if any, on the Contract Price and Contract Times; or, if negotiations are unsuccessful, by a determination under the

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terms of the Contract Documents governing adjustments, expressly including Paragraph 11.07 regarding change of Contract Price.

B. If Owner has issued a Work Change Directive and:

1. Contractor believes that an adjustment in Contract Times or Contract Price is necessary, then Contractor shall submit any Change Proposal seeking such an adjustment no later than 30 days after the completion of the Work set out in the Work Change Directive.

2. Owner believes that an adjustment in Contract Times or Contract Price is necessary, then Owner shall submit any Claim seeking such an adjustment no later than 60 days after issuance of the Work Change Directive.

11.04 *Field Orders*

A. Engineer may authorize minor changes in the Work if the changes do not involve an adjustment in the Contract Price or the Contract Times and are compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents. Such changes will be accomplished by a Field Order and will be binding on Owner and also on Contractor, which shall perform the Work involved promptly.

B. If Contractor believes that a Field Order justifies an adjustment in the Contract Price or Contract Times, then before proceeding with the Work at issue, Contractor shall submit a Change Proposal as provided herein.

11.05 *Owner-Authorized Changes in the Work*

A. Without invalidating the Contract and without notice to any surety, Owner may, at any time or from time to time, order additions, deletions, or revisions in the Work. Changes involving the design (as set forth in the Drawings, Specifications, or otherwise) or other engineering or technical matters will be supported by Engineer's recommendation.

B. Such changes in the Work may be accomplished by a Change Order, if Owner and Contractor have agreed as to the effect, if any, of the changes on Contract Times or Contract Price; or by a Work Change Directive. Upon receipt of any such document, Contractor shall promptly proceed with the Work involved; or, in the case of a deletion in the Work, promptly cease construction activities with respect to such deleted Work. Added or revised Work must be performed under the applicable conditions of the Contract Documents.

C. Nothing in this Paragraph 11.05 obligates Contractor to undertake work that Contractor reasonably concludes cannot be performed in a manner consistent with Contractor's safety obligations under the Contract Documents or Laws and Regulations.

11.06 *Unauthorized Changes in the Work*

A. Contractor shall not be entitled to an increase in the Contract Price or an extension of the Contract Times with respect to any work performed that is not required by the Contract Documents, as amended, modified, or supplemented, except in the case of an emergency as provided in Paragraph 7.15 or in the case of uncovering Work as provided in Paragraph 14.05.C.2.

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11.07 *Change of Contract Price*

A. The Contract Price may only be changed by a Change Order. Any Change Proposal for an adjustment in the Contract Price must comply with the provisions of Paragraph 11.09. Any Claim for an adjustment of Contract Price must comply with the provisions of Article 12.

B. An adjustment in the Contract Price will be determined as follows:

1. Where the Work involved is covered by unit prices contained in the Contract Documents, then by application of such unit prices to the quantities of the items involved (subject to the provisions of Paragraph 13.03);

2. Where the Work involved is not covered by unit prices contained in the Contract Documents, then by a mutually agreed lump sum (which may include an allowance for overhead and profit not necessarily in accordance with Paragraph 11.07.C.2); or

3. Where the Work involved is not covered by unit prices contained in the Contract Documents and the parties do not reach mutual agreement to a lump sum, then on the basis of the Cost of the Work (determined as provided in Paragraph 13.01) plus a Contractor's fee for overhead and profit (determined as provided in Paragraph 11.07.C).

C. *Contractor's Fee*: When applicable, the Contractor's fee for overhead and profit will be determined as follows:

1. A mutually acceptable fixed fee; or

2. If a fixed fee is not agreed upon, then a fee based on the following percentages of the various portions of the Cost of the Work:

a. For costs incurred under Paragraphs 13.01.B.1 and 13.01.B.2, the Contractor's fee will be 15 percent;

b. For costs incurred under Paragraph 13.01.B.3, the Contractor's fee will be 5 percent;

c. Where one or more tiers of subcontracts are on the basis of Cost of the Work plus a fee and no fixed fee is agreed upon, the intent of Paragraphs 11.07.C.2.a and 11.07.C.2.b is that the Contractor's fee will be based on: (1) a fee of 15 percent of the costs incurred under Paragraphs 13.01.B.1 and 13.01.B.2 by the Subcontractor that actually performs the Work, at whatever tier, and (2) with respect to Contractor itself and to any Subcontractors of a tier higher than that of the Subcontractor that actually performs the Work, a fee of 5 percent of the amount (fee plus underlying costs incurred) attributable to the next lower tier Subcontractor; provided, however, that for any such subcontracted Work the maximum total fee to be paid by Owner will be no greater than 27 percent of the costs incurred by the Subcontractor that actually performs the Work;

d. No fee will be payable on the basis of costs itemized under Paragraphs 13.01.B.4, 13.01.B.5, and 13.01.C;

e. The amount of credit to be allowed by Contractor to Owner for any change which results in a net decrease in Cost of the Work will be the amount of the actual net

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decrease in Cost of the Work and a deduction of an additional amount equal to 5 percent of such actual net decrease in Cost of the Work; and

f. When both additions and credits are involved in any one change or Change Proposal, the adjustment in Contractor's fee will be computed by determining the sum of the costs in each of the cost categories in Paragraph 13.01.B (specifically, payroll costs, Paragraph 13.01.B.1; incorporated materials and equipment costs, Paragraph 13.01.B.2; Subcontract costs, Paragraph 13.01.B.3; special consultants costs, Paragraph 13.01.B.4; and other costs, Paragraph 13.01.B.5) and applying to each such cost category sum the appropriate fee from Paragraphs 11.07.C.2.a through 11.07.C.2.e, inclusive.

11.08 *Change of Contract Times*

A. The Contract Times may only be changed by a Change Order. Any Change Proposal for an adjustment in the Contract Times must comply with the provisions of Paragraph 11.09. Any Claim for an adjustment in the Contract Times must comply with the provisions of Article 12.

B. Delay, disruption, and interference in the Work, and any related changes in Contract Times, are addressed in and governed by Paragraph 4.05.

11.09 *Change Proposals*

A. *Purpose and Content*: Contractor shall submit a Change Proposal to Engineer to request an adjustment in the Contract Times or Contract Price; contest an initial decision by Engineer concerning the requirements of the Contract Documents or relating to the acceptability of the Work under the Contract Documents; challenge a set-off against payment due; or seek other relief under the Contract. The Change Proposal will specify any proposed change in Contract Times or Contract Price, or other proposed relief, and explain the reason for the proposed change, with citations to any governing or applicable provisions of the Contract Documents. Each Change Proposal will address only one issue, or a set of closely related issues.

B. *Change Proposal Procedures*

1. *Submittal*: Contractor shall submit each Change Proposal to Engineer within 30 days after the start of the event giving rise thereto, or after such initial decision.

2. *Supporting Data*: The Contractor shall submit supporting data, including the proposed change in Contract Price or Contract Time (if any), to the Engineer and Owner within 15 days after the submittal of the Change Proposal.

a. Change Proposals based on or related to delay, interruption, or interference must comply with the provisions of Paragraphs 4.05.D and 4.05.E.

b. Change proposals related to a change of Contract Price must include full and detailed accounts of materials incorporated into the Work and labor and equipment used for the subject Work.

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The supporting data must be accompanied by a written statement that the supporting data are accurate and complete, and that any requested time or price adjustment is the entire adjustment to which Contractor believes it is entitled as a result of said event.

3. *Engineer's Initial Review*: Engineer will advise Owner regarding the Change Proposal, and consider any comments or response from Owner regarding the Change Proposal. If in its discretion Engineer concludes that additional supporting data is needed before conducting a full review and making a decision regarding the Change Proposal, then Engineer may request that Contractor submit such additional supporting data by a date specified by Engineer, prior to Engineer beginning its full review of the Change Proposal.

4. *Engineer's Full Review and Action on the Change Proposal*: Upon receipt of Contractor's supporting data (including any additional data requested by Engineer), Engineer will conduct a full review of each Change Proposal and, within 30 days after such receipt of the Contractor's supporting data, either approve the Change Proposal in whole, deny it in whole, or approve it in part and deny it in part. Such actions must be in writing, with a copy provided to Owner and Contractor. If Engineer does not take action on the Change Proposal within 30 days, then either Owner or Contractor may at any time thereafter submit a letter to the other party indicating that as a result of Engineer's inaction the Change Proposal is deemed denied, thereby commencing the time for appeal of the denial under Article 12.

5. *Binding Decision*: Engineer's decision is final and binding upon Owner and Contractor, unless Owner or Contractor appeals the decision by filing a Claim under Article 12.

C. *Resolution of Certain Change Proposals*: If the Change Proposal does not involve the design (as set forth in the Drawings, Specifications, or otherwise), the acceptability of the Work, or other engineering or technical matters, then Engineer will notify the parties in writing that the Engineer is unable to resolve the Change Proposal. For purposes of further resolution of such a Change Proposal, such notice will be deemed a denial, and Contractor may choose to seek resolution under the terms of Article 12.

D. *Post-Completion*: Contractor shall not submit any Change Proposals after Engineer issues a written recommendation of final payment pursuant to Paragraph 15.06.B.

11.10 *Notification to Surety*

A. If the provisions of any bond require notice to be given to a surety of any change affecting the general scope of the Work or the provisions of the Contract Documents (including, but not limited to, Contract Price or Contract Times), the giving of any such notice will be Contractor's responsibility. The amount of each applicable bond will be adjusted to reflect the effect of any such change.

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ARTICLE 12—CLAIMS

12.01 *Claims*

A. *Claims Process*: The following disputes between Owner and Contractor are subject to the Claims process set forth in this article:

1. Appeals by Owner or Contractor of Engineer's decisions regarding Change Proposals;

2. Owner demands for adjustments in the Contract Price or Contract Times, or other relief under the Contract Documents;

3. Disputes that Engineer has been unable to address because they do not involve the design (as set forth in the Drawings, Specifications, or otherwise), the acceptability of the Work, or other engineering or technical matters; and

4. Subject to the waiver provisions of Paragraph 15.07, any dispute arising after Engineer has issued a written recommendation of final payment pursuant to Paragraph 15.06.B.

B. *Submittal of Claim*: The party submitting a Claim shall deliver it directly to the other party to the Contract promptly (but in no event later than 30 days) after the start of the event giving rise thereto; in the case of appeals regarding Change Proposals within 30 days of the decision under appeal. The party submitting the Claim shall also furnish a copy to the Engineer, for its information only. The responsibility to substantiate a Claim rests with the party making the Claim. In the case of a Claim by Contractor seeking an increase in the Contract Times or Contract Price, Contractor shall certify that the Claim is made in good faith, that the supporting data are accurate and complete, and that to the best of Contractor's knowledge and belief the amount of time or money requested accurately reflects the full amount to which Contractor is entitled.

C. *Review and Resolution*: The party receiving a Claim shall review it thoroughly, giving full consideration to its merits. The two parties shall seek to resolve the Claim through the exchange of information and direct negotiations. The parties may extend the time for resolving the Claim by mutual agreement. All actions taken on a Claim will be stated in writing and submitted to the other party, with a copy to Engineer.

D. *Mediation*

1. At any time after initiation of a Claim, Owner and Contractor may mutually agree to mediation of the underlying dispute. The agreement to mediate will stay the Claim submittal and response process.

2. If Owner and Contractor agree to mediation, then after 60 days from such agreement, either Owner or Contractor may unilaterally terminate the mediation process, and the Claim submittal and decision process will resume as of the date of the termination. If the mediation proceeds but is unsuccessful in resolving the dispute, the Claim submittal and decision process will resume as of the date of the conclusion of the mediation, as determined by the mediator.

3. Owner and Contractor shall each pay one-half of the mediator's fees and costs.

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E. *Partial Approval*: If the party receiving a Claim approves the Claim in part and denies it in part, such action will be final and binding unless within 30 days of such action the other party invokes the procedure set forth in Article 17 for final resolution of disputes.

F. *Denial of Claim*: If efforts to resolve a Claim are not successful, the party receiving the Claim may deny it by giving written notice of denial to the other party. If the receiving party does not take action on the Claim within 90 days, then either Owner or Contractor may at any time thereafter submit a letter to the other party indicating that as a result of the inaction, the Claim is deemed denied, thereby commencing the time for appeal of the denial. A denial of the Claim will be final and binding unless within 30 days of the denial the other party invokes the procedure set forth in Article 17 for the final resolution of disputes.

G. *Final and Binding Results*: If the parties reach a mutual agreement regarding a Claim, whether through approval of the Claim, direct negotiations, mediation, or otherwise; or if a Claim is approved in part and denied in part, or denied in full, and such actions become final and binding; then the results of the agreement or action on the Claim will be incorporated in a Change Order or other written document to the extent they affect the Contract, including the Work, the Contract Times, or the Contract Price.

ARTICLE 13—COST OF THE WORK; ALLOWANCES; UNIT PRICE WORK

13.01 *Cost of the Work*

A. *Purposes for Determination of Cost of the Work*: The term Cost of the Work means the sum of all costs necessary for the proper performance of the Work at issue, as further defined below. The provisions of this Paragraph 13.01 are used for two distinct purposes:

1. To determine Cost of the Work when Cost of the Work is a component of the Contract Price, under cost-plus-fee, time-and-materials, or other cost-based terms; or

2. When needed to determine the value of a Change Order, Change Proposal, Claim, set-off, or other adjustment in Contract Price. When the value of any such adjustment is determined on the basis of Cost of the Work, Contractor is entitled only to those additional or incremental costs required because of the change in the Work or because of the event giving rise to the adjustment.

B. *Costs Included*: Except as otherwise may be agreed to in writing by Owner, costs included in the Cost of the Work will be in amounts no higher than those commonly incurred in the locality of the Project, will not include any of the costs itemized in Paragraph 13.01.C, and will include only the following items:

1. Payroll costs for employees in the direct employ of Contractor in the performance of the Work under schedules of job classifications agreed upon by Owner and Contractor in advance of the subject Work. Such employees include, without limitation, superintendents, foremen, safety managers, safety representatives, and other personnel employed full time on the Work. Payroll costs for employees not employed full time on the Work will be apportioned on the basis of their time spent on the Work. Payroll costs include, but are not limited to, salaries and wages plus the cost of fringe benefits, which include social security contributions, unemployment, excise, and payroll taxes, workers'

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compensation, health and retirement benefits, sick leave, and vacation and holiday pay applicable thereto. The expenses of performing Work outside of regular working hours, on Saturday, Sunday, or legal holidays, will be included in the above to the extent authorized by Owner.

2. Cost of all materials and equipment furnished and incorporated in the Work, including costs of transportation and storage thereof, and Suppliers' field services required in connection therewith. All cash discounts accrue to Contractor unless Owner deposits funds with Contractor with which to make payments, in which case the cash discounts will accrue to Owner. All trade discounts, rebates, and refunds and returns from sale of surplus materials and equipment will accrue to Owner, and Contractor shall make provisions so that they may be obtained.

3. Payments made by Contractor to Subcontractors for Work performed by Subcontractors. If required by Owner, Contractor shall obtain competitive bids from subcontractors acceptable to Owner and Contractor and shall deliver such bids to Owner, which will then determine, with the advice of Engineer, which bids, if any, will be acceptable. If any subcontract provides that the Subcontractor is to be paid on the basis of Cost of the Work plus a fee, the Subcontractor's Cost of the Work and fee will be determined in the same manner as Contractor's Cost of the Work and fee as provided in this Paragraph 13.01.

4. Costs of special consultants (including but not limited to engineers, architects, testing laboratories, surveyors, attorneys, and accountants) employed or retained for services specifically related to the Work.

5. Other costs consisting of the following:

    a. The proportion of necessary transportation, travel, and subsistence expenses of Contractor's employees incurred in discharge of duties connected with the Work.

    b. Cost, including transportation and maintenance, of all materials, supplies, equipment, machinery, appliances, office, and temporary facilities at the Site, which are consumed in the performance of the Work, and cost, less market value, of such items used but not consumed which remain the property of Contractor.

        1) In establishing included costs for materials such as scaffolding, plating, or sheeting, consideration will be given to the actual or the estimated life of the material for use on other projects; or rental rates may be established on the basis of purchase or salvage value of such items, whichever is less. Contractor will not be eligible for compensation for such items in an amount that exceeds the purchase cost of such item.

    c. *Construction Equipment Rental*

        1) Rentals of all construction equipment and machinery, and the parts thereof, in accordance with rental agreements approved by Owner as to price (including any surcharge or special rates applicable to overtime use of the construction equipment or machinery), and the costs of transportation, loading, unloading, assembly, dismantling, and removal thereof. All such costs will be in accordance with the terms of said rental agreements. The rental of any such equipment,

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machinery, or parts must cease when the use thereof is no longer necessary for the Work.

2) Costs for equipment and machinery owned by Contractor or a Contractor-related entity will be paid at a rate shown for such equipment in the equipment rental rate book specified in the Supplementary Conditions. An hourly rate will be computed by dividing the monthly rates by 176. These computed rates will include all operating costs.

3) With respect to Work that is the result of a Change Order, Change Proposal, Claim, set-off, or other adjustment in Contract Price ("changed Work"), included costs will be based on the time the equipment or machinery is in use on the changed Work and the costs of transportation, loading, unloading, assembly, dismantling, and removal when directly attributable to the changed Work. The cost of any such equipment or machinery, or parts thereof, must cease to accrue when the use thereof is no longer necessary for the changed Work.

d. Sales, consumer, use, and other similar taxes related to the Work, and for which Contractor is liable, as imposed by Laws and Regulations.

e. Deposits lost for causes other than negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable, and royalty payments and fees for permits and licenses.

f. Losses and damages (and related expenses) caused by damage to the Work, not compensated by insurance or otherwise, sustained by Contractor in connection with the performance of the Work (except losses and damages within the deductible amounts of builder's risk or other property insurance established in accordance with Paragraph 6.04), provided such losses and damages have resulted from causes other than the negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable. Such losses include settlements made with the written consent and approval of Owner. No such losses, damages, and expenses will be included in the Cost of the Work for the purpose of determining Contractor's fee.

g. The cost of utilities, fuel, and sanitary facilities at the Site.

h. Minor expenses such as communication service at the Site, express and courier services, and similar petty cash items in connection with the Work.

i. The costs of premiums for all bonds and insurance that Contractor is required by the Contract Documents to purchase and maintain.

C. *Costs Excluded*: The term Cost of the Work does not include any of the following items:

1. Payroll costs and other compensation of Contractor's officers, executives, principals, general managers, engineers, architects, estimators, attorneys, auditors, accountants, purchasing and contracting agents, expediters, timekeepers, clerks, and other personnel employed by Contractor, whether at the Site or in Contractor's principal or branch office for general administration of the Work and not specifically included in the agreed upon

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schedule of job classifications referred to in Paragraph 13.01.B.1 or specifically covered by Paragraph 13.01.B.4. The payroll costs and other compensation excluded here are to be considered administrative costs covered by the Contractor's fee.

2. The cost of purchasing, renting, or furnishing small tools and hand tools.

3. Expenses of Contractor's principal and branch offices other than Contractor's office at the Site.

4. Any part of Contractor's capital expenses, including interest on Contractor's capital employed for the Work and charges against Contractor for delinquent payments.

5. Costs due to the negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable, including but not limited to, the correction of defective Work, disposal of materials or equipment wrongly supplied, and making good any damage to property.

6. Expenses incurred in preparing and advancing Claims.

7. Other overhead or general expense costs of any kind and the costs of any item not specifically and expressly included in Paragraph 13.01.B.

D. *Contractor's Fee*

1. When the Work as a whole is performed on the basis of cost-plus-a-fee, then:

a. Contractor's fee for the Work set forth in the Contract Documents as of the Effective Date of the Contract will be determined as set forth in the Agreement.

b. for any Work covered by a Change Order, Change Proposal, Claim, set-off, or other adjustment in Contract Price on the basis of Cost of the Work, Contractor's fee will be determined as follows:

1) When the fee for the Work as a whole is a percentage of the Cost of the Work, the fee will automatically adjust as the Cost of the Work changes.

2) When the fee for the Work as a whole is a fixed fee, the fee for any additions or deletions will be determined in accordance with Paragraph 11.07.C.2.

2. When the Work as a whole is performed on the basis of a stipulated sum, or any other basis other than cost-plus-a-fee, then Contractor's fee for any Work covered by a Change Order, Change Proposal, Claim, set-off, or other adjustment in Contract Price on the basis of Cost of the Work will be determined in accordance with Paragraph 11.07.C.2.

E. *Documentation and Audit*: Whenever the Cost of the Work for any purpose is to be determined pursuant to this Article 13, Contractor and pertinent Subcontractors will establish and maintain records of the costs in accordance with generally accepted accounting practices. Subject to prior written notice, Owner will be afforded reasonable access, during normal business hours, to all Contractor's accounts, records, books, correspondence, instructions, drawings, receipts, vouchers, memoranda, and similar data relating to the Cost of the Work and Contractor's fee. Contractor shall preserve all such documents for a period of three years after the final payment by Owner. Pertinent Subcontractors will afford such access to Owner, and preserve such documents, to the same extent required of Contractor.

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13.02 *Allowances*

A. It is understood that Contractor has included in the Contract Price all allowances so named in the Contract Documents and shall cause the Work so covered to be performed for such sums and by such persons or entities as may be acceptable to Owner and Engineer.

B. *Cash Allowances*: Contractor agrees that:

1. the cash allowances include the cost to Contractor (less any applicable trade discounts) of materials and equipment required by the allowances to be delivered at the Site, and all applicable taxes; and

2. Contractor's costs for unloading and handling on the Site, labor, installation, overhead, profit, and other expenses contemplated for the cash allowances have been included in the Contract Price and not in the allowances, and no demand for additional payment for any of the foregoing will be valid.

C. *Owner's Contingency Allowance*: Contractor agrees that an Owner's contingency allowance, if any, is for the sole use of Owner to cover unanticipated costs.

D. Prior to final payment, an appropriate Change Order will be issued as recommended by Engineer to reflect actual amounts due Contractor for Work covered by allowances, and the Contract Price will be correspondingly adjusted.

13.03 *Unit Price Work*

A. Where the Contract Documents provide that all or part of the Work is to be Unit Price Work, initially the Contract Price will be deemed to include for all Unit Price Work an amount equal to the sum of the unit price for each separately identified item of Unit Price Work times the estimated quantity of each item as indicated in the Agreement.

B. The estimated quantities of items of Unit Price Work are not guaranteed and are solely for the purpose of comparison of Bids and determining an initial Contract Price. Payments to Contractor for Unit Price Work will be based on actual quantities.

C. Each unit price will be deemed to include an amount considered by Contractor to be adequate to cover Contractor's overhead and profit for each separately identified item.

D. Engineer will determine the actual quantities and classifications of Unit Price Work performed by Contractor. Engineer will review with Contractor the Engineer's preliminary determinations on such matters before rendering a written decision thereon (by recommendation of an Application for Payment or otherwise). Engineer's written decision thereon will be final and binding (except as modified by Engineer to reflect changed factual conditions or more accurate data) upon Owner and Contractor, and the final adjustment of Contract Price will be set forth in a Change Order, subject to the provisions of the following paragraph.

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E. *Adjustments in Unit Price*

1. Contractor or Owner shall be entitled to an adjustment in the unit price with respect to an item of Unit Price Work if:

   a. the quantity of the item of Unit Price Work performed by Contractor differs materially and significantly from the estimated quantity of such item indicated in the Agreement; and

   b. Contractor's unit costs to perform the item of Unit Price Work have changed materially and significantly as a result of the quantity change.

2. The adjustment in unit price will account for and be coordinated with any related changes in quantities of other items of Work, and in Contractor's costs to perform such other Work, such that the resulting overall change in Contract Price is equitable to Owner and Contractor.

3. Adjusted unit prices will apply to all units of that item.

ARTICLE 14—TESTS AND INSPECTIONS; CORRECTION, REMOVAL, OR ACCEPTANCE OF DEFECTIVE WORK

14.01 *Access to Work*

A. Owner, Engineer, their consultants and other representatives and personnel of Owner, independent testing laboratories, and authorities having jurisdiction have access to the Site and the Work at reasonable times for their observation, inspection, and testing. Contractor shall provide them proper and safe conditions for such access and advise them of Contractor's safety procedures and programs so that they may comply with such procedures and programs as applicable.

14.02 *Tests, Inspections, and Approvals*

A. Contractor shall give Engineer timely notice of readiness of the Work (or specific parts thereof) for all required inspections and tests, and shall cooperate with inspection and testing personnel to facilitate required inspections and tests.

B. Owner shall retain and pay for the services of an independent inspector, testing laboratory, or other qualified individual or entity to perform all inspections and tests expressly required by the Contract Documents to be furnished and paid for by Owner, except that costs incurred in connection with tests or inspections of covered Work will be governed by the provisions of Paragraph 14.05.

C. If Laws or Regulations of any public body having jurisdiction require any Work (or part thereof) specifically to be inspected, tested, or approved by an employee or other representative of such public body, Contractor shall assume full responsibility for arranging and obtaining such inspections, tests, or approvals, pay all costs in connection therewith, and furnish Engineer the required certificates of inspection or approval.

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D. Contractor shall be responsible for arranging, obtaining, and paying for all inspections and tests required:

1. by the Contract Documents, unless the Contract Documents expressly allocate responsibility for a specific inspection or test to Owner;

2. to attain Owner's and Engineer's acceptance of materials or equipment to be incorporated in the Work;

3. by manufacturers of equipment furnished under the Contract Documents;

4. for testing, adjusting, and balancing of mechanical, electrical, and other equipment to be incorporated into the Work; and

5. for acceptance of materials, mix designs, or equipment submitted for approval prior to Contractor's purchase thereof for incorporation in the Work.

Such inspections and tests will be performed by independent inspectors, testing laboratories, or other qualified individuals or entities acceptable to Owner and Engineer.

E. If the Contract Documents require the Work (or part thereof) to be approved by Owner, Engineer, or another designated individual or entity, then Contractor shall assume full responsibility for arranging and obtaining such approvals.

F. If any Work (or the work of others) that is to be inspected, tested, or approved is covered by Contractor without written concurrence of Engineer, Contractor shall, if requested by Engineer, uncover such Work for observation. Such uncovering will be at Contractor's expense unless Contractor had given Engineer timely notice of Contractor's intention to cover the same and Engineer had not acted with reasonable promptness in response to such notice.

14.03 *Defective Work*

A. *Contractor's Obligation*: It is Contractor's obligation to assure that the Work is not defective.

B. *Engineer's Authority*: Engineer has the authority to determine whether Work is defective, and to reject defective Work.

C. *Notice of Defects*: Prompt written notice of all defective Work of which Owner or Engineer has actual knowledge will be given to Contractor.

D. *Correction, or Removal and Replacement*: Promptly after receipt of written notice of defective Work, Contractor shall correct all such defective Work, whether or not fabricated, installed, or completed, or, if Engineer has rejected the defective Work, remove it from the Project and replace it with Work that is not defective.

E. *Preservation of Warranties*: When correcting defective Work, Contractor shall take no action that would void or otherwise impair Owner's special warranty and guarantee, if any, on said Work.

F. *Costs and Damages*: In addition to its correction, removal, and replacement obligations with respect to defective Work, Contractor shall pay all claims, costs, losses, and damages arising out of or relating to defective Work, including but not limited to the cost of the inspection, testing, correction, removal, replacement, or reconstruction of such defective Work, fines

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levied against Owner by governmental authorities because the Work is defective, and the costs of repair or replacement of work of others resulting from defective Work. Prior to final payment, if Owner and Contractor are unable to agree as to the measure of such claims, costs, losses, and damages resulting from defective Work, then Owner may impose a reasonable set-off against payments due under Article 15.

14.04 *Acceptance of Defective Work*

A. If, instead of requiring correction or removal and replacement of defective Work, Owner prefers to accept it, Owner may do so (subject, if such acceptance occurs prior to final payment, to Engineer's confirmation that such acceptance is in general accord with the design intent and applicable engineering principles, and will not endanger public safety). Contractor shall pay all claims, costs, losses, and damages attributable to Owner's evaluation of and determination to accept such defective Work (such costs to be approved by Engineer as to reasonableness), and for the diminished value of the Work to the extent not otherwise paid by Contractor. If any such acceptance occurs prior to final payment, the necessary revisions in the Contract Documents with respect to the Work will be incorporated in a Change Order. If the parties are unable to agree as to the decrease in the Contract Price, reflecting the diminished value of Work so accepted, then Owner may impose a reasonable set-off against payments due under Article 15. If the acceptance of defective Work occurs after final payment, Contractor shall pay an appropriate amount to Owner.

14.05 *Uncovering Work*

A. Engineer has the authority to require additional inspection or testing of the Work, whether or not the Work is fabricated, installed, or completed.

B. If any Work is covered contrary to the written request of Engineer, then Contractor shall, if requested by Engineer, uncover such Work for Engineer's observation, and then replace the covering, all at Contractor's expense.

C. If Engineer considers it necessary or advisable that covered Work be observed by Engineer or inspected or tested by others, then Contractor, at Engineer's request, shall uncover, expose, or otherwise make available for observation, inspection, or testing as Engineer may require, that portion of the Work in question, and provide all necessary labor, material, and equipment.

1. If it is found that the uncovered Work is defective, Contractor shall be responsible for all claims, costs, losses, and damages arising out of or relating to such uncovering, exposure, observation, inspection, and testing, and of satisfactory replacement or reconstruction (including but not limited to all costs of repair or replacement of work of others); and pending Contractor's full discharge of this responsibility the Owner shall be entitled to impose a reasonable set-off against payments due under Article 15.

2. If the uncovered Work is not found to be defective, Contractor shall be allowed an increase in the Contract Price or an extension of the Contract Times, directly attributable to such uncovering, exposure, observation, inspection, testing, replacement, and reconstruction. If the parties are unable to agree as to the amount or extent thereof, then

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Contractor may submit a Change Proposal within 30 days of the determination that the Work is not defective.

14.06 *Owner May Stop the Work*

A. If the Work is defective, or Contractor fails to supply sufficient skilled workers or suitable materials or equipment, or fails to perform the Work in such a way that the completed Work will conform to the Contract Documents, then Owner may order Contractor to stop the Work, or any portion thereof, until the cause for such order has been eliminated; however, this right of Owner to stop the Work will not give rise to any duty on the part of Owner to exercise this right for the benefit of Contractor, any Subcontractor, any Supplier, any other individual or entity, or any surety for, or employee or agent of any of them.

14.07 *Owner May Correct Defective Work*

A. If Contractor fails within a reasonable time after written notice from Engineer to correct defective Work, or to remove and replace defective Work as required by Engineer, then Owner may, after 7 days' written notice to Contractor, correct or remedy any such deficiency.

B. In exercising the rights and remedies under this Paragraph 14.07, Owner shall proceed expeditiously. In connection with such corrective or remedial action, Owner may exclude Contractor from all or part of the Site, take possession of all or part of the Work and suspend Contractor's services related thereto, and incorporate in the Work all materials and equipment stored at the Site or for which Owner has paid Contractor but which are stored elsewhere. Contractor shall allow Owner, Owner's representatives, agents and employees, Owner's other contractors, and Engineer and Engineer's consultants access to the Site to enable Owner to exercise the rights and remedies under this paragraph.

C. All claims, costs, losses, and damages incurred or sustained by Owner in exercising the rights and remedies under this Paragraph 14.07 will be charged against Contractor as set-offs against payments due under Article 15. Such claims, costs, losses and damages will include but not be limited to all costs of repair, or replacement of work of others destroyed or damaged by correction, removal, or replacement of Contractor's defective Work.

D. Contractor shall not be allowed an extension of the Contract Times because of any delay in the performance of the Work attributable to the exercise by Owner of Owner's rights and remedies under this Paragraph 14.07.

ARTICLE 15—PAYMENTS TO CONTRACTOR; SET-OFFS; COMPLETION; CORRECTION PERIOD

15.01 *Progress Payments*

A. *Basis for Progress Payments*: The Schedule of Values established as provided in Article 2 will serve as the basis for progress payments and will be incorporated into a form of Application for Payment acceptable to Engineer. Progress payments for Unit Price Work will be based on the number of units completed during the pay period, as determined under the provisions of Paragraph 13.03. Progress payments for cost-based Work will be based on Cost of the Work completed by Contractor during the pay period.

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B. *Applications for Payments*

1. At least 20 days before the date established in the Agreement for each progress payment (but not more often than once a month), Contractor shall submit to Engineer for review an Application for Payment filled out and signed by Contractor covering the Work completed as of the date of the Application and accompanied by such supporting documentation as is required by the Contract Documents.

2. If payment is requested on the basis of materials and equipment not incorporated in the Work but delivered and suitably stored at the Site or at another location agreed to in writing, the Application for Payment must also be accompanied by: (a) a bill of sale, invoice, copies of subcontract or purchase order payments, or other documentation establishing full payment by Contractor for the materials and equipment; (b) at Owner's request, documentation warranting that Owner has received the materials and equipment free and clear of all Liens; and (c) evidence that the materials and equipment are covered by appropriate property insurance, a warehouse bond, or other arrangements to protect Owner's interest therein, all of which must be satisfactory to Owner.

3. Beginning with the second Application for Payment, each Application must include an affidavit of Contractor stating that all previous progress payments received by Contractor have been applied to discharge Contractor's legitimate obligations associated with prior Applications for Payment.

4. The amount of retainage with respect to progress payments will be as stipulated in the Agreement.

C. *Review of Applications*

1. Engineer will, within 10 days after receipt of each Application for Payment, including each resubmittal, either indicate in writing a recommendation of payment and present the Application to Owner, or return the Application to Contractor indicating in writing Engineer's reasons for refusing to recommend payment. In the latter case, Contractor may make the necessary corrections and resubmit the Application.

2. Engineer's recommendation of any payment requested in an Application for Payment will constitute a representation by Engineer to Owner, based on Engineer's observations of the executed Work as an experienced and qualified design professional, and on Engineer's review of the Application for Payment and the accompanying data and schedules, that to the best of Engineer's knowledge, information and belief:

   a. the Work has progressed to the point indicated;

   b. the quality of the Work is generally in accordance with the Contract Documents (subject to an evaluation of the Work as a functioning whole prior to or upon Substantial Completion, the results of any subsequent tests called for in the Contract Documents, a final determination of quantities and classifications for Unit Price Work under Paragraph 13.03, and any other qualifications stated in the recommendation); and

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c. the conditions precedent to Contractor's being entitled to such payment appear to have been fulfilled in so far as it is Engineer's responsibility to observe the Work.

3. By recommending any such payment Engineer will not thereby be deemed to have represented that:

   a. inspections made to check the quality or the quantity of the Work as it has been performed have been exhaustive, extended to every aspect of the Work in progress, or involved detailed inspections of the Work beyond the responsibilities specifically assigned to Engineer in the Contract; or

   b. there may not be other matters or issues between the parties that might entitle Contractor to be paid additionally by Owner or entitle Owner to withhold payment to Contractor.

4. Neither Engineer's review of Contractor's Work for the purposes of recommending payments nor Engineer's recommendation of any payment, including final payment, will impose responsibility on Engineer:

   a. to supervise, direct, or control the Work;

   b. for the means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto;

   c. for Contractor's failure to comply with Laws and Regulations applicable to Contractor's performance of the Work;

   d. to make any examination to ascertain how or for what purposes Contractor has used the money paid by Owner; or

   e. to determine that title to any of the Work, materials, or equipment has passed to Owner free and clear of any Liens.

5. Engineer may refuse to recommend the whole or any part of any payment if, in Engineer's opinion, it would be incorrect to make the representations to Owner stated in Paragraph 15.01.C.2.

6. Engineer will recommend reductions in payment (set-offs) necessary in Engineer's opinion to protect Owner from loss because:

   a. the Work is defective, requiring correction or replacement;

   b. the Contract Price has been reduced by Change Orders;

   c. Owner has been required to correct defective Work in accordance with Paragraph 14.07, or has accepted defective Work pursuant to Paragraph 14.04;

   d. Owner has been required to remove or remediate a Hazardous Environmental Condition for which Contractor is responsible; or

   e. Engineer has actual knowledge of the occurrence of any of the events that would constitute a default by Contractor and therefore justify termination for cause under the Contract Documents.

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D. *Payment Becomes Due*

1. Ten days after presentation of the Application for Payment to Owner with Engineer's recommendation, the amount recommended (subject to any Owner set-offs) will become due, and when due will be paid by Owner to Contractor.

E. *Reductions in Payment by Owner*

1. In addition to any reductions in payment (set-offs) recommended by Engineer, Owner is entitled to impose a set-off against payment based on any of the following:

   a. Claims have been made against Owner based on Contractor's conduct in the performance or furnishing of the Work, or Owner has incurred costs, losses, or damages resulting from Contractor's conduct in the performance or furnishing of the Work, including but not limited to claims, costs, losses, or damages from workplace injuries, adjacent property damage, non-compliance with Laws and Regulations, and patent infringement;

   b. Contractor has failed to take reasonable and customary measures to avoid damage, delay, disruption, and interference with other work at or adjacent to the Site;

   c. Contractor has failed to provide and maintain required bonds or insurance;

   d. Owner has been required to remove or remediate a Hazardous Environmental Condition for which Contractor is responsible;

   e. Owner has incurred extra charges or engineering costs related to submittal reviews, evaluations of proposed substitutes, tests and inspections, or return visits to manufacturing or assembly facilities;

   f. The Work is defective, requiring correction or replacement;

   g. Owner has been required to correct defective Work in accordance with Paragraph 14.07, or has accepted defective Work pursuant to Paragraph 14.04;

   h. The Contract Price has been reduced by Change Orders;

   i. An event has occurred that would constitute a default by Contractor and therefore justify a termination for cause;

   j. Liquidated or other damages have accrued as a result of Contractor's failure to achieve Milestones, Substantial Completion, or final completion of the Work;

   k. Liens have been filed in connection with the Work, except where Contractor has delivered a specific bond satisfactory to Owner to secure the satisfaction and discharge of such Liens; or

   l. Other items entitle Owner to a set-off against the amount recommended.

2. If Owner imposes any set-off against payment, whether based on its own knowledge or on the written recommendations of Engineer, Owner will give Contractor immediate written notice (with a copy to Engineer) stating the reasons for such action and the specific amount of the reduction, and promptly pay Contractor any amount remaining after deduction of the amount so withheld. Owner shall promptly pay Contractor the

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amount so withheld, or any adjustment thereto agreed to by Owner and Contractor, if Contractor remedies the reasons for such action. The reduction imposed will be binding on Contractor unless it duly submits a Change Proposal contesting the reduction.

3. Upon a subsequent determination that Owner's refusal of payment was not justified, the amount wrongfully withheld will be treated as an amount due as determined by Paragraph 15.01.D.1 and subject to interest as provided in the Agreement.

15.02 *Contractor's Warranty of Title*

A. Contractor warrants and guarantees that title to all Work, materials, and equipment furnished under the Contract will pass to Owner free and clear of (1) all Liens and other title defects, and (2) all patent, licensing, copyright, or royalty obligations, no later than 7 days after the time of payment by Owner.

15.03 *Substantial Completion*

A. When Contractor considers the entire Work ready for its intended use Contractor shall notify Owner and Engineer in writing that the entire Work is substantially complete and request that Engineer issue a certificate of Substantial Completion. Contractor shall at the same time submit to Owner and Engineer an initial draft of punch list items to be completed or corrected before final payment.

B. Promptly after Contractor's notification, Owner, Contractor, and Engineer shall make an inspection of the Work to determine the status of completion. If Engineer does not consider the Work substantially complete, Engineer will notify Contractor in writing giving the reasons therefor.

C. If Engineer considers the Work substantially complete, Engineer will deliver to Owner a preliminary certificate of Substantial Completion which will fix the date of Substantial Completion. Engineer shall attach to the certificate a punch list of items to be completed or corrected before final payment. Owner shall have 7 days after receipt of the preliminary certificate during which to make written objection to Engineer as to any provisions of the certificate or attached punch list. If, after considering the objections to the provisions of the preliminary certificate, Engineer concludes that the Work is not substantially complete, Engineer will, within 14 days after submission of the preliminary certificate to Owner, notify Contractor in writing that the Work is not substantially complete, stating the reasons therefor. If Owner does not object to the provisions of the certificate, or if despite consideration of Owner's objections Engineer concludes that the Work is substantially complete, then Engineer will, within said 14 days, execute and deliver to Owner and Contractor a final certificate of Substantial Completion (with a revised punch list of items to be completed or corrected) reflecting such changes from the preliminary certificate as Engineer believes justified after consideration of any objections from Owner.

D. At the time of receipt of the preliminary certificate of Substantial Completion, Owner and Contractor will confer regarding Owner's use or occupancy of the Work following Substantial Completion, review the builder's risk insurance policy with respect to the end of the builder's risk coverage, and confirm the transition to coverage of the Work under a permanent property insurance policy held by Owner. Unless Owner and Contractor agree otherwise in

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writing, Owner shall bear responsibility for security, operation, protection of the Work, property insurance, maintenance, heat, and utilities upon Owner's use or occupancy of the Work.

E. After Substantial Completion the Contractor shall promptly begin work on the punch list of items to be completed or corrected prior to final payment. In appropriate cases Contractor may submit monthly Applications for Payment for completed punch list items, following the progress payment procedures set forth above.

F. Owner shall have the right to exclude Contractor from the Site after the date of Substantial Completion subject to allowing Contractor reasonable access to remove its property and complete or correct items on the punch list.

15.04 *Partial Use or Occupancy*

A. Prior to Substantial Completion of all the Work, Owner may use or occupy any substantially completed part of the Work which has specifically been identified in the Contract Documents, or which Owner, Engineer, and Contractor agree constitutes a separately functioning and usable part of the Work that can be used by Owner for its intended purpose without significant interference with Contractor's performance of the remainder of the Work, subject to the following conditions:

1. At any time, Owner may request in writing that Contractor permit Owner to use or occupy any such part of the Work that Owner believes to be substantially complete. If and when Contractor agrees that such part of the Work is substantially complete, Contractor, Owner, and Engineer will follow the procedures of Paragraph 15.03.A through 15.03.E for that part of the Work.

2. At any time, Contractor may notify Owner and Engineer in writing that Contractor considers any such part of the Work substantially complete and request Engineer to issue a certificate of Substantial Completion for that part of the Work.

3. Within a reasonable time after either such request, Owner, Contractor, and Engineer shall make an inspection of that part of the Work to determine its status of completion. If Engineer does not consider that part of the Work to be substantially complete, Engineer will notify Owner and Contractor in writing giving the reasons therefor. If Engineer considers that part of the Work to be substantially complete, the provisions of Paragraph 15.03 will apply with respect to certification of Substantial Completion of that part of the Work and the division of responsibility in respect thereof and access thereto.

4. No use or occupancy or separate operation of part of the Work may occur prior to compliance with the requirements of Paragraph 6.04 regarding builder's risk or other property insurance.

15.05 *Final Inspection*

A. Upon written notice from Contractor that the entire Work or an agreed portion thereof is complete, Engineer will promptly make a final inspection with Owner and Contractor and will notify Contractor in writing of all particulars in which this inspection reveals that the Work, or

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agreed portion thereof, is incomplete or defective. Contractor shall immediately take such measures as are necessary to complete such Work or remedy such deficiencies.

15.06 *Final Payment*

A. *Application for Payment*

1. After Contractor has, in the opinion of Engineer, satisfactorily completed all corrections identified during the final inspection and has delivered, in accordance with the Contract Documents, all maintenance and operating instructions, schedules, guarantees, bonds, certificates or other evidence of insurance, certificates of inspection, annotated record documents (as provided in Paragraph 7.12), and other documents, Contractor may make application for final payment.

2. The final Application for Payment must be accompanied (except as previously delivered) by:

   a. all documentation called for in the Contract Documents;

   b. consent of the surety, if any, to final payment;

   c. satisfactory evidence that all title issues have been resolved such that title to all Work, materials, and equipment has passed to Owner free and clear of any Liens or other title defects, or will so pass upon final payment.

   d. a list of all duly pending Change Proposals and Claims; and

   e. complete and legally effective releases or waivers (satisfactory to Owner) of all Lien rights arising out of the Work, and of Liens filed in connection with the Work.

3. In lieu of the releases or waivers of Liens specified in Paragraph 15.06.A.2 and as approved by Owner, Contractor may furnish receipts or releases in full and an affidavit of Contractor that: (a) the releases and receipts include all labor, services, material, and equipment for which a Lien could be filed; and (b) all payrolls, material and equipment bills, and other indebtedness connected with the Work for which Owner might in any way be responsible, or which might in any way result in liens or other burdens on Owner's property, have been paid or otherwise satisfied. If any Subcontractor or Supplier fails to furnish such a release or receipt in full, Contractor may furnish a bond or other collateral satisfactory to Owner to indemnify Owner against any Lien, or Owner at its option may issue joint checks payable to Contractor and specified Subcontractors and Suppliers.

B. *Engineer's Review of Final Application and Recommendation of Payment*: If, on the basis of Engineer's observation of the Work during construction and final inspection, and Engineer's review of the final Application for Payment and accompanying documentation as required by the Contract Documents, Engineer is satisfied that the Work has been completed and Contractor's other obligations under the Contract have been fulfilled, Engineer will, within 10 days after receipt of the final Application for Payment, indicate in writing Engineer's recommendation of final payment and present the final Application for Payment to Owner for payment. Such recommendation will account for any set-offs against payment that are necessary in Engineer's opinion to protect Owner from loss for the reasons stated above with respect to progress payments. Otherwise, Engineer will return the Application for Payment to

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Contractor, indicating in writing the reasons for refusing to recommend final payment, in which case Contractor shall make the necessary corrections and resubmit the Application for Payment.

C. *Notice of Acceptability*: In support of its recommendation of payment of the final Application for Payment, Engineer will also give written notice to Owner and Contractor that the Work is acceptable, subject to stated limitations in the notice and to the provisions of Paragraph 15.07.

D. *Completion of Work*: The Work is complete (subject to surviving obligations) when it is ready for final payment as established by the Engineer's written recommendation of final payment and issuance of notice of the acceptability of the Work.

E. *Final Payment Becomes Due*: Upon receipt from Engineer of the final Application for Payment and accompanying documentation, Owner shall set off against the amount recommended by Engineer for final payment any further sum to which Owner is entitled, including but not limited to set-offs for liquidated damages and set-offs allowed under the provisions of this Contract with respect to progress payments. Owner shall pay the resulting balance due to Contractor within 30 days of Owner's receipt of the final Application for Payment from Engineer.

15.07 *Waiver of Claims*

A. By making final payment, Owner waives its claim or right to liquidated damages or other damages for late completion by Contractor, except as set forth in an outstanding Claim, appeal under the provisions of Article 17, set-off, or express reservation of rights by Owner. Owner reserves all other claims or rights after final payment.

B. The acceptance of final payment by Contractor will constitute a waiver by Contractor of all claims and rights against Owner other than those pending matters that have been duly submitted as a Claim, or appealed under the provisions of Article 17.

15.08 *Correction Period*

A. If within one year after the date of Substantial Completion (or such longer period of time as may be prescribed by the Supplementary Conditions or the terms of any applicable special guarantee required by the Contract Documents), Owner gives Contractor written notice that any Work has been found to be defective, or that Contractor's repair of any damages to the Site or adjacent areas has been found to be defective, then after receipt of such notice of defect Contractor shall promptly, without cost to Owner and in accordance with Owner's written instructions:

1. correct the defective repairs to the Site or such adjacent areas;

2. correct such defective Work;

3. remove the defective Work from the Project and replace it with Work that is not defective, if the defective Work has been rejected by Owner, and

4. satisfactorily correct or repair or remove and replace any damage to other Work, to the work of others, or to other land or areas resulting from the corrective measures.

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B. Owner shall give any such notice of defect within 60 days of the discovery that such Work or repairs is defective. If such notice is given within such 60 days but after the end of the correction period, the notice will be deemed a notice of defective Work under Paragraph 7.17.B.

C. If, after receipt of a notice of defect within 60 days and within the correction period, Contractor does not promptly comply with the terms of Owner's written instructions, or in an emergency where delay would cause serious risk of loss or damage, Owner may have the defective Work corrected or repaired or may have the rejected Work removed and replaced. Contractor shall pay all costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such correction or repair or such removal and replacement (including but not limited to all costs of repair or replacement of work of others). Contractor's failure to pay such costs, losses, and damages within 10 days of invoice from Owner will be deemed the start of an event giving rise to a Claim under Paragraph 12.01.B, such that any related Claim must be brought within 30 days of the failure to pay.

D. In special circumstances where a particular item of equipment is placed in continuous service before Substantial Completion of all the Work, the correction period for that item may start to run from an earlier date if so provided in the Specifications.

E. Where defective Work (and damage to other Work resulting therefrom) has been corrected or removed and replaced under this paragraph, the correction period hereunder with respect to such Work will be extended for an additional period of one year after such correction or removal and replacement has been satisfactorily completed.

F. Contractor's obligations under this paragraph are in addition to all other obligations and warranties. The provisions of this paragraph are not to be construed as a substitute for, or a waiver of, the provisions of any applicable statute of limitation or repose.

ARTICLE 16—SUSPENSION OF WORK AND TERMINATION

16.01 *Owner May Suspend Work*

A. At any time and without cause, Owner may suspend the Work or any portion thereof for a period of not more than 90 consecutive days by written notice to Contractor and Engineer. Such notice will fix the date on which Work will be resumed. Contractor shall resume the Work on the date so fixed. Contractor shall be entitled to an adjustment in the Contract Price or an extension of the Contract Times directly attributable to any such suspension. Any Change Proposal seeking such adjustments must be submitted no later than 30 days after the date fixed for resumption of Work.

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16.02 *Owner May Terminate for Cause*

A. The occurrence of any one or more of the following events will constitute a default by Contractor and justify termination for cause:

1. Contractor's persistent failure to perform the Work in accordance with the Contract Documents (including, but not limited to, failure to supply sufficient skilled workers or suitable materials or equipment, or failure to adhere to the Progress Schedule);

2. Failure of Contractor to perform or otherwise to comply with a material term of the Contract Documents;

3. Contractor's disregard of Laws or Regulations of any public body having jurisdiction; or

4. Contractor's repeated disregard of the authority of Owner or Engineer.

B. If one or more of the events identified in Paragraph 16.02.A occurs, then after giving Contractor (and any surety) 10 days' written notice that Owner is considering a declaration that Contractor is in default and termination of the Contract, Owner may proceed to:

1. declare Contractor to be in default, and give Contractor (and any surety) written notice that the Contract is terminated; and

2. enforce the rights available to Owner under any applicable performance bond.

C. Subject to the terms and operation of any applicable performance bond, if Owner has terminated the Contract for cause, Owner may exclude Contractor from the Site, take possession of the Work, incorporate in the Work all materials and equipment stored at the Site or for which Owner has paid Contractor but which are stored elsewhere, and complete the Work as Owner may deem expedient.

D. Owner may not proceed with termination of the Contract under Paragraph 16.02.B if Contractor within 7 days of receipt of notice of intent to terminate begins to correct its failure to perform and proceeds diligently to cure such failure.

E. If Owner proceeds as provided in Paragraph 16.02.B, Contractor shall not be entitled to receive any further payment until the Work is completed. If the unpaid balance of the Contract Price exceeds the cost to complete the Work, including all related claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals) sustained by Owner, such excess will be paid to Contractor. If the cost to complete the Work including such related claims, costs, losses, and damages exceeds such unpaid balance, Contractor shall pay the difference to Owner. Such claims, costs, losses, and damages incurred by Owner will be reviewed by Engineer as to their reasonableness and, when so approved by Engineer, incorporated in a Change Order. When exercising any rights or remedies under this paragraph, Owner shall not be required to obtain the lowest price for the Work performed.

F. Where Contractor's services have been so terminated by Owner, the termination will not affect any rights or remedies of Owner against Contractor then existing or which may thereafter accrue, or any rights or remedies of Owner against Contractor or any surety under

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any payment bond or performance bond. Any retention or payment of money due Contractor by Owner will not release Contractor from liability.

G. If and to the extent that Contractor has provided a performance bond under the provisions of Paragraph 6.01.A, the provisions of that bond will govern over any inconsistent provisions of Paragraphs 16.02.B and 16.02.D.

16.03 *Owner May Terminate for Convenience*

A. Upon 7 days' written notice to Contractor and Engineer, Owner may, without cause and without prejudice to any other right or remedy of Owner, terminate the Contract. In such case, Contractor shall be paid for (without duplication of any items):

1. completed and acceptable Work executed in accordance with the Contract Documents prior to the effective date of termination, including fair and reasonable sums for overhead and profit on such Work;

2. expenses sustained prior to the effective date of termination in performing services and furnishing labor, materials, or equipment as required by the Contract Documents in connection with uncompleted Work, plus fair and reasonable sums for overhead and profit on such expenses; and

3. other reasonable expenses directly attributable to termination, including costs incurred to prepare a termination for convenience cost proposal.

B. Contractor shall not be paid for any loss of anticipated profits or revenue, post-termination overhead costs, or other economic loss arising out of or resulting from such termination.

16.04 *Contractor May Stop Work or Terminate*

A. If, through no act or fault of Contractor, (1) the Work is suspended for more than 90 consecutive days by Owner or under an order of court or other public authority, or (2) Engineer fails to act on any Application for Payment within 30 days after it is submitted, or (3) Owner fails for 30 days to pay Contractor any sum finally determined to be due, then Contractor may, upon 7 days' written notice to Owner and Engineer, and provided Owner or Engineer do not remedy such suspension or failure within that time, terminate the contract and recover from Owner payment on the same terms as provided in Paragraph 16.03.

B. In lieu of terminating the Contract and without prejudice to any other right or remedy, if Engineer has failed to act on an Application for Payment within 30 days after it is submitted, or Owner has failed for 30 days to pay Contractor any sum finally determined to be due, Contractor may, 7 days after written notice to Owner and Engineer, stop the Work until payment is made of all such amounts due Contractor, including interest thereon. The provisions of this paragraph are not intended to preclude Contractor from submitting a Change Proposal for an adjustment in Contract Price or Contract Times or otherwise for expenses or damage directly attributable to Contractor's stopping the Work as permitted by this paragraph.

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ARTICLE 17—FINAL RESOLUTION OF DISPUTES

17.01 *Methods and Procedures*

A. *Disputes Subject to Final Resolution*: The following disputed matters are subject to final resolution under the provisions of this article:

1. A timely appeal of an approval in part and denial in part of a Claim, or of a denial in full, pursuant to Article 12; and

2. Disputes between Owner and Contractor concerning the Work, or obligations under the Contract Documents, that arise after final payment has been made.

B. *Final Resolution of Disputes*: For any dispute subject to resolution under this article, Owner or Contractor may:

1. elect in writing to invoke the dispute resolution process provided for in the Supplementary Conditions;

2. agree with the other party to submit the dispute to another dispute resolution process; or

3. if no dispute resolution process is provided for in the Supplementary Conditions or mutually agreed to, give written notice to the other party of the intent to submit the dispute to a court of competent jurisdiction.

ARTICLE 18—MISCELLANEOUS

18.01 *Giving Notice*

A. Whenever any provision of the Contract requires the giving of written notice to Owner, Engineer, or Contractor, it will be deemed to have been validly given only if delivered:

1. in person, by a commercial courier service or otherwise, to the recipient's place of business;

2. by registered or certified mail, postage prepaid, to the recipient's place of business; or

3. by e-mail to the recipient, with the words "Formal Notice" or similar in the e-mail's subject line.

18.02 *Computation of Times*

A. When any period of time is referred to in the Contract by days, it will be computed to exclude the first and include the last day of such period. If the last day of any such period falls on a Saturday or Sunday or on a day made a legal holiday by the law of the applicable jurisdiction, such day will be omitted from the computation.

18.03 *Cumulative Remedies*

A. The duties and obligations imposed by these General Conditions and the rights and remedies available hereunder to the parties hereto are in addition to, and are not to be construed in any way as a limitation of, any rights and remedies available to any or all of them which are

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otherwise imposed or available by Laws or Regulations, by special warranty or guarantee, or by other provisions of the Contract. The provisions of this paragraph will be as effective as if repeated specifically in the Contract Documents in connection with each particular duty, obligation, right, and remedy to which they apply.

18.04 *Limitation of Damages*

A. With respect to any and all Change Proposals, Claims, disputes subject to final resolution, and other matters at issue, neither Owner nor Engineer, nor any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors, shall be liable to Contractor for any claims, costs, losses, or damages sustained by Contractor on or in connection with any other project or anticipated project.

18.05 *No Waiver*

A. A party's non-enforcement of any provision will not constitute a waiver of that provision, nor will it affect the enforceability of that provision or of the remainder of this Contract.

18.06 *Survival of Obligations*

A. All representations, indemnifications, warranties, and guarantees made in, required by, or given in accordance with the Contract, as well as all continuing obligations indicated in the Contract, will survive final payment, completion, and acceptance of the Work or termination of the Contract or of the services of Contractor.

18.07 *Controlling Law*

A. This Contract is to be governed by the law of the state in which the Project is located.

18.08 *Assignment of Contract*

A. Unless expressly agreed to elsewhere in the Contract, no assignment by a party to this Contract of any rights under or interests in the Contract will be binding on the other party without the written consent of the party sought to be bound; and, specifically but without limitation, money that may become due and money that is due may not be assigned without such consent (except to the extent that the effect of this restriction may be limited by law), and unless specifically stated to the contrary in any written consent to an assignment, no assignment will release or discharge the assignor from any duty or responsibility under the Contract.

18.09 *Successors and Assigns*

A. Owner and Contractor each binds itself, its successors, assigns, and legal representatives to the other party hereto, its successors, assigns, and legal representatives in respect to all covenants, agreements, and obligations contained in the Contract Documents.

18.10 *Headings*

A. Article and paragraph headings are inserted for convenience only and do not constitute parts of these General Conditions.

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This document has important legal consequences; consultation with an attorney is encouraged with respect to its use or modification. This document should be adapted to the particular circumstances of the contemplated Project and the controlling Laws and Regulations.

SUPPLEMENTARY CONDITIONS OF THE CONSTRUCTION CONTRACT

Prepared By

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ENGINEERS JOINT CONTRACT DOCUMENTS COMMITTEE

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SUPPLEMENTARY CONDITIONS OF THE CONSTRUCTION CONTRACT

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SUPPLEMENTARY CONDITIONS OF THE CONSTRUCTION CONTRACT

These Supplementary Conditions amend or supplement EJCDC® C-700, Standard General Conditions of the Construction Contract (2018). The General Conditions remain in full force and effect except as amended.

The terms used in these Supplementary Conditions have the meanings stated in the General Conditions. Additional terms used in these Supplementary Conditions have the meanings stated below, which are applicable to both the singular and plural thereof.

The address system used in these Supplementary Conditions is the same as the address system used in the General Conditions, with the prefix "SC" added—for example, "Paragraph SC-4.05."

ARTICLE 1—DEFINITIONS AND TERMINOLOGY

1.01 *Defined Terms*

SC-1.01.A.42 Add the following language at the end of the definition:

For the purposes of M.G.L. Chapter 30, Section 39G, Completion of public works; semi-final and final estimates; payments; extra work; disputed items, Substantial Completion shall also mean either that the Work has been completed except for Work having a valued at less than 1 percent of the then adjusted total Contract Price, or substantially all of the Work has been completed and opened to public use except for minor incomplete or unsatisfactory Work items that do not materially impair the usefulness of the Work as required by the Contract.

SC-1.01.A.51 Add the following definition to the General Conditions:

"State" shall mean the Commonwealth of Massachusetts.

SC-1.01.A.52 Add the following definition to the General Conditions:

"Project Closeout Documents" shall mean Complete As-Built Drawings; Complete Set of Technical Specifications; Operations & Maintenance Manuals in electronic format; Warranties; Project submittals and shop drawings; Commissioning and systems testing reports; Threshold Inspection reports; Executed Substantial/Final Completion forms; LEED documentation; Test & Balance Report; or other documents as requested by the Owner or Engineer.

SC-1.01.A.53 Add the following definition to the General Conditions:

"Material" shall mean and include any article, assembly, system, included in the Work, or any component part thereof, as used in M.G.L. Chapter 30, Section 39M, Contracts for construction and materials; manner of awarding, regarding items equal to those specified.

ARTICLE 2—PRELIMINARY MATTERS

2.01 *Delivery of Bonds and Evidence of Insurance*

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SC-2.01.B Delete Paragraph 2.01.B. in its entirety and insert the following in its place:

B. *Evidence of Contractor's Insurance:* When Contractor delivers the signed counterparts of the Agreement to Owner, Contractor shall also deliver to Owner copies of the policies (including all endorsements, and identification of applicable self-insured retentions and deductibles) of insurance required to be provided by Contractor in this Contract. Contractor may block out (redact) any confidential premium or pricing information contained in any policy or endorsement furnished under this provision.

SC-2.01.C Delete Paragraph 2.01.C in its entirety.

SC-2.01.D Add a new paragraph immediately after Paragraph 2.01.C of the General Conditions, which is to read as follows:

D. Non-Resident Contractor: The Contractor, if a corporation established under laws other than the State in which the proposed construction is located, shall file with the Owner, notice of the name of its resident attorney-in-fact, appointed as required by the laws of the State in which the proposed construction is located. The Contractor, if a resident of a State other than that in which the proposed construction is located and not a corporation, shall file, at the time of execution of the Agreement, with the Owner a written appointment of a resident of the State in which the construction is located, having an office or place of business therein, to be his true and lawful attorney upon whom all lawful processes in any actions or proceedings against him may be served; and in such writing, which shall set forth said attorney's place of residence, shall agree that any lawful process against him which is served on said attorney shall be of the same legal force and validity as if served on him and that the authority shall continue in force so long as any liability remains outstanding against him in said State. The power of attorney shall be filed in the office of the Secretary of the State if required, and copies certified by the Secretary shall be sufficient evidence thereof. Such appointment shall continue in force until revoked by an instrument in writing, designating in a like manner some other person upon whom such processes may be served, which instrument shall be filed in the manner provided herein for the original appointment.

2.02 *Copies of Documents*

SC-2.02 Amend the first sentence of Paragraph 2.02.A. to read as follows:

Owner shall furnish to Contractor 3 printed copies of the Contract Documents (including one fully signed counterpart of the Agreement), and one copy in electronic portable document format (PDF).

SC-2.02 Delete Paragraph 2.02.A in its entirety and insert the following new paragraph in its place:

A. Owner shall furnish to Contractor 3 printed copies of conformed Contract Documents incorporating and integrating all Addenda and any amendments negotiated prior to the Effective Date of the Contract (including one fully signed counterpart of the Agreement), and one copy in electronic portable document format (PDF). Additional printed copies of the conformed Contract Documents will be furnished upon request at the cost of reproduction.

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2.03 *Before Starting Construction*

SC-2.03.B Add a new paragraph immediately after Paragraph 2.03.A of the General Conditions, which is to read as follows:

B. Before any work at the site is started, Contractor shall deliver to Owner, with a copy to Engineer, certificates of insurance (and other evidence of insurance requested by Owner) which Contractor is required to purchase and maintain in accordance with the requirements of Article 6. Contractor shall include and identify on the certificate of insurance, indemnification as required by Article 7.18.

2.06 *Electronic Transmittals*

SC-2.06 Delete Paragraphs 2.06.B and 2.06.C in their entirety and insert the following in their place:

B. *Electronic Documents Protocol:* The parties shall conform to the following provisions in Paragraphs 2.06.B and 2.06.C, together referred to as the Electronic Documents Protocol ("EDP" or "Protocol") for exchange of electronic transmittals.

1. *Basic Requirements*

a. To the fullest extent practical, the parties agree to and will transmit and accept Electronic Documents in an electronic or digital format using the procedures described in this Protocol. Use of the Electronic Documents and any information contained therein is subject to the requirements of this Protocol and other provisions of the Contract.

b. The contents of the information in any Electronic Document will be the responsibility of the transmitting party.

c. Electronic Documents as exchanged by this Protocol may be used in the same manner as the printed versions of the same documents that are exchanged using non-electronic format and methods, subject to the same governing requirements, limitations, and restrictions, set forth in the Contract Documents.

d. Except as otherwise explicitly stated herein, the terms of this Protocol will be incorporated into any other agreement or subcontract between a party and any third party for any portion of the Work on the Project, or any Project-related services, where that third party is, either directly or indirectly, required to exchange Electronic Documents with a party or with Engineer. Nothing herein will modify the requirements of the Contract regarding communications between and among the parties and their subcontractors and consultants.

e. When transmitting Electronic Documents, the transmitting party makes no representations as to long term compatibility, usability, or readability of the items resulting from the receiving party's use of software application packages, operating systems, or computer hardware differing from those established in this Protocol.

f. Nothing herein negates any obligation 1) in the Contract to create, provide, or maintain an original printed record version of Drawings and Specifications, signed and sealed according to applicable Laws and Regulations; 2) to comply with any applicable Law or Regulation governing the signing and sealing of design documents or the signing and electronic transmission of any other documents; or

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3) to comply with the notice requirements of Paragraph 18.01 of the General Conditions.

2. *System Infrastructure for Electronic Document Exchange*

   a. Each party will provide hardware, operating system(s) software, internet, e-mail, and large file transfer functions ("System Infrastructure") at its own cost and sufficient for complying with the EDP requirements. With the exception of minimum standards set forth in this EDP, and any explicit system requirements specified by attachment to this EDP, it is the obligation of each party to determine, for itself, its own System Infrastructure.

      1) The maximum size of an email attachment for exchange of Electronic Documents under this EDP is **15** MB. Attachments larger than that may be exchanged using large file transfer functions or physical media.

      2) Each Party assumes full and complete responsibility for any and all of its own costs, delays, deficiencies, and errors associated with converting, translating, updating, verifying, licensing, or otherwise enabling its System Infrastructure, including operating systems and software, for use with respect to this EDP.

   b. Each party is responsible for its own system operations, security, back-up, archiving, audits, printing resources, and other Information Technology ("IT") for maintaining operations of its System Infrastructure during the Project, including coordination with the party's individual(s) or entity responsible for managing its System Infrastructure and capable of addressing routine communications and other IT issues affecting the exchange of Electronic Documents.

   c. Each party will operate and maintain industry-standard, industry-accepted, ISO-standard, commercial-grade security software and systems that are intended to protect the other party from: software viruses and other malicious software like worms, trojans, adware; data breaches; loss of confidentiality; and other threats in the transmission to or storage of information from the other parties, including transmission of Electronic Documents by physical media such as CD/DVD/flash drive/hard drive. To the extent that a party maintains and operates such security software and systems, it shall not be liable to the other party for any breach of system security.

   d. In the case of disputes, conflicts, or modifications to the EDP required to address issues affecting System Infrastructure, the parties shall cooperatively resolve the issues; but, failing resolution, the Owner is authorized to make and require reasonable and necessary changes to the EDP to effectuate its original intent. If the changes cause additional cost or time to Contractor, not reasonably anticipated under the original EDP, Contractor may seek an adjustment in price or time under the appropriate process in the Contract.

   e. Each party is responsible for its own back-up and archive of documents sent and received during the term of the contract under this EDP, unless this EDP establishes a Project document archive, either as part of a mandatory Project website or other communications protocol, upon which the parties may rely for document archiving during the specified term of operation of such Project document archive. Further,

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each party remains solely responsible for its own post-Project back-up and archive of Project documents after the term of the Contract, or after termination of the Project document archive, if one is established, for as long as required by the Contract and as each party deems necessary for its own purposes.

f. If a receiving party receives an obviously corrupted, damaged, or unreadable Electronic Document, the receiving party will advise the sending party of the incomplete transmission.

g. The parties will bring any non-conforming Electronic Documents into compliance with the EDP. The parties will attempt to complete a successful transmission of the Electronic Document or use an alternative delivery method to complete the communication.

C. *Software Requirements for Electronic Document Exchange; Limitations*

1. Each party will acquire the software and software licenses necessary to create and transmit Electronic Documents and to read and to use any Electronic Documents received from the other party (and if relevant from third parties), using the software formats required in this section of the EDP.

a. Prior to using any updated version of the software required in this section for sending Electronic Documents to the other party, the originating party will first notify and receive concurrence from the other party for use of the updated version or adjust its transmission to comply with this EDP.

2. The parties agree not to intentionally edit, reverse engineer, decrypt, remove security or encryption features, or convert to another format for modification purposes any Electronic Document or information contained therein that was transmitted in a software data format, including Portable Document Format (PDF), intended by sender not to be modified, unless the receiving party obtains the permission of the sending party or is citing or quoting excerpts of the Electronic Document for Project purposes.

3. Software and data formats for exchange of Electronic Documents will conform to the requirements set forth in Exhibit A to this EDP, including software versions, if listed.

SC-2.06 Supplement Paragraph 2.06 of the General Conditions by adding the following paragraph:

D. *Requests by Contractor for Electronic Documents in Other Formats*

1. Release of any Electronic Document versions of the Project documents in formats other than those identified in the Electronic Documents Protocol (if any) or elsewhere in the Contract will be at the sole discretion of the Owner.

2. To extent determined by Owner, in its sole discretion, to be prudent and necessary, release of Electronic Documents versions of Project documents and other Project information requested by Contractor ("Request") in formats other than those identified in the Electronic Documents Protocol (if any) or elsewhere in the Contract will be subject to the provisions of the Owner's response to the Request, and to the following conditions to which Contractor agrees:

a. The content included in the Electronic Documents created by Engineer and covered by the Request was prepared by Engineer as an internal working document for

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Engineer's purposes solely, and is being provided to Contractor on an "AS IS" basis without any warranties of any kind, including, but not limited to any implied warranties of fitness for any purpose. As such, Contractor is advised and acknowledges that the content may not be suitable for Contractor's application, or may require substantial modification and independent verification by Contractor. The content may include limited resolution of models, not-to-scale schematic representations and symbols, use of notes to convey design concepts in lieu of accurate graphics, approximations, graphical simplifications, undocumented intermediate revisions, and other devices that may affect subsequent reuse.

b. Electronic Documents containing text, graphics, metadata, or other types of data that are provided by Engineer to Contractor under the request are only for convenience of Contractor. Any conclusion or information obtained or derived from such data will be at the Contractor's sole risk and the Contractor waives any claims against Engineer or Owner arising from use of data in Electronic Documents covered by the Request.

c. Contractor shall indemnify and hold harmless Owner and Engineer and their subconsultants from all claims, damages, losses, and expenses, including attorneys' fees and defense costs arising out of or resulting from Contractor's use, adaptation, or distribution of any Electronic Documents provided under the Request.

d. Contractor agrees not to sell, copy, transfer, forward, give away or otherwise distribute this information (in source or modified file format) to any third party without the direct written authorization of Engineer, unless such distribution is specifically identified in the Request and is limited to Contractor's subcontractors. Contractor warrants that subsequent use by Contractor's subcontractors complies with all terms of the Contract Documents and Owner's response to Request.

3. In the event that Owner elects to provide or directs the Engineer to provide to Contractor any Contractor-requested Electronic Document versions of Project information that is not explicitly identified in the Contract Documents as being available to Contractor, the Owner shall be reimbursed by Contractor on an hourly basis (at **$200** per hour) for any engineering costs necessary to create or otherwise prepare the data in a manner deemed appropriate by Engineer.

ARTICLE 3—CONTRACT DOCUMENTS: INTENT, REQUIREMENTS, REUSE

3.01 *Intent*

SC-3.01.A Add the following paragraph immediately after Paragraph 3.01.A of the General Conditions which is to read as follows:

1. Each and every provision of law and clause required by law to be inserted in the Contract shall be deemed to be inserted herein, and the Contract shall be read and enforced as though they were included herein. If through mistake or otherwise any such provision is not inserted, or is not correctly inserted, then upon the application of either party, the Contract shall forthwith be physically amended to make such insertion.

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SC-3.03.A Delete Paragraph 3.03.A.3 in its entirety and insert the following:

3. Contractor shall be liable to Owner and/or Engineer for failure to report any such conflict, error, ambiguity or discrepancy if Contractor knew or reasonably should have known thereof.

ARTICLE 4—COMMENCEMENT AND PROGRESS OF THE WORK

4.03 *Reference Points*

SC-4.03 Add a new paragraph at the end of Paragraph 4.03.A of the General Conditions, which is to read as follows:

B. Engineer may check the lines, elevations, reference marks, batter boards, etc., set by Contractor, and Contractor shall correct any errors disclosed by such check. Such a check shall not be considered as approval of Contractor's work and shall not relieve Contractor of the responsibility for accurate and satisfactory construction and completion of the entire Work. Contractor shall furnish personnel to assist Engineer in checking lines and grades.

4.04 *Progress Schedule*

SC-4.04 Add the following paragraph after Paragraph 4.04.A.2 of the General Conditions:

3. The Contractor's resident superintendent shall attend monthly progress meetings at the site of the work with the Engineer and others as appropriate to review schedule status and such other pertinent subjects as may be listed on the agenda by the Engineer.

4.05 *Delays in Contractor's Progress*

SC-4.05 At the beginning of the first sentence of Paragraph 4.05.A, insert the following: "In accordance with G.L. c. 30, §39O, …" In the first sentence of paragraph 4.05.A, strike the word "shall" and replace with "may".

Amend Paragraph 4.05.C by adding the following subparagraphs:

5. *Weather-Related Delays*

a. If "abnormal weather conditions" as set forth in Paragraph 4.05.C.2 of the General Conditions are the basis for a request for an equitable adjustment in the Contract Times, such request must be documented by data substantiating each of the following: 1) that weather conditions were abnormal for the period of time in which the delay occurred, 2) that such weather conditions could not have been reasonably anticipated, and 3) that such weather conditions had an adverse effect on the Work as scheduled.

b. Contractor shall base the bid on costs that anticipate up to five days of abnormal weather conditions throughout the duration of this Contract.

1) Every workday on which one or more of the following conditions exist will be considered a "bad weather day":

i) Total precipitation (as rain equivalent) occurring between 7:00 p.m. on the preceding day (regardless of whether such preceding day is a workday) through 7:00 p.m. on the workday in question equals or

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exceeds 2" of precipitation (as rain equivalent, based on the snow/rain conversion indicated in the table entitled Foreseeable Bad Weather Days; such table is hereby incorporated in this SC-4.05.C by reference.

Delete Paragraph 4.05.G and insert the following in its place:

G. Delays caused by or within the control of the Owner: In such event, and except as provided in M.G.L. c. 30, §39O, the Contractor's sole remedy shall be an extension of the Contract Time. Except as provided in M.G.L. c. 30, §39O, Contractor shall not be eligible for any increase in the Contract Price on account of any delay in the Work, no matter by whom such delay is caused, and Contractor shall make no claim for such an increase, whether such claim is styled as a claim for delay damages, acceleration of work, loss of production, or otherwise.

ARTICLE 5—SITE, SUBSURFACE AND PHYSICAL CONDITIONS, HAZARDOUS ENVIRONMENTAL CONDITIONS

5.01 *Availability of Lands*

SC-5.01 Add a new paragraph immediately after paragraph 5.01.A of the General Conditions, which is to read as follows:

1. If all lands and rights-of-way are not obtained as herein contemplated before construction begins, Contractor shall begin the Work upon such land and rights-of-way as Owner has previously acquired and no claim for damages whatsoever will be allowed by reason of the delay in obtaining the remaining lands and rights-of-way. Should Owner be prevented or enjoined from proceeding with the Work, or from authorizing its prosecution, either before or after the commencement, by reason of any litigation, or by reason of its inability to procure any lands or rights-of-way for the Work, Contractor shall not be entitled to make or assert claim for damage by reason of said delay, or to withdraw from the Agreement except by consent of Owner. Time for completion of the Work will be extended as provided in Article 11, to such time as Owner determines will compensate for the time lost by such delay.

Delete Paragraph 5.01.B in its entirety.

5.03 *Subsurface and Physical Conditions*

SC-5.03 In paragraph 5.03.C insert the word "reasonably" before the word "rely" in the first line and insert the following at the end of the first sentence:

; the Owner does not warrant or guarantee the accuracy or completeness of the information therein, and the Contractor may not so rely to the extent that the Contractor knows, or reasonably should have known, of any inaccuracy or omission therein.

Add the following new paragraphs immediately after Paragraph 5.03.D:

E. The following table lists the reports of explorations and tests of subsurface conditions at or adjacent to the Site that contain Technical Data, and specifically identifies the Technical Data in the report upon which Contractor may rely:

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Report Title	Date of Report	Technical Data
Little River Dam Removal Hydrologic and Hydraulic Modeling Analysis Memo	6/30/2022 (revised 12/15/2023 & 3/14/2024	Hydrologic and hydraulic modeling data/results
MassDOT Structures Inspection Field Report, Winter Street Bridge Over Little River	7/22/2020	Winter Street Bridge data
MassDOT Routine Underwater Inspection Report, Winter Street Bridge Over Little River	8/11/2020	Winter Street Bridge data
Winter Street Bridge Record Plans 1-4	1887 & 1935	Winter Street Bridge data
Sediment Sampling Report Compilation	2/2024	Documentation of all sediment sampling and results obtained prior to February 2024
Little River Dam Phase I Inspections/Evaluation Report	6/19/2019	Little River Dam data
Little River Dam Phase I Inspections/Evaluation Report	6/19/2013	Little River Dam data
Preliminary Geotechnical Engineering Recommendations Report, Little River Fishing Platform and Pedestrian Overlook	5/31/2022	Geotechnical findings at proposed Little River Fishing Platform and Pedestrian Overlook
Preliminary Geotechnical Engineering Recommendations Report, Little River Pedestrian Bridge	5/25/2022	Geotechnical findings at proposed Little River Pedestrian Bridge

F. The following table lists the drawings of existing physical conditions at or adjacent to the Site, including those drawings depicting existing surface or subsurface structures at or adjacent to the Site (except Underground Facilities), that contain Technical Data, and specifically identifies the Technical Data upon which Contractor may rely:

Drawings Title	Date of Drawings	Technical Data
Little River Dam Removal and River Restoration Construction Plans	12/16/2024	Existing conditions

G. Contractor may request copies of reports and drawings identified in SC-5.03.E and SC-5.03.F that were not included with the Bidding Documents from Engineer.

5.04 *Differing Subsurface and Physical Conditions*

Insert the following paragraph before Paragraph 5.04.A:

In accordance with Massachusetts General Laws Chapter 30, Section 39N, if, during the progress of the Work, the Contractor or the OWNER discovers that the actual subsurface or latent physical conditions encountered at the site differ substantially or materially from those shown on the plans or indicated in the Contract Documents either the Contractor or the Owner may request an equitable adjustment in the Contract Price applying to work affected by the differing site conditions. A request for such an adjustment shall be in writing and shall be delivered by the party making such request to the other party as soon as possible after

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such conditions are discovered. Upon receipt of such a request from the Contractor, or upon its own initiative, the Owner will make an investigation of such physical conditions, and if they differ substantially or materially from those shown on the plans or indicated in the Contract Documents or from those ordinarily encountered and generally recognized as inherent in work of the character provided for in the plans and Contract Documents and are of such a nature as to cause an increase or decrease in the cost of performance of the Work or a change in the construction methods required for the performance of the Work which results in an increase or decrease in the cost of the Work, the Owner will make an equitable adjustment in the Contract Price and the Contract shall be modified in writing accordingly.

SC-5.04 Amend Paragraph 5.04.E to add the following before the first sentence of that paragraph:

Adjustments resulting from actual subsurface or latent physical conditions from those indicated will be in accordance with Massachusetts General Law, Chapter 30, Section 39N and the applicable provisions of the Contract Documents.

Replace the word "shall" in the first sentence with "may."

Amend sub-paragraph b. to add the following after the words "Paragraph 13.03":

and provided that the Contractor shall only be entitled to an adjustment in Contract Price to the extent required by Massachusetts General Law, Chapter 30, Section 39N

5.05 *Underground Facilities*

SC-5.05 Delete the phrase "or was not shown or indicated with reasonable accuracy" following the words "Contract Documents" in the first sentence of Paragraph 5.05.B and Paragraph 5.05.C.1.

5.06 *Hazardous Environmental Conditions*

SC-5.06 Add the following new paragraphs immediately after Paragraph 5.06.A.3:

4. The following table lists the reports known to Owner relating to Hazardous Environmental Conditions at or adjacent to the Site, and the Technical Data (if any) upon which Contractor may rely:

Report Title	Date of Report	Technical Data
Sediment Sampling Report Compilation	2/2024	Documentation of all sediment sampling and results obtained prior to February 2024

SC-5.06 Add the word "reasonably" before the word "rely" in the first sentence of Paragraph 5.06.B.3.

Add the following at the end of Paragraph 5.06.C: ", or unless Contractor caused or contributed to such Hazardous Environmental Condition."

Delete the second and third sentences of Paragraph 5.06.E.

Delete Paragraph 5.06.I in its entirety.

Delete the last sentence of Paragraph 5.06.J.

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ARTICLE 6—BONDS AND INSURANCE

6.01 *Performance, Payment, and Other Bonds*

SC-6.01 Add the following paragraphs immediately after Paragraph 6.01.A:

1. *Required Performance Bond Form:* The performance bond that Contractor furnishes will be in the form of EJCDC® C-610, Performance Bond (2010, 2013, or 2018 edition).
2. *Required Payment Bond Form:* The payment bond that Contractor furnishes will be in the form of EJCDC® C-615, Payment Bond (2010, 2013, or 2018 edition).
3. Pursuant to M.G.L. Chapter 30, Section 39A, Construction contracts for public ways, airports or public works; truck rentals; security for payment, and M.G.L. Chapter 149, Section 29, Bonds for payment for labor, materials, rentals or transportation charges (et al), the required payment bond shall also cover payment by the Contractor and Subcontractors for the rental or hire of dump trucks and "the rental or hire of vehicles, steam shovels, rollers propelled by steam or other power, concrete mixers, tools and other appliances and equipment employed in such construction," and for payment of transportation charges directly related to such rental or hire. Such security for payment of transportation charges shall be incorporated by appropriate reference thereto as an additional obligation or condition in the required bonds.
4. In addition, such bonds shall cover payment by Contractor and Subcontractors of any sums due trustees or other persons authorized to collect such payments from the Contractor or Subcontractors, for health and welfare plans, supplementary unemployment benefit plans and other fringe benefits which are payable in cash and provided for in collective bargaining agreements between organized labor and the Contractor or Subcontractors.

Add the following new paragraph immediately after 6.01.H:

I. If there is more than one surety company, the surety companies shall be jointly and severally liable.

6.02 *Insurance—General Provisions*

SC-6.02 Delete Paragraph 6.02.E in its entirety.

Delete Paragraph 6.02.I in its entirety and replace it with the following:

I. If Owner has any objection to the coverage afforded by or other provisions of the insurance purchased and maintained by Contractor in accordance with this Article 6 on the basis of its not complying with the Contract Documents, Owner will notify Contractor in writing thereof within thirty days of the date of delivery of such certificates to Owner in accordance with paragraph 2.01.B, and Contractor will provide such additional information in respect of insurance provided by him as Owner may reasonably request.

6.03 *Contractor's Insurance*

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SC-6.03 Supplement Paragraph 6.03 with the following provisions after Paragraph 6.03.C:

D. *Workers' Compensation and Employer's Liability:* Contractor shall purchase and maintain workers' compensation and employer's liability insurance, including, as applicable, United States Longshoreman and Harbor Workers' Compensation Act, Jones Act, stop-gap employer's liability coverage for monopolistic states, and foreign voluntary workers' compensation (from available sources, notwithstanding the jurisdictional requirement of Paragraph 6.02.B of the General Conditions).

Workers' Compensation and Related Policies	Policy limits of not less than:
Workers' Compensation	
State	Statutory
Applicable Federal (e.g., Longshoreman's)	Statutory
Foreign voluntary workers' compensation (employer's responsibility coverage), if applicable	Statutory
Employer's Liability	
Each accident	$1,000,000
Each employee	$1,000,000
Policy limit	$1,000,000

F. *Commercial General Liability—Claims Covered:* Contractor shall purchase and maintain commercial general liability insurance, covering all operations by or on behalf of Contractor, on an occurrence basis, against claims for:

1. damages because of bodily injury, sickness or disease, or death of any person other than Contractor's employees,
2. damages insured by reasonably available personal injury liability coverage, and
3. damages because of injury to or destruction of tangible property wherever located, including loss of use resulting therefrom.

G. *Commercial General Liability—Form and Content:* Contractor's commercial liability policy must be written on a 1996 (or later) Insurance Services Organization, Inc. (ISO) commercial general liability form (occurrence form) and include the following coverages and endorsements:

1. Products and completed operations coverage.
   a. Such insurance must be maintained for three years after final payment.
   b. Contractor shall furnish Owner and each other additional insured (as identified in the Supplementary Conditions or elsewhere in the Contract) evidence of continuation of such insurance at final payment and three years thereafter.
2. Blanket contractual liability coverage, including but not limited to coverage of Contractor's contractual indemnity obligations in Paragraph 7.18.
3. Severability of interests and no insured-versus-insured or cross-liability exclusions.
4. Underground, explosion, and collapse coverage.

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5. Personal injury coverage.

6. Additional insured endorsements that include both ongoing operations and products and completed operations coverage through ISO Endorsements CG 20 10 10 01 and CG 20 37 10 01 (together). If Contractor demonstrates to Owner that the specified ISO endorsements are not commercially available, then Contractor may satisfy this requirement by providing equivalent endorsements.

7. For design professional additional insureds, ISO Endorsement CG 20 32 07 04 "Additional Insured—Engineers, Architects or Surveyors Not Engaged by the Named Insured" or its equivalent.

H. *Commercial General Liability—Excluded Content:* The commercial general liability insurance policy, including its coverages, endorsements, and incorporated provisions, must not include any of the following:

1. Any modification of the standard definition of "insured contract" (except to delete the railroad protective liability exclusion if Contractor is required to indemnify a railroad or others with respect to Work within 50 feet of railroad property).

2. Any exclusion for water intrusion or water damage.

3. Any provisions resulting in the erosion of insurance limits by defense costs other than those already incorporated in ISO form CG 00 01.

4. Any exclusion of coverage relating to earth subsidence or movement.

5. Any exclusion for the insured's vicarious liability, strict liability, or statutory liability (other than worker's compensation).

6. Any limitation or exclusion based on the nature of Contractor's work.

7. Any professional liability exclusion broader in effect than the most recent edition of ISO form CG 22 79.

I. *Commercial General Liability—Minimum Policy Limits*

Commercial General Liability	**Policy limits of not less than:**
General Aggregate	$2,000,000
Products—Completed Operations Aggregate	$2,000,000
Personal and Advertising Injury	$1,000,000
Bodily Injury and Property Damage—Each Occurrence	$1,000,000

J. *Automobile Liability:* Contractor shall purchase and maintain automobile liability insurance for damages because of bodily injury or death of any person or property damage arising out of the ownership, maintenance, or use of any motor vehicle. The automobile liability policy must be written on an occurrence basis.

Automobile Liability	**Policy limits of not less than:**
Combined Single Limit	

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Automobile Liability	Policy limits of not less than:
Combined Single Limit (Bodily Injury and Property Damage)	$1,000,000

K. *Umbrella or Excess Liability:* Contractor shall purchase and maintain umbrella or excess liability insurance written over the underlying employer's liability, commercial general liability, and automobile liability insurance described in the Paragraphs above. The coverage afforded must be at least as broad as that of each and every one of the underlying policies.

Excess or Umbrella Liability	Policy limits of not less than:
Each Occurrence	$5,000,000
General Aggregate	$5,000,000

M. *Contractor's Pollution Liability Insurance:* Contractor shall purchase and maintain a policy covering third-party injury and property damage, including cleanup costs, as a result of pollution conditions arising from Contractor's operations and completed operations. This insurance must be maintained for no less than three years after final completion.

Contractor's Pollution Liability	Policy limits of not less than:
Each Occurrence/Claim	$1,000,000
General Aggregate	$1,000,000

N. *Contractor's Professional Liability Insurance:* If Contractor will provide or furnish professional services under this *Contract*, through a delegation of professional design services or otherwise, then Contractor shall be responsible for purchasing and maintaining applicable professional liability insurance. This insurance must cover negligent acts, errors, or omissions in the performance of professional design or related services by the insured or others for whom the insured is legally liable. The insurance must be maintained throughout the duration of the Contract and for a minimum of two years after Substantial Completion. The retroactive date on the policy must pre-date the commencement of furnishing services on the Project.

Contractor's Professional Liability	Policy limits of not less than:
Each Claim	$1,000,000
Annual Aggregate	$3,000,000

O. *Railroad Protective Liability Insurance:* Prior to commencing any Work within 50 feet of railroad-owned and controlled property, Contractor shall (1) endorse its commercial general liability policy with ISO CG 24 17, removing the contractual liability exclusion for work within 50 feet of a railroad, (2) purchase and maintain railroad protective liability insurance meeting MBTA's requirements, (3) furnish a copy of the endorsement to Owner, and (4) submit a copy

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of the railroad protective policy and other railroad-required documentation to the railroad, and notify Owner of such submittal.

6.04 *Builder's Risk and Other Property Insurance*

SC-6.04 Delete Paragraph 6.04 in its entirety. The Owner is not requiring Builder's Risk insurance.

6.05 *Property Losses; Subrogation*

SC-6.05 Delete paragraph 6.05.B of the General Conditions in its entirety and insert the following in its place:

Contractor will provide at least thirty days' prior written notice to Owner by certified mail prior to canceling coverage afforded under all the policies of insurance (or the certificates or other evidence thereof) required to be purchased and maintained by Contractor in accordance with paragraph 6.05. If the renewal of any policy of insurance is refused, Contractor shall provide Owner immediate written notice thereof, and take all reasonable steps to procure replacement insurance in accordance with the requirements of the Contract Documents. If Contractor is unable to obtain replacement insurance within ten (10) days of notice of non-renewal is given to Owner, Owner shall be entitled to obtain the required insurance and all costs associated therewith will be processed in accordance with Article 11.

6.06 *Receipt and Application of Property Insurance Proceeds*

SC-6.06.C Delete Paragraph 6.06.C in its entirety and replace with the following:

The Contractor shall pay for all costs not covered because of the application of a policy deductible due under any of its insurance policies required hereunder.

ARTICLE 7—CONTRACTOR'S RESPONSIBILITIES

7.01 *Contractor's Means and Methods of Construction*

SC-7.02 Add the following new Paragraph 7.02.C immediately after Paragraph 7.02.B:

The site superintendent may be a direct employee of the subcontractor provided that this individual has the full authority and responsibility of the general contractor's specified superintendent. The General Contractor shall submit a letter to the Owner and the Engineer stating who the supervisor is and defining his/her authority during all construction related activities.

7.03 *Labor; Working Hours*

SC-7.03 Add the following new subparagraphs immediately after Paragraph 7.03.C:

1. Regular working hours are defined as Monday through Friday, excluding holidays, between the hours of 7:00 AM and 5:00 PM. Requests to work other than regular working hours shall be submitted to Engineer not less than 48 hours prior to any proposed change. Occasional unscheduled overtime on weekdays may be permitted provided it is approved by Engineer.
2. Owner's legal holidays are: N/A.

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SC-7.03 Add the following new paragraphs immediately after Paragraph 7.03.C:

D. Contractor shall be responsible for the cost of any overtime pay or other expense incurred by the Owner for Engineer's services (including those of the Resident Project Representative, if any), Owner's representative, and construction observation services, occasioned by the performance of Work on Saturday, Sunday, any legal holiday, or as overtime on any regular work day. If Contractor is responsible but does not pay, or if the parties are unable to agree as to the amount owed, then Owner may impose a reasonable set-off against payments due under Article 15.

E. This agreement is subject to the applicable provisions of the Contract Work Hours and Safety Standards Act, Public Law 87-581 87th Congress. No Contractor or Subcontractor contracting for any part of the Work shall require or permit any laborer or mechanic to be employed on the Work in excess of forty hours in any work week unless such laborer or mechanic receives compensation at a rate not less than one and one-half times that person's basic rate of pay for all hours worked in excess of forty hours in such work week."

F. Contractor and Subcontractors shall, insofar as practicable, give preference in the hiring of workers for the Project to qualified local residents with first preference being given to citizens of the United States who have served in the armed forces of the United States and have been honorably discharged therefrom or released from active duty therein.

G. Contractor shall employ only competent persons to do the work and whenever Owner shall notify Contractor, in writing, that any person on the Work appears to be incompetent, disorderly, or otherwise unsatisfactory, such person shall be removed from the Project and shall not again be employed on it except with the consent of Owner."

H. Contractor shall provide and maintain sanitary facilities for all persons employed on the Work, beginning with the first worker at the Site. Said facilities shall meet the following requirements unless otherwise specified in the Supplementary General Conditions or Specifications.

1. There shall be no fewer facilities than the number required by applicable Laws;

2. Facilities shall be kept in a clean sanitary condition at all times and shall be adequately screened to be inaccessible to flies. (Note: If existing sanitary facilities at the Site are to be used by the Contractor, this requirement will be modified accordingly in the Supplementary General Conditions or Specifications.)"

7.05 *"Or Equals"*

SC-7.05 Insert the following at the end of the third sentence of Paragraph 7.05.A: ", and in accordance with G.L. c.30, §39M."

Add a new paragraph SC-7.04.A.1.c immediately after paragraph 7.04A.1.b, which is to read as follows:

c. It shall be Contractor's responsibility to coordinate all submittals to Engineer for approval to eliminate any conflicts which might arise due to the use of "or equal" items. Any additional costs incidental to the use of "or equal" items shall be paid by Contractor.

7.07 *Concerning Subcontractors and Suppliers*

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SC-7.07 Delete the third and fourth sentences of Paragraph 7.07.E in their entirety and replace them as follows:

If Contractor has submitted the identity of certain Subcontractors or Suppliers for acceptance by Owner, and Owner has accepted it in writing, then Owner may subsequently revoke the acceptance of any such Subcontractor or Supplier so identified solely on the basis of substantive, reasonable objection after due investigation. Contractor shall submit a replacement for the rejected Subcontractor or Supplier that is acceptable to Owner.

Add the following paragraph immediately after Paragraph 7.07.M:

N. Contractor shall make payments to Subcontractors in accordance with Massachusetts General Laws Chapter 30, Section 39F.

7.08 *Patent Fees and Royalties*

SC-7.08 Delete the second sentence of Paragraph 7.07.A.

Delete Paragraph 7.08.B in its entirety.

7.10 *Taxes*

SC-7.10 Add a new paragraph immediately after Paragraph 7.10.A:

B. Owner is exempt from payment of sales and compensating use taxes of the State of Massachusetts and of cities and counties thereof on all materials to be incorporated into the Work.

1. Owner will furnish the required certificates of tax exemption to Contractor for use in the purchase of supplies and materials to be incorporated into the Work.

2. Owner's exemption does not apply to construction tools, machinery, equipment, or other property purchased by or leased by Contractor, or to supplies or materials not incorporated into the Work.

7.12 *Record Documents*

SC-7.12 Add the following new paragraph and subparagraphs immediately after Paragraph 7.12.A.

B. The Contractor shall return to the Engineer one set of the Contract Drawings marked in colored pencil, showing all changes made during construction and including the location, by dimensions and elevations, of installed equipment, and underground facilities that will become concealed or buried by the construction. This shall include ties to all concealed work, etc. measured from permanent structures. Additionally, the Contractor shall be required to keep marked-up drawings current and on site and to provide mark-ups to the Owner on a monthly basis.

C. Contractor shall comply with all applicable provisions of Chapter 30, Section 39R of the Massachusetts General Laws regarding Contractor's records.

7.16 *Submittals*

SC-7.16 Add the following new paragraph immediately after paragraph 7.16.F of the General Conditions, which is to read as follows:

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G. The accuracy of all such information submitted by the Contractor is the responsibility of the Contractor. In reviewing Shop Drawings, Samples, and similar submittals, the Engineer shall be entitled to rely upon the Contractor's representation that such information is correct and accurate.

7.17 *Contractor's General Warranty and Guarantee*

SC-7.17 Add the following new paragraph 7.17.F, immediately after paragraph 7.17.E of the General Conditions:

F. Contractor shall guarantee all materials and equipment furnished and Work performed for a period of one (1) year from the date of Substantial Completion. Contractor warrants and guarantees for a period of one (1) year from the date of Substantial Completion that the completed Work is free from all defects due to faulty materials or workmanship and Contractor shall promptly make such corrections as may be necessary by reason of any such defects including the repairs of any damage to other parts of the Work resulting from such defects. In the event that Contractor should fail to make such repairs, adjustments, or other work that may be made necessary by such defects, Owner may do so and charge Contractor the cost thereby incurred. The Performance Bond shall remain in full force and effect through the guarantee period.

7.18 *Indemnification*

SC-7.18 Insert the following at the end of Paragraph 7.18.B:

If, through the acts or neglect of Contractor, any other Contractor or any Subcontractor shall suffer loss or damage on the Work, Contractor shall settle with such other Contractor or Subcontractor by agreement if such other Contractor or Subcontractor will so settle. If such other Contractor or Subcontractor shall assert any claim against Owner on account of any damage alleged to have been sustained, Owner shall notify Contractor, who shall indemnify and hold harmless Owner against any such claims.

ARTICLE 8—OTHER WORK AT THE SITE

8.02 *Coordination*

SC-8.02 Delete Paragraph 8.02 in its entirety and replace with the following:

Owner may contract with others for performance of work at the Site. Contractor will be responsible for the coordination of the performance of its Work at the Site.

8.03 *Legal Relationships*

SC-8.03 Delete Paragraph 8.03.A in its entirety and replace with the following:

If, in the course of performing other work for Owner at or adjacent to the Site, the Owner's employees, any other contractor working for Owner, or any utility owner that Owner has arranged to perform work, causes damage to the Work or to the property of Contractor or its Subcontractors, or delays, disrupts, interferes with, or increases the scope or cost of the performance of the Work, through actions or inaction, then Contractor shall be entitled to an equitable adjustment in the Contract Times. Contractor must submit any Change Proposal seeking an equitable adjustment in the Contract Times

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under this paragraph within 30 days of the damaging, delaying, disrupting, or interfering event. The entitlement to, and extent of, any such equitable adjustment will take into account information (if any) regarding such other work that was provided to Contractor in the Contract Documents prior to the submittal of the Bid or the final negotiation of the terms of the Contract, and any remedies available to Contractor under Laws or Regulations concerning utility action or inaction. Contractor's entitlement to an adjustment of the Contract Times is subject to the provisions of Paragraphs 4.05.D and 4.05.E.

ARTICLE 9—OWNER'S RESPONSIBILITIES

9.02 *Replacement of Engineer*

SC-9.02 Delete the phrase "provided Contractor makes no reasonable objection to the replacement engineer" in Paragraph 9.02.A.

9.06 *Insurance*

SC-9.06 Delete Paragraph 9.06 of the General Conditions in its entirety.

9.09 *Limitations on Owner's Responsibilities*

SC-9.09 Insert the following after the first sentence of Paragraph 9.09.A:

However, the Owner shall have the right to direct the Contractor to perform the Work according to any sequence schedule set forth in the Contract Documents or established pursuant thereto.

ARTICLE 10—ENGINEER'S STATUS DURING CONSTRUCTION

10.01 *Owner's Representative*

SC-10.01 Add a new paragraph 10.01.B after paragraph 10.01.A of the General Conditions, which is to read as follows:

B. Nothing contained in the Contract Documents shall be construed to create a contractual relationship of any kind (1) between the Engineer and Contractor, (2) between the Owner and a Subcontractor or Subcontractors, or (3) between any person or entities other than the Owner and Contractor. The Engineer shall, however, be entitled to performance and enforcement of obligations under the Contract Documents intended to facilitate performance of the Engineer's duties.

10.02 *Visits to Site*

SC-10.02 Insert the following at the end of Paragraph 10.02.B:

However, the Engineer shall have the right to direct the Contractor to perform the Work according to any sequence schedule set forth in the Contract Documents or established pursuant thereto.

10.03 *Resident Project Representative*

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SC-10.03 Add the following new paragraphs immediately after Paragraph 10.03.B:

C. The Resident Project Representative (RPR) will be Engineer's representative at the Site. RPR's dealings in matters pertaining to the Work in general will be with Engineer and Contractor. RPR's dealings with Subcontractors will only be through or with the full knowledge or approval of Contractor. The RPR will:

1. *Conferences and Meetings:* Attend meetings with Contractor, such as preconstruction conferences, progress meetings, job conferences, and other Project-related meetings (but not including Contractor's safety meetings), and as appropriate prepare and circulate copies of minutes thereof.

2. *Safety Compliance:* Comply with Site safety programs, as they apply to RPR, and if required to do so by such safety programs, receive safety training specifically related to RPR's own personal safety while at the Site.

3. *Liaison*

   a. Serve as Engineer's liaison with Contractor. Working principally through Contractor's authorized representative or designee, assist in providing information regarding the provisions and intent of the Contract Documents.

   b. Assist Engineer in serving as Owner's liaison with Contractor when Contractor's operations affect Owner's on-Site operations.

   c. Assist in obtaining from Owner additional details or information, when required for Contractor's proper execution of the Work.

4. *Review of Work; Defective Work*

   a. Conduct on-Site observations of the Work to assist Engineer in determining, to the extent set forth in Paragraph 10.02, if the Work is in general proceeding in accordance with the Contract Documents.

   b. Observe whether any Work in place appears to be defective.

   c. Observe whether any Work in place should be uncovered for observation, or requires special testing, inspection or approval.

5. *Inspections and Tests*

   a. Observe Contractor-arranged inspections required by Laws and Regulations, including but not limited to those performed by public or other agencies having jurisdiction over the Work.

   b. Accompany visiting inspectors representing public or other agencies having jurisdiction over the Work.

6. *Payment Requests:* Review Applications for Payment with Contractor.

7. *Completion*

   a. Participate in Engineer's visits regarding Substantial Completion.

   b. Assist in the preparation of a punch list of items to be completed or corrected.

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c. Participate in Engineer's visit to the Site in the company of Owner and Contractor regarding completion of the Work, and prepare a final punch list of items to be completed or corrected by Contractor.

d. Observe whether items on the final punch list have been completed or corrected.

D. The RPR will not:

1. Authorize any deviation from the Contract Documents or substitution of materials or equipment (including "or-equal" items).

2. Exceed limitations of Engineer's authority as set forth in the Contract Documents.

3. Undertake any of the responsibilities of Contractor, Subcontractors, or Suppliers.

4. Advise on, issue directions relative to, or assume control over any aspect of the means, methods, techniques, sequences or procedures of construction.

5 Advise on, issue directions regarding, or assume control over security or safety practices, precautions, and programs in connection with the activities or operations of Owner or Contractor.

6. Participate in specialized field or laboratory tests or inspections conducted off-site by others except as specifically authorized by Engineer.

7. Authorize Owner to occupy the Project in whole or in part.

10.07 *Limitations on Engineer's Authority and Responsibilities*

SC-10.08.B Insert the following after the first sentence in Paragraph 10.08.B:

However, the Engineer shall have the right to direct the Contractor to perform the Work according to any sequence schedule set forth in the Contract Documents or established pursuant thereto.

Add a new paragraph immediately after paragraph 10.08.E of the General Conditions which is to read as follows:

Engineer's interpretations will be made in accordance with Massachusetts General Laws Chapter 30, Section 39P.

ARTICLE 11—CHANGES TO THE CONTRACT

11.05 *Owner-Authorized Changes in Work*

SC-11.05 Add a new paragraph immediately after paragraph 11.05.A of the General Conditions which is to read as follows:

Engineer's interpretations will be made in accordance with Massachusetts General Law, Chapter 30, Section 39P.

Add the following new paragraph immediately after paragraph 11.05.C of the General Conditions, which is to read as follows:

Upon request of the Owner or Engineer, the Contractor shall without cost to the Owner submit to the Engineer, in such form as the Engineer may require, an accurate

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written estimate of the cost of any such proposed extra Work or change. The estimate shall indicate the quantity and unit cost of each item of materials, and the number of hours of work and hourly rate for each class of labor, as well as the description and amounts of all other costs chargeable under the terms of this Article. Unit labor costs for the installation of each item of materials shall be shown if required by the Engineer. The Contractor shall promptly revise and resubmit such estimate if the Engineer determines that it is not in compliance with the requirements of this Article, or that it contains errors of facts or mathematical errors. If required by the Engineer, in order to establish the exact cost of new Work added or previously required Work omitted, the Contractor shall obtain and furnish to the Engineer bona fide proposals from recognized suppliers for furnishing any material included in such Work, and shall be furnished at Contractor's expense. The Contractor shall state in the estimate any extension of time required for the completion of the Work if the change or extra work is ordered.

11.07 *Change of Contract Price*

SC-11.07 In paragraph 11.07.C.2.a change "15 percent" to "10 percent."

Delete paragraph 11.07.C.2.c.

ARTICLE 12—CLAIMS

12.01 *Claims*

SC-12.01 Add a new paragraph immediately after paragraph 12.01.D.1 of the General Conditions to read as follows:

Contractor shall carry on the Work and maintain the progress schedule during the dispute resolution proceedings unless otherwise agreed in writing by Owner and Contractor.

ARTICLE 13—COST OF WORK; ALLOWANCES, UNIT PRICE WORK

13.01 *Cost of the Work*

SC-13.01 Add the following to the end of Paragraph 13.01.B.1 of the General Conditions to read as follows:

Following the Notice of Award and prior to the execution of the Agreement the Owner, prospective contractor and, if any, each prospective filed sub-bid contractor shall agree on what percentage markup shall be used as direct labor costs in determination of extra work costs.

Delete subparagraphs a, d, e, f, g, and h of Paragraph 13.01.B.5.

13.02 *Allowances*

SC-13.02 Delete Paragraph 13.02 of the General Conditions in its entirety.

13.03 *Unit Price Work*

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SC-13.03 Delete Paragraph 13.03.E in its entirety.

ARTICLE 14—TESTS AND INSPECTIONS; CORRECTION; REMOVAL; OR ACCEPTANCE OF DEFECTIVE WORK

14.02 *Tests, Inspections, and Approvals*

SC-14.02 Delete the remainder of Paragraph 14.02.F after the words "Contractor's expense."

Delete Paragraph 14.05.C.2 in its entirety.

14.06 *Owner May Stop the Work*

SC-14.06 Insert the following new paragraph 14.06.B immediately after Paragraph 14.06.A:

If Owner stops Work under paragraph 14.06.A, Contractor shall not be entitled to any extension of Contract Time or increase in Contract Price, except as may be provided under G.L. c. 30, §39O.

ARTICLE 15—PAYMENTS TO CONTRACTOR, SET OFFS; COMPLETIONS; CORRECTION PERIOD

15.01 *Applications for Payments*

SC-15.01 Delete the first phrase prior to the words "Contractor shall" in the first sentence of Paragraph 15.01.B.1 and insert the following:

On a monthly basis and in accordance with G.L. c.30, §39G,

Delete paragraph 15.01.B.4 and insert the following in its place:

Retainage with respect to progress payments will be five percent or, if stipulated, the maximum allowed by law.

Insert the following new paragraph immediately after Paragraph 15.01.B.4:

Contractor shall furnish evidence that payment received on the basis of materials and equipment not incorporated and suitably stored, has in fact been paid to the respective supplier(s) within ten (10) days of payment by Owner. Failure to provide such evidence of payment may result in the withdrawal of previous approval(s) and removal of the cost of related materials and equipment from the next submitted Application for Payment.

Delete Paragraph 15.01.D.1 and insert the following:

Payment shall be made in accordance with G.L. c.30, §39G.

Delete the words "immediate" and "promptly" in the first sentence of Paragraph 15.01.E.2.

Delete Paragraph 15.01.E.3 in its entirety.

15.02 *Contractor's Warranty of Title*

SC-15.02 Insert the following new paragraphs immediately after Paragraph 15.02.A:

B. No materials or supplies for the Work shall be purchased by Contractor or Subcontractor subject to any chattel mortgage or under a conditional sale contract or other agreement

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by which an interest is retained by the seller. Contractor warrants that Contractor has good title to all materials and supplies used by Contractor in the Work, free from all liens, claims or encumbrances.

C. Contractor shall indemnify and save Owner harmless from all claims growing out of the lawful demands of Subcontractors, laborers, workmen, mechanics, materialmen, and furnishers of machinery and parts thereof, equipment, power tools, and all supplies, including commissary, incurred in the furtherance of the performance of this Contract. Contractor shall, at Owner's request, furnish satisfactory evidence that all obligations of the nature hereinabove designated have been paid, discharged, or waived. If Contractor fails to do so, then Owner may, after having served written notice on the Contractor, either pay unpaid bills, of which Owner has written notice, or withhold from the Contractor's unpaid compensation a sum of money deemed reasonably sufficient to pay any and all such lawful claims until satisfactory evidence is furnished that all liabilities have been fully discharged whereupon payment to Contractor shall be resumed, in accordance with the terms of this Contract, but in no event shall the provisions of this sentence be construed to impose any obligation upon Owner to either Contractor, or Contractor's Surety. In paying any unpaid bills of the Contractor, Owner's payment shall be considered as payment made under the Contract by Owner to Contractor and Owner shall not be liable to Contractor for any such payment made in good faith.

15.03 *Substantial Completion*

SC-15.03 Delete the third sentence of Paragraph 15.03.C and insert the following:

Owner may review the preliminary certificate and make written objection to Engineer as to any provisions of the certificate or attached list.

Delete the phrase ", within 14 days after submission of the preliminary certificate to Owner," in the fourth sentence of paragraph 15.03.C.

Delete the phrase ", within said 14 days," in the fifth sentence of Paragraph 15.03.C.

Insert the following new Paragraph 15.03.G immediately following 15.03.F

G. Notification to Owner and Engineer of Substantial Completion shall include the delivery of the Project Closeout Documents.

15.04 *Partial Use or Occupancy*

SC-15.04 Delete the phrase "subject to the following conditions" at the end of the first sentence of Paragraph 15.04.A.

Delete Paragraph 15.04.A.2 in its entirety.

15.06 *Final Payment*

SC-15.06 Insert the following at the end of Paragraph 15.06.E:

Final payment shall be made in accordance with G.L. c.30, §39G.

ARTICLE 16—SUSPENSION OF WORK AND TERMINATION

16.01 *Owner May Suspend Work*

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SC-16.01 Delete Paragraph 16.01.A in its entirety and insert the following:

Owner may suspend the Work or any portion thereof in accordance with M.1G.L. c.30, §39O.

16.02 *Owner May Terminate for Cause*

SC-16.02 Insert new paragraph immediately after Paragraph 16.02.A.4:

5. If Contractor abandons the Work, or sublets this Contract or any part thereof, without the previous written consent of Owner, or if the Contract or any claim thereunder shall be assigned by Contractor otherwise than as herein specified.

Append to the end of the last sentence of Paragraph 16.02.D, "…to Owner's satisfaction."

16.03 *Owner May Terminate for Convenience*

SC-16.03 Delete the phrase "including fair and reasonable sums for overhead and profit on such Work" in Paragraph 16.03.A.1

Delete the phrase "plus fair and reasonable sums for overhead and profit on such expenses" in Paragraph 16.03.A.2.

Delete Paragraph 16.03.A.3 in its entirety.

16.04 *Contractor May Stop Work or Terminate*

SC-16.04 Delete the last sentence of Paragraph 16.04.B.

ARTICLE 17—FINAL RESOLUTIONS OF DISPUTES

17.01 *Methods and Procedures*

SC-17.01 Insert a new Paragraph 17.01.C after Paragraph 17.01.B:

C. Contractor shall carry on the Work and maintain the progress schedule during the dispute resolution proceedings, unless otherwise agreed by Contractor and Owner in writing.

17.02 *Venue*

SC-17.02 Add the following new paragraph immediately after Paragraph 17.01.

17.02 *Venue*

A. Any legal action relating to this Contract shall be filed in the Superior Court for the County in the Commonwealth of Massachusetts in which the Project is located, unless otherwise agreed by Contractor and Owner in writing.

ARTICLE 18—MISCELLANEOUS

18.07 *Controlling Law*

SC-18.07 Amend Paragraph 18.07.A to state, "This contract is to be governed by the laws of the Commonwealth of Massachusetts."

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18.10 *Wage Rates*

SC-18.10 Insert the following new paragraph:

18.10 *Wage Rates*

A. The requirements and provisions of all applicable laws and any amendments thereof or additions thereto as to employment of labor, and to the schedule of minimum wage rates established in compliance with laws shall be a part of the Contract Documents. If after the Notice of Award, it becomes necessary to employ any person in a trade or occupation not classified in the wage determinations, such person shall be paid at not less than such rates as shall be determined by the officials administering the laws mentioned above.

B. The schedule of wages referred to above is minimum rates only, and OWNER will not consider any claims for additional compensation made by CONTRACTOR because of payment by CONTRACTOR of any wage in excess of the applicable, required rates."

18.11 *Funding*

SC-18.11 Insert the following new Paragraph 18.11.A:

A. Notwithstanding anything in the Contract documents to the contrary, any and all payments which the Owner is required to make under this Contract shall be subject to appropriation or other availability of funds as certified by the City Auditor. In the absence of appropriation or availability as certified herein, this Contract shall be immediately terminated without liability for damages, penalties or other charges to the Owner. In the event this is a multi-year contract, this Contract shall be subject to annual appropriation and in the event funds are not so appropriated, this Contract shall terminate immediately without liability for damages, penalties or charges to the Owner.

18.12 *Conflicts of Interest*

SC-18.12 Insert the following new Paragraph 18.12.A:

A. The parties acknowledge the provisions of the State Conflict of Interest Law (General Laws Chapter 268A), and this Contract expressly prohibits any activity which shall constitute a violation of that law. The Contractor shall be deemed to have investigated the application of M.G.L. c. 268A to the performance of this Contract; and by executing the Contract documents the Contractor certifies to the Owner that neither it nor its agents, employees, or subcontractors are thereby in violation of General Laws Chapter 268A.

ARTICLE 19—FEDERAL PROVISIONS

Add new Article 19 as follows:

19.01 *Applicability of Federal Contractual Provisions*

A. The following contractual provisions are hereby incorporated into the Contract Documents, where applicable. In the event of any conflict between the below provisions and other provisions of these Contract Documents, the provisions in this Addendum shall control.

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B. In the event of any inconsistency between the Davis-Bacon Wage Rates and any prevailing wage rates published by the Commonwealth of Massachusetts and applicable to this Contract, the higher of the two wages shall apply.

19.02 REMEDIES FOR BREACH OF CONTRACTUAL AGREEMENT; SANCTIONS AND PENALTIES

A. APPLICABILITY: This provision shall apply in the event that the Contract or Purchase Order exceeds the Simplified Acquisition Threshold. See 2 CFR § 200 App. II(A).

B. It is hereby understood and mutually agreed, by and between the Contractor and the Owner, that the date of beginning and the time for completion of the work to be done hereunder are ESSENTIAL CONDITIONS of the Contract; and it is further mutually understood and agreed that the work embraced in this Contract shall be commenced on a date to be specified in the "Notice to Proceed".

C. The Contractor agrees that said work shall be prosecuted regularly, diligently and uninterruptedly at such rate of progress as will ensure full completion thereof within the time specified. It is expressly understood and agreed, by and between the Contractor and the Owner, that the time for the completion of the work described herein is a reasonable time for the completion of the same, taking into consideration the average climatic range and usual industrial conditions prevailing in this locality.

D. If the said Contractor shall neglect, fail or refuse to complete the work within the time herein specified, or any extension thereof granted by the Owner, then the Contractor does hereby agree, as a partial consideration for the awarding of this Contract, to pay the Owner the amount specified in the Contract, not as a penalty but as liquidated damages for such Breach of Contract as hereinafter set forth, for each and every calendar day the Contractor shall be in default after the time stipulated in the Contract for completing the work.

E. The said amount of liquidated damages is fixed and agreed upon by and between the Contractor and the Owner because of the impracticability and extreme difficulty of fixing and ascertaining the actual damages the Owner would sustain in such event and said amount shall be retained from time to time by the Owner from current periodic estimates.

F. It is further agreed that time is of the essence of each and every portion of this Contract and of any specifications wherein a definite and certain length of time is fixed for the performance of any act whatsoever; and where under the Contract as additional time is allowed for the completion of any work, the new time limit fixed by such extension shall be of the essence of this Contract. Provided, that the Contractor shall not be charged with liquidated damages or any excess cost when the Owner determines that the Contractor is without fault and the Contractor's reasons for the time extensions are acceptable to the Owner; provided further, that the Contractor shall not be charged with liquidated damages or an excess cost when the delay in completion of the work is due to:

1. Any preference, priority or allocation order duly issued by the government;

2. Unforeseeable cause beyond the control and without fault of negligence of the Contractor, including, but not restricted to, acts of God or the public enemy, acts of the

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Owner, acts of another Contractor in the performance of a contract with the Owner, fires, floods, epidemics, quarantine restrictions, strikes, freight embargoes and severe weather; or

3. Any delays of subcontractors or suppliers occasioned by any of the causes specified in subsections (a) and (b) of this article.

G. PROVIDED FURTHER, that the Contractor shall within ten (10) days from the beginning of such delay, unless the Owner shall grant a further period of time prior to the date of final settlement of the Contract, notify the Owner, in writing, of the causes of the delay, who shall ascertain the facts and extent of the delay and notify the Contractor within a reasonable time of its decision in the matter. The amount of liquidated damages for this project shall be Five Hundred Dollars ($500.00) per consecutive calendar day.

19.03 TERMINATION FOR CAUSE AND CONVENIENCE

A. APPLICABILITY: This provision shall apply in the event that the Contract or Purchase Order exceeds $10,000.00. See 2 CFR 200 App. II(B).

B. Where Contract exceeds $10,000.00, the Owner may terminate this Contract by providing the Contractor and the Surety (if any there be) with ten (10) days written notice specifying the reasons for termination, as outlined below:

1. Violation of any of the provisions of this Contract by the Contractor or any of their subcontractors;

2. A determination by the Owner that the Contractor has engaged in fraud, waste, mismanagement, misuse of funds, or criminal activity with any funds provided by this Contract;

Failure of the Contractor, for any reason, to fulfill in a timely and proper manner their obligations under this Contract, including compliance with applicable Federal, State and/or local law or regulations, and such procedures or guidelines as may be established.

C. In the event of any such termination, the Surety shall have the right to take over and perform the Contract; provided, however, that if the Surety does not commence performance within ten (10) days from the date of the mailing to such Surety of notice of termination, the Owner may take over the work and prosecute the same to completion at the expense of the Contractor, and the Contractor and their Surety shall be liable to the Owner for any excess cost occasioned by the Owner thereby, and in such event the Owner may take possession of and utilize in completing the work, such materials, appliances and plants as may be on the site of the work and necessary therefore.

D. If the Owner determines that a continuation of work on the project would endanger the life, health or safety of those working or living at or near the project site, or that immediate action is necessary to protect public funds and/or property, the Owner may suspend work or terminate this agreement by providing notice to the Contractor in the form of a telegram, mailgram, hand-carried letter, or other appropriate written means.

E. In addition, notwithstanding anything to the contrary in the Contract, the Owner may also terminate this Contract for its conveniences, including due to the lack of sufficient funds to complete the work. In such event, the Owner shall provide written notice of termination to the

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Contractor, and the Contractor shall thereupon cease all work other than work that is required to make the work and surrounding property safe, and the Owner shall pay the Contractor for all work performed in accordance with the terms of the Contract up to the date of the Contract, provided the Contractor shall not be entitled to any termination (or similar) damages or other costs and expenses that may be associated with a termination for convenience.

19.04 CLEAN AIR ACT

A. APPLICABILITY: This provision shall apply in the event that the Contract or any subgrant thereunder is a sum in excess of $150,000.00. See 2 CFR § 200 App. II(G)

B. Contractor shall comply with all applicable standards, orders or regulations issued pursuant to the Clean Air Act (42 U.S.C. 7401–7671q) and the Federal Water Pollution Control Act as amended (33 U.S.C. 1251–1387). Contractor further acknowledges and understands that Contractor shall be required to report any violations of said acts to the Federal awarding agency and the Regional Office of the Environmental Protection Agency.

19.05 DEBARMENT AND SUSPENSION (EXECUTIVE ORDERS 12549 AND 12689)

A. APPLICABILITY: This provision shall apply to all Contracts.

B. Contractor certifies that neither Contractor nor any employer or subcontractor is a party listed on the government wide exclusions in the System for Award Management (SAM), in accordance with the OMB guidelines at 2 CFR 180 that implement Executive Orders 12549 (3 CFR part 1986 Comp., p. 189) and 12689 (3 CFR part 1989 Comp., p. 235), "Debarment and Suspension." SAM Exclusions contains the names of parties debarred, suspended, or otherwise excluded by agencies, as well as parties declared in-eligible under statutory or regulatory authority other than Executive Order 12549.

19.06 PROCUREMENT OF RECOVERED MATERIALS (2 C.F.R. § 200.323)

A. APPLICABILITY: This provision shall all apply to all Contracts. See 2 CFR § 200 App. II(J); 2 CFR § 200.323.

B. Contractor acknowledges and understands that, in performing the work specified under this contract, Contractor shall be required to comply with Section 6002 of the Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act. The requirements of Section 6002 include procuring only items designated in guidelines of the Environmental Protection Agency (EPA) at 40 CFR part 247 that contain the highest percentage of recovered materials practicable, consistent with maintaining a satisfactory level of competition, where the purchase price of the item exceeds $10,000 or the value of the quantity acquired during the preceding fiscal year exceeded $10,000; procuring solid waste management services in a manner that maximizes energy and resource recovery; and establishing an affirmative procurement program for procurement of recovered materials identified in the EPA guidelines.

19.07 PROHIBITION ON CERTAIN TELECOMMUNICATIONS AND VIDEO SURVEILLANCE SERVICES OR EQUIPMENT (2 C.F.R. § 200.216)

A. APPLICABILITY: This provision shall all apply to all Contracts. See 2 CFR § 200 App. II(K); 2 CFR § 200.216.

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B. Contractor certifies that it shall not procure or obtain equipment, services, or systems that uses covered telecommunications equipment or services as a substantial or essential component of any system, or as critical technology as part of any system. As described in Public Law 115–232, section 889, covered telecommunications equipment is telecommunications equipment produced by Huawei Technologies Company or ZTE Corporation (or any subsidiary or affiliate of such entities).

C. For the purpose of public safety, security of government facilities, physical security surveillance of critical infrastructure, and other national security purposes, video surveillance and telecommunications equipment produced by Hytera Communications Corporation, Hangzhou Hikvision Digital Technology Company, or Dahua Technology Company (or any subsidiary or affiliate of such entities);

D. Telecommunications or video surveillance services provided by such entities or using such equipment;

E. Telecommunications or video surveillance equipment or services produced or provided by an entity that the Secretary of Defense, in consultation with the Director of the National Intelligence or the Director of the Federal Bureau of Investigation, reasonably believes to be an entity owned or controlled by, or otherwise connected to, the government of a covered foreign country.

19.08 DOMESTIC PREFERENCES FOR PROCUREMENTS (2 C.F.R. § 200.322)

A. APPLICABILITY: This provision shall all apply to all Contracts. See 2 CFR § 200 App. II(L); 2 CFR § 200.322.

B. As appropriate and to the extent consistent with law, the non-Federal entity should, to the greatest extent practicable under a Federal award, provide a preference for the purchase, acquisition, or use of goods, products, or materials produced in the United States (including but not limited to iron, aluminum, steel, cement, and other manufactured products). The requirements of this section must be included in all subawards including all contracts and purchase orders for work or products under this award.

C. For purposes of this section:

1. "Produced in the United States" means, for iron and steel products, that all manufacturing processes, from the initial melting stage through the application of coatings, occurred in the United States.

2. "Manufactured products" means items and construction materials composed in whole or in part of non-ferrous metals such as aluminum; plastics and polymer-based products such as polyvinyl chloride pipe; aggregates such as concrete; glass, including optical fiber; and lumber.

19.09 EQUAL EMPLOYMENT OPPORTUNITY CLAUSE

A. APPLICABILITY: This provision shall apply in the event that the Contract meets the definition of "federally assisted construction contract" as set forth at 41 CFR § 60–§1.3, where not otherwise provided under 41 CFR Part 60. See 2 CFR § 200 App. II(C).

B. All contracts that meet the definition of "federally assisted construction contract" set forth at 41 CFR § 60–1.3.

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C. During the performance of this Contract, the Contractor agrees as follows:

1. The Contractor will not discriminate against any employee or applicant for employment because of race, color, religion, sex, sexual orientation, gender identity, or national origin. The Contractor will take affirmative action to ensure that applicants are employed, and that employees are treated during employment without regard to their race, color, religion, sex, sexual orientation, gender identity, or national origin. Such action shall include, but not be limited to the following:

   A. Employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship.

   B. The Contractor agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided setting forth the provisions of this nondiscrimination clause.

2. The Contractor will, in all solicitations or advertisements for employees placed by or on behalf of the Contractor, state that all qualified applicants will receive consideration for employment without regard to race, color, religion, sex, sexual orientation, gender identity, or national origin.

3. The Contractor will not discharge or in any other manner discriminate against any employee or applicant for employment because such employee or applicant has inquired about, discussed, or disclosed the compensation of the employee or applicant or another employee or applicant. This provision shall not apply to instances in which an employee who has access to the compensation information of other employees or applicants as a part of such employee's essential job functions discloses the compensation of such other employees or applicants to individuals who do not otherwise have access to such information, unless such disclosure is in response to a formal complaint or charge, in furtherance of an investigation, proceeding, hearing, or action, including an investigation conducted by the employer, or is consistent with the Contractor's legal duty to furnish information.

4. The Contractor will send to each labor union or representative of workers with which he has a collective bargaining agreement or other contract or understanding, a notice to be provided advising the said labor union or workers' representatives of the Contractor's commitments under this section, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.

5. The Contractor will comply with all provisions of Executive Order 11246 of September 24, 1965, and of the rules, regulations, and relevant orders of the Secretary of Labor.

6. The Contractor will furnish all information and reports required by Executive Order 11246 of September 24, 1965, and by rules, regulations, and orders of the Secretary of Labor, or pursuant thereto, and will permit access to his books, records, and accounts by the administering agency and the Secretary of Labor for purposes of investigation to ascertain compliance with such rules, regulations, and orders.

7. In the event of the Contractor's noncompliance with the nondiscrimination clauses of this contract or with any of the said rules, regulations, or orders, this contract may be

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canceled, terminated, or suspended in whole or in part and the Contractor may be declared ineligible for further Government contracts or federally assisted construction contracts in accordance with procedures authorized in Executive Order 11246 of September 24, 1965, and such other sanctions may be imposed and remedies invoked as provided in Executive Order 11246 of September 24, 1965, or by rule, regulation, or order of the Secretary of Labor, or as otherwise provided by law.

8. The Contractor will include the portion of the sentence immediately preceding paragraph (1) and the provisions of paragraphs (1) through (8) in every subcontract or purchase order unless exempted by rules, regulations, or orders of the Secretary of Labor issued pursuant to section 204 of Executive Order 11246 of September 24, 1965, so that such provisions will be binding upon each subcontractor or vendor. The Contractor will take such action with respect to any subcontract or purchase order as the administering agency may direct as a means of enforcing such provisions, including sanctions for noncompliance:

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19.10 DAVIS-BACON ACT

A. APPLICABILITY: This provision shall apply to all prime construction contracts in excess of $2,000.00 utilizing federal funding. See 2 CFR § 200 App. II(D).

B. DAVIS-BACON/PREVAILING WAGE

1. The Contractor acknowledges that the decision to award this contract is conditioned upon Contractor's acceptance of the wage determination, and upon continuing compliance with the Davis–Bacon Act (40 U.S.C. 3141–3144, and 3146–3148) as supplemented by Department of Labor regulations (29 CFR Part 5, "Labor Standards Provisions Applicable to Contracts Covering Federally Financed and Assisted Construction"), if applicable.

2. Pursuant to the Davis-Bacon Act and/or G.L. c.149 §§ 26–27H, Contractors are required to pay wages to laborers and mechanics at a rate not less than the prevailing wages specified in the Secretary of Labor's wage determinations, incorporated into this Contract and enclosed as "Attachment A." Contractor further acknowledges and understands that Contractor shall be required to pay wages not less than once a week.

C. DAVIS-BACON/PREVAILING WAGE CERTIFICATION

Contractor certifies that Contractor and all subcontractors shall provide certified payroll affidavits verifying compliance with G.L. c.149 §§ 26–27H, the federal Davis Bacon Act, and any other related acts that are applicable to the project.

_____

Signature of Contractor's authorized official Date: _____

_____

Name (printed)

_____

Title (printed)

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19.11 CONTRACT WORK HOURS AND SAFETY STANDARDS ACT

A. APPLICABILITY: This provision shall apply in the event that the contract is awarded for a sum exceeding $100,000.00 and involves the employment of mechanics or laborers.

B. Where the Contract: (1) is awarded for a sum exceeding $100,000; and (2) will involve the employment of mechanics or laborers, the Contractor shall comply with the Contract Work Hours and Safety Standards Act, 40 U.S.C. 3702 and 3704, as supplemented by Department of Labor regulations (29 CFR Part 5).

C. Pursuant to 40 U.S.C. 3702 of the Contract Work Hours and Safety Standards Act, Contractor shall be required to compute the wages of every mechanic and laborer on the basis of a standard work week of 40 hours. Work in excess of the standard work week is permissible provided that the worker is compensated at a rate of not less than one and a half times the basic rate of pay for all hours worked in excess of 40 hours in the work week. The requirements of 40 U.S.C. 3704 shall apply construction work and provide that no laborer or mechanic must be required to work in surroundings or under working conditions which are unsanitary, hazardous or dangerous. These requirements do not apply to the purchases of supplies or materials or articles ordinarily available on the open market, or contracts for transportation or transmission of intelligence.

19.12 BYRD ANTI-LOBBYING; COPELAND "ANTI-KICKBACK" ACT (40 U.S.C. § 3145)

A. APPLICABILITY: This provision shall all apply to all Contracts. In the event that the Contract is for a sum exceeding $100,000.00, the Contractor shall also certify and file the Byrd Anti-Lobbying Amendment Certification.

B. BYRD ANTI-LOBBYING AMENDMENT

1. Contractor certifies that it will not and has not used Federal appropriated funds to pay any person or organization for influencing or attempting to influence an officer or employee of any agency, a member of Congress, officer or employee of Congress, or an employee of a member of Congress in connection with obtaining any Federal contract, grant or any other award covered by 31 U.S.C. 1352.

2. Contractor further understands and acknowledges that it shall disclose any lobbying with non–Federal funds that takes place in connection with obtaining any Federal award. Such disclosures shall be forwarded from tier to tier up to the non–Federal award.

C. COPELAND "ANTI-KICKBACK" ACT

1. Contractor acknowledges and understands that the awarding of this contract is conditioned upon Contractor's compliance with the Federal Copeland "Anti–Kickback" Act (40 U.S.C. 3145), as supplemented by Department of Labor regulations (29 CFR Part 3, "Contractors and Subcontractors on Public Building or Public Work Financed in Whole or in Part by Loans or Grants from the United States"). The Act provides that each Contractor or subrecipient must be prohibited from inducing, by any means, any person employed in the construction, completion, or repair of public work, to give up any part of the compensation to which he or she is otherwise entitled. The non–Federal entity must report all suspected or reported violations to the Federal awarding agency.

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D. BYRD ANTI-LOBBYING AMENDMENT (REQUIRED CERTIFICATION FOR AWARDS EXCEEDING $100,000)

The undersigned certifies, to the best of their knowledge and belief, that:

No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of an agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.[1]

The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all contractors shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

Bidder certifies or affirms the truthfulness and accuracy of each statement of its certification and disclosure, if any. In addition, the bidding party understands and agrees that the provisions of 31 U.S.C. Ch. 38, Administrative Remedies for False Claims and Statements, apply to this certification and disclosure, if any.

_____

Signature of Contractor's authorized official Date: _____

_____

Name (printed)

_____

Title (printed)

_____

[1] Standard Form-LLL available at https://www.grants.gov/web/grants/forms/post-award-reporting-forms.html.

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19.13 **RIGHTS TO INVENTIONS MADE UNDER A CONTRACT OR AGREEMENT**

A. APPLICABILITY: This provision shall apply in the event that the Contract is funded by a Federal award meeting the definition of "funding agreement' under 37 CFR § 401.2(a). A "funding agreement" is "any contract, grant, or cooperative agreement entered into between any Federal agency… and any contractor for the performance of experimental, developmental, or research work funded in whole or in part by the Federal government."

B. In the event that this Contract is funded by a Federal award meeting the definition of "funding agreement" under 37 C.F.R. § 401.2(a) and the recipient or subrecipient wishes to enter into a contract with a small business firm or nonprofit organization regarding the substitution of parties, assignment or performance of experimental, developmental, or research work under that "funding agreement," the recipient or subrecipient must comply with the requirements of 37 C.F.R. Part 401, "Rights to Inventions Made by Nonprofit Organizations and Small Business Firms Under Government Grants, Contracts and Cooperative Agreements," and any implementing regulations issued by the awarding agency.

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SECTION 01 11 00 – SUMMARY OF WORK

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes:

1. Furnishing of all labor, materials, and equipment required in accordance with provisions of the Contract Documents.
2. Coordination of work with all other trades.
3. Although such work may not be specifically indicated, the Contractor shall furnish and install all miscellaneous items incidental to or necessary for completion of the Project.

1.2 WORK COVERED BY CONTRACT

A. The Work includes, but is not limited to, the furnishing of the labor, materials and equipment, and the Construction of the following:

1. Little River Dam Removal and River Restoration Drawing Sheets 1 through 55, prepared by Fuss & O'Neill, Inc.
    a. Access development and management of pedestrian traffic within the site
    b. Clearing and demolition,
    c. Erosion, sedimentation and pollution control, and flow management;
    d. Earthwork including excavating, stockpiling, sorting, grading
        1) Dredging sediment for targeted sediment cleanup and off-site disposal
        2) Construction of a low flow channel, channel bed and banks
        3) Grading of river banks and installation of bioengineered slope stabilization and scour protection
    e. Removal of the Little River Dam
    f. Replacement and extension of an existing retaining wall
    g. Construction of a retaining wall on the channel side of the former Stevens Mill building at the corner of Stevens Street and Winter Street
    h. Restoration of Little River
        1) Disposal of debris/trash
        2) Installation of rock weirs for fish passage
        3) Construction of vehicle crossing;
        4) Installation of native plantings and seed
    i. Construction of community amenities and recreational access improvements
        1) Construction of a kayak/canoe launch and fishing platform
        2) Installation of a pedestrian bridge

3) Installation of pedestrian walking trails

4) Installation of a river overlook/pocket park at Winter Street

5) Installation of a floating safety boom across Little River

1.3 CONTRACTOR'S USE OF PREMISES

A. Contractor shall limit use of the premises for Work and storage. Contractor shall allow for work by other contractors/subcontractors and access by Owner for normal operations in areas of the site not actively under construction.

B. Contractor shall coordinate use of premises with Owner and Engineer. Public access to areas outside of the active construction phase shall be maintained as indicated in the Drawings.

C. Contractor assumes full responsibility for the protection of products and materials Contractor stores on site.

D. Contractor is responsible for management of surface water and dewatering as necessary to satisfactorily complete the work.

E. Any stored products, or materials, under Contractor's responsibility which interfere with operations of Owner or separate contractor/subcontractor shall be moved by the Contractor.

F. If any additional storage or work areas are needed for Contractor operations, the Contractor shall obtain and pay for their use.

G. All materials storage, equipment storage, and employee and subcontractor parking shall be confined to areas within the limit of disturbance.

H. Any areas used for materials storage, equipment storage, or employee and subcontractor parking shall be restored by the Contractor to their original condition or better, unless specified otherwise.

I. Sanitary facilities shall be provided by the Contractor within the designated staging area.

1.4 WORK SEQUENCE

A. Operations shall be sequenced for efficient progress of all Work shown in the Drawings.

B. Construction for the base bid is anticipated to span two construction seasons. Within each season in-water work is limited to the period from July 1 through October 31.

C. Sequences other than those specified in the Drawings will be considered by the Engineer, provided they assure completion of the Work as shown on the Drawings.

D. All on site work shall be completed during regular working hours, which are defined as weekdays, 7:00 a.m. to 7:00 p.m., excluding holidays. Contractor may apply to work outside of regular working hours upon written approval from the Engineer and Owner.

1.5 LINES AND GRADES

A. Provide all survey, layout, and measurement work required.

1. Locate and protect control points prior to starting site work, and preserve all permanent reference points during construction.

2. Make no changes or relocations without prior written notice and approval by the Engineer.

3. Report to the Engineer when any reference point is lost or destroyed, or requires relocation because of necessary changes in grades or locations.

4. Require Professional Land Surveyor to replace Project control points and all Federal, State, City, County and private land monuments that may be lost or destroyed.
    a. Establish replacements based on original survey control.
    b. Comply with local and State requirements for monument replacement and restoration.

B. Establish lines and levels, locate, and lay out by instrumentation and similar appropriate means.

C. From time to time, verify layouts by the same methods.

D. Maintain a complete, accurate log of all control and survey work as it progresses.

E. On request of the Engineer, submit documentation to verify accuracy of survey work.

1.6 REGULATORY REQUIREMENTS

A. Comply with all Federal, State, and local regulations, codes, permits, and ordinances applicable to the Work.

B. References in the Contract Documents to local codes shall mean the City of Haverhill and/or Essex County, Massachusetts.

C. Specifications designate other standards and codes that apply to the Work.

1.7 ACCESS BY GOVERNMENT OFFICIALS

A. Authorized representatives of government agencies shall have access to the Work at all times where it is in preparation or progress. Contractor shall provide proper facilities for access and inspection by representatives.

1.8 EASEMENTS AND RIGHTS-OF-WAY

A. Restrict construction operations to the immediate vicinity of the location indicated on Drawings and place equipment, materials, and supplies so as to cause the least possible damage to property and interference with traffic.

B. Any work proposed outside the limit of disturbance shown on the Drawings shall be reviewed in advance by the Owner, Property Owner, and Engineer and agreed to in writing prior to commencement.

1.9 FENCES

A. Maintain all fences affected by the Work until completion of the Work. Erect temporary fencing per OSHA requirements.

B. Keep gates closed and locked when not in use.

1.10 PROTECTION OF PUBLIC AND PRIVATE PROPERTY

A. Protect, shore, brace, support, and maintain pipes, drains, and other materials that are part of or otherwise affected by construction operations.

B. Restore to their original condition: pavement, surfacing, trails, buildings, utility poles, guy wires, fences, and other surface structures affected by construction operations, whether within or outside the work area or easement. Remove all equipment and imported materials from staging areas.

C. Use new materials for replacements of all items.

D. Contractor shall be responsible for all damage to roads, ditches, embankments, culverts, bridges, and other public or private property, regardless of location or character, that may be caused by transporting equipment, materials, or workers to or from the Work or any part of the site, whether by Contractor or Contractor's subcontractors or suppliers.

E. Make satisfactory arrangements with Owner of any damaged property concerning its repair, replacement, or payment of costs incurred related to the damage.

F. In areas where the Contractor's operations are near a utility and may cause damage which might result in significant expense, loss, and inconvenience, the operation shall be suspended until arrangements necessary for the protection thereof have been made by the Contractor.

1.11 MAINTENANCE AND TRAFFIC

A. Maintain entry and access paths. All entry and access paths used by the Contractor shall be restored to previous condition or better prior to project completion.

B. Conduct work to minimize interference with vehicular or pedestrian public travel.

C. Whenever it is necessary to cross, close, or obstruct access ways, provide and maintain suitable construction signage.

D. Contractor shall comply with all rules and regulations of the local, County, and State authorities regarding the closure of public roads to public traffic. No public road shall be closed to the public except by express permission of the public agency responsible for the road.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 22 00 – MEASUREMENT AND PAYMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, MASSDOT Standard Specifications for Highways and Bridges, and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section describes the measurement and payment for the Work to be completed under each item on the Bid Form. The descriptions may not reference all the associated Work. Work specified but not designated as a separate Bid Item is considered incidental to all Bid Items. The Contractor shall review all work associated with each work item and shall have no claim for being unfamiliar with the requirements of these specifications.

1. All work items described herein, including in measurement and payment descriptions or otherwise, do not state all requirement of the work stated in the Contract Documents; all such descriptions shall be inclusive of all incidental work for respective items, as stated in the Contract Documents.
2. This Section addresses general measurement and payment requirements for:
    a. Contract Base Bid Items
    b. Alternate Bid Items

B. Related Sections of the Specifications include the following:
1. Divisions 01 through 33 for detailed procedural, material, and installation requirements associated with the Work of each payment item.

C. Related Requirements in the Specifications:
1. Section 01 26 00 - Contract Modification Procedures

1.3 DEFINITIONS

A. Payment Items: Contractor's distribution of the Contract Sum through listed work items, as outlined in this Specification, reviewed, and accepted by the Engineer.

1. Each item is specified to include a defined scope of services. However, not all materials, labor, equipment, or services of a payment item are guaranteed to be listed or specified.
2. Include costs associated with items of work required to complete the defined scope of services within the appropriately specified payment item.
3. Payment items include all necessary materials, plus cost for delivery, installation, applicable fees and taxes, administrative oversite, tools, labor, incidentals, overhead, and profit.
4. Work directed in the field that falls outside the payment items or quantities will only be incorporated into the project and paid if authorized in writing by the Owner.

5. Unit bid price items shall be paid only as accepted and where accepted prior to the completion of the respective work.

6. All work described in the Contract Documents shall be included in the payment items described herein.

B. Unit Price: An amount proposed by bidders, stated on the Bid Form, as a price per unit of measurement for materials or services identified in the Contract Documents.

C. Lump Sum: When used as an item of payment, means complete payment for the work prescribed for that portion of the Work under the item, or all work prescribed in the Contract, as the case may be.

1. Lump sum payment items are groupings of the Work as determined by the Owner only for the Owner's convenience. Such listings of payment items shall establish the minimum level of detail for the Schedule of Values.

2. The Schedule of Values shall further include the breakdown of each lump sum bid item that appears in the Agreement and shall include the Contractor's verified quantities it used in preparing its bid. If accepted by the Engineer, this breakdown will be used in approximating percentages of completion of the lump sum bid items during the processing of payment applications.

D. Provide: Procure, fabricate, sample/test, deliver, place/install, adjust, correct and replace if needed all products or materials to be incorporated into all temporary and permanent elements of the Work in accordance with the Contract Documents.

E. Complete and In Place: When used in the measurement and payment provisions, means the completion of the contract item, including the fabrication, testing, reporting, furnishing, installation, adjustment and correction of all products and materials to be incorporated into the Work including all equipment, tools, labor, health and safety requirements, and work incidental thereto, in accordance with all provisions stated in the Contract Documents.

1.4 PROCEDURES

A. To ensure payment items are balanced, Mobilization/Demobilization for the base bid shall be limited to no more than five (5) percent of the total bid price for the base bid. Such limit will not prohibit the Contractor from seeking payment for documented expenditures (i.e., invoices or cancelled checks) in excess of this amount under other bid items during project startup and mobilization.

B. Unit price items, lump sum items and alternate unit price items include all necessary material, plus cost for delivery, installation, insurance, applicable taxes, overhead, and profit.

C. Estimated quantities provided in the Contract Documents are approximate. The Contractor shall be responsible for making independent quantity estimates in order to determine the actual quantities necessary to construct the project as shown on the Drawings and described in the Specifications. The Contractor agrees to make no claim for damages, anticipated profits, or otherwise because of any difference between the quantities of work actually performed and the estimated quantities included herein and on the Bid Form.

D. The Contractor shall notify the Engineer at least 72 hours prior to the time at which necessary measurements must be taken. Notification must be in advance of obscuring pay item; do not proceed until such measurements have been taken in the presence of the Owner's Representative.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 LIST OF CONTRACT BASE BID ITEMS

A. The payment items listed below include references to specification sections of work to be completed under the payment item, however not all sections of related work are guaranteed to be listed.

B. Base Bid Item No. 1 – Mobilization

1. Work associated with this item will be paid for at the stated price including respective portions of work under all specifications necessary to initiate Contractor's activities at the project site.
    a. All or portions of the Contract Requirements and Division 01 specifications, as applicable.
    b. Includes, but is not limited to: All products, materials, equipment, tools, labor, overhead and profit, fees, and incidentals required to complete the work associated with the mobilization of materials, personnel, and equipment to the project site. Also includes posting all required temporary and project signage. The bid amount for this item shall not exceed 3% of the Total Contract Base Bid Price.
2. Measurement: This item will not be measured for payment but will be pro-rated with the Contractor's progress of work as accepted by Engineer.
3. Payment: Mobilization will be paid for on a lump sum basis.

C. Base Bid Item No. 2 – General Requirements

1. Work associated with this item will be paid for at the stated price including respective portions of work under all specifications necessary to sustain Contractor's activities at the project site.
    a. All or portions of the Contract Requirements and Division 00 and 01 specifications, as applicable.
    b. Includes, but is not limited to: All products, materials, equipment, tools, labor, overhead and profit, fees, and incidentals required for Contractor's general requirements to complete the work, including insurance, bonds, administrative and general requirements, meetings, schedules (including, but not limited to, construction schedules, submittal schedules, and schedule of values), coordination with utility owners for temporary and permanent utility relocations (not including utility owner fees which are paid under Allowances), temporary facilities and controls for field office trailers and support utilities

(including associated permits, fees and electrical/communication utility connection and usage costs), securing local permits as required, and all other measures not specified elsewhere and miscellaneous costs associated with the Work including incidentals not covered by other payment items. The bid amount for this item shall not exceed 5% of the Total Contract Base Bid Price.

c. Also includes other incidental items such as obtaining necessary remaining permits, field and laboratory testing, construction survey layout, and project record drawings/mapping.

2. Measurement: This item will not be measured for payment but will be pro-rated with the Contractor's progress of work as accepted by Engineer.

3. Payment: General Requirements will be paid for on a lump sum basis. Contractor will be paid 40% upon completion of mobilization, 30% upon earning 50% of the total base bid contract value, and the remaining 30% upon completion of demobilization from the site as accepted by the Engineer.

D. Base Bid Item No. 3 – Demobilization

1. Work associated with this item will be paid for at the stated price including respective portions of work under all specifications necessary to conclude Contractor's activities at the project site.

a. All or portions of the Contract Requirements and Division 01 specifications, as applicable.

b. Includes, but is not limited to: All products, materials, equipment, tools, labor, overhead and profit, fees, and incidentals required for demobilization of materials, personnel, and equipment from the project site. Also includes restoring all areas inside or outside the project limits damaged by Contractor's activities or traffic control to existing condition or better including construction access ways (e.g., temporary staging and storage areas) and restoring and establishing a satisfactory cover of vegetation in non-hardscape areas affected by construction.

2. Measurement: This item will not be measured for payment but will be paid as a lump sum.

3. Payment: Demobilization will be paid for on a lump sum basis, complete and in place. Demobilization shall be considered complete when the Contractor has achieved final completion of the work and removed all equipment and materials from the site.

E. Base Bid Item No. 4 – Traffic Control and Protection of Public

1. Work associated with this item will be paid for at the stated price including, but not limited to, work under the following:

a. All portions of Division 01 specifications, as applicable, including:

b. Section 01 50 00 - Temporary Facilities and Controls

c. Includes, but is not limited to: All products, materials, equipment, tools, labor, overhead and profit, fees, and incidentals required for installation, maintenance and removal of all temporary pavement markings, impact attenuators, concrete barriers, construction barricades, drums, advanced warning and traffic signs, cones, lights, temporary traffic signing, including associated costs for electrical

utility and land-based or wireless communication connections and services, flaggers, and other products and materials required for the control and protection of the traveling public and working personnel throughout construction as indicated within the Contract Documents. Any traffic control devices which are lost, stolen, destroyed, or deemed unacceptable while in use shall be replaced without additional compensation. All materials, labor, and equipment necessary to complete the work shall be considered as incidental to the construction and be included in the lump sum price.

2. Measurement: This item will not be measured for payment but will be pro-rated with the Contractor's progress of work as accepted by Engineer.

3. Payment: Payment for this bid item will be made on a lump sum basis based on a percentage of completion as estimated by the Contractor and accepted by the Engineer.

F. Base Bid Item No. 5 – Site Clearing

1. Work associated with this item will be paid for at the stated price including, but not limited to, work under the following:

    a. All or portions of Division 01 specifications, as applicable.

    b. Section 31 10 00 - Site Clearing

    c. Includes, but is not limited to: All products, materials, equipment, tools, labor, overhead and profit, fees, and incidentals required for site clearing as required for completion of the Work; stockpiling of trees for use in Large Wood installation; protection of existing and vegetation to remain within and adjacent to work areas; controlling the import and spread of invasive plant species; and repairing any damage to such features resulting from the Contractor's operations.

2. Measurement: The estimated quantity for this item of work shall be the final pay quantity, unless the dimensions of any portion of the item are revised by the Engineer, or the item or any portion of the item is eliminated. If the final pay quantity is revised, compensation will be the final pay quantity multiplied by the bid unit price for the item. The estimated quantity is based on areal measurement of vegetated ground within the limits of disturbance.

3. Payment: Payment for this bid item will be made per acre based on a percentage of completion as estimated from measurements made by the Contractor and accepted by the Engineer.

G. Base Bid Item No. 6 – Temporary Erosion and Sedimentation Control

1. Work associated with this item will be paid for at the stated price including, but not limited to, work under the following:

    a. All or portions of Division 01 specifications, as applicable, including:

    b. Section 01 57 13 - Temporary Erosion and Sedimentation Control

    c. Includes, but is not limited to: All products, materials, equipment, tools, labor, overhead and profit, fees, and incidentals required for installing, maintaining, and removing and disposing all temporary erosion and sedimentation control measures and practices for completion of all work associated with the project. Such measures include, but are not limited to, compost filter tubes,

construction entrances, temporary construction dewatering basins, catch basin inlet protection devices, biodegradable erosion control blanketing, silt sock, and floating turbidity curtains.

d. Also includes removing and disposing of all accumulated sediment off site and establishing temporary vegetation in areas to remain dormant for extended periods as indicated on the Contract Drawings.

2. Measurement: This item will not be measured for payment but will be pro-rated with the Contractor's progress of work as accepted by Engineer.

3. Payment: Payment for this bid item will be made on a lump sum basis based on a percentage of completion as estimated by the Contractor and accepted by the Engineer.

H. Base Bid Item No. 7 – Control of Water

1. Work associated with this item will be paid for at the stated price including, but not limited to, work under the following:

a. All or portions of Division 01 specifications, as applicable.

b. Section 31 23 19 - Control of Water

c. Includes, but is not limited to: All products, materials, equipment, tools, labor, overhead and profit, and incidentals required for controlling surface and groundwater within project work areas through the furnishing, installation, operation, maintenance, and removal of temporary water control measures including cofferdams, steel sheeting, and other appurtenances as indicated on the Contract Drawings, in the Specifications, and as required to implement the Contractor's accepted Water Control and Diversion Plan, Flood Response Plan, and Cofferdam Designs; groundwater/surface water pumps and temporary dewatering areas; and other water control measures and appurtenances such as temporary tide gates, surface and subsurface dams, flow diversions, special linings for erosion protection, pipes, barriers, prefabricated sediment containment devices, pumps, and watertight seals.

2. Measurement: This item will not be measured for payment but will be pro-rated with the Contractor's progress of work as accepted by Engineer.

3. Payment: Payment for this bid item will be made on a lump sum basis based on a percentage of completion as estimated by the Contractor and accepted by the Engineer.

I. Base Bid Item No. 8 – Demolition

1. Work associated with this item will be paid for at the stated price including, but not limited to, work under the following:

a. All or portions of Division 01 specifications, as applicable.

b. Section 02 41 19 - Selective Demolition

c. Includes, but is not limited to: Ground truthing of existing conditions, protection and monitoring of adjacent infrastructure, partial demolition of the existing Little River Dam and adjacent stone masonry wall as shown on the Drawings, salvaging and stockpiling granite blocks and boulders for incorporation into the Work, and off-site disposal of demolition waste.

2. Measurement: This item will not be measured for payment but will be pro-rated with the Contractor's progress of work as accepted by Engineer.

3. Payment: Payment for this bid item will be made on a lump sum basis based on a percentage of completion as estimated by the Contractor and accepted by the Engineer.

J. Base Bid Item No. 9 – Excavation and Off-site Disposal of Contaminated Soils as Hazardous Waste

1. Work associated with this item will be paid for at the stated price including, but not limited to, work under the following:

    a. All or portions of Division 01 specifications, as applicable.

    b. Section 31 20 00 - Earthwork

    c. Includes, but is not limited to: All products, materials, equipment, tools, labor, overhead and profit, fees, and incidentals required for removal, and legal off-site disposal of excavated materials from within the limits of sediment contamination at Transect 2 as shown on the Contract Drawings. Associated earthwork operations may include excavation, subgrade excavation, subgrade preparation, and fine grading.

2. Measurement: This item shall be measured on the basis of cubic yards of sediment or soil accepted for disposal at a licensed facility. The estimated quantity is based on comparison of existing and design terrain surfaces and reflects estimated in-situ volumes. The Contractor shall furnish the Engineer with trip tickets for each load of sediment or soil. Basis for volume shall be the actual volume in each load, regardless of whether the truck is full to its volumetric capacity. Each load volume shall be confirmed and recorded by the Engineer prior to leaving site.

3. Payment: Payment for this bid item will be made per cubic yard removed from the Site for off-site disposal, as estimated by the Contractor and accepted by the Engineer. The Contractor shall furnish with request for payment all corresponding, fully executed disposal documents (i.e., Material Shipping Records, Bills of Lading, waste manifests, etc.) and disposal facility weight slips/receipts. The Owner reserves the right to withhold payment approval until all corresponding disposal records are submitted.

K. Base Bid Item No. 10 – Excavation and Off-site Disposal of Contaminated Soils as Regulated Waste

1. Work associated with this item will be paid for at the stated price including, but not limited to, work under the following:

    a. All or portions of Division 01 specifications, as applicable.

    b. Section 31 20 00 - Earthwork

    c. Includes, but is not limited to: All products, materials, equipment, tools, labor, overhead and profit, fees, and incidentals required for removal, and legal off-site disposal of excavated materials from within the limits of sediment contamination at Transect 7, SED-19, and SED-4 as shown on the Contract Drawings. Associated earthwork operations may include excavation, subgrade excavation, subgrade preparation, and fine grading. This items also includes all products, materials, equipment, tools, labor, overhead and profit, fees, and

incidentals required for additional testing and coordination with the Engineer and MassDEP to refine the limits of contamination at SED-19.

2. Measurement: This item shall be measured on the basis of cubic yards of sediment or soil accepted for disposal at a licensed facility. The estimated quantity is based on comparison of existing and design terrain surfaces and reflects estimated in-situ volumes. The Contractor shall furnish the Engineer with trip tickets for each load of sediment or soil. Basis for volume shall be the actual volume in each load, regardless of whether the truck is full to its volumetric capacity. Each load volume shall be confirmed and recorded by the Engineer prior to leaving site.

3. Payment: Payment for this bid item will be made per cubic yard removed from the Site for off-site disposal, as estimated by the Contractor and accepted by the Engineer. The Contractor shall furnish with request for payment all corresponding, fully executed disposal documents (i.e., Material Shipping Records, Bills of Lading, waste manifests, etc.) and disposal facility weight slips/receipts. The Owner reserves the right to withhold payment approval until all corresponding disposal records are submitted.

L. Base Bid Item No. 11 – Excavation and Reuse of Satisfactory Soils

1. Work associated with this item will be paid for at the stated price including, but not limited to, work under the following:

   a. All or portions of Division 01 specifications, as applicable.

   b. Section 31 20 00 - Earthwork

   c. Includes, but is not limited to: All products, materials, equipment, tools, labor, overhead and profit, fees, and incidentals required for excavation and reuse of satisfactory soils. Associated earthwork operations may include excavation, subgrade excavation, subgrade preparation, stockpiling, and fine grading.

2. Measurement: The estimated quantity for this item of work shall be the final pay quantity, unless the dimensions of any portion of the item are revised by the Engineer, or the item or any portion of the item is eliminated. If the final pay quantity is revised, compensation will be the final pay quantity multiplied by the bid unit price for the item. The estimated quantity is based on comparison of existing and design terrain surfaces and reflects in-situ volumes.

3. Payment: Payment for this bid item will be made per cubic yard based on a percentage of completion as estimated from measurements made by the Contractor and accepted by the Engineer.

M. Base Bid Item No. 12 – Excavation and Off-site Disposal of Other Soils

1. Work associated with this item will be paid for at the stated price including, but not limited to, work under the following:

   a. All or portions of Division 01 specifications, as applicable.

   b. Section 31 20 00 - Earthwork

   c. Includes, but is not limited to: All products, materials, equipment, tools, labor, overhead and profit, fees, and incidentals required for removal, and legal off-site disposal of excavated materials not incorporated into the project or covered by other pay items. Associated earthwork operations may include excavation, subgrade excavation, subgrade preparation, stockpiling, and fine grading.

2. Measurement: This item shall be measured on the basis of cubic yards of sediment or soil accepted for disposal at a licensed facility. The estimated quantity is based on comparison of existing and design terrain surfaces and reflects estimated in-situ volumes. The Contractor shall furnish the Engineer with trip tickets for each load of sediment or soil. Load volume shall be confirmed by the Engineer prior to leaving site.

3. Payment: Payment for this bid item will be made per cubic yard removed from the Site for off-site disposal, as estimated by the Contractor and accepted by the Engineer. The Contractor shall furnish with request for payment all corresponding, fully executed disposal documents (i.e., Material Shipping Records, Bills of Lading, waste manifests, etc.) and disposal facility weight slips/receipts. The Owner reserves the right to withhold payment approval until all corresponding disposal records are submitted.

N. Base Bid Item No. 13 – Riprap Type A

1. Work associated with this item will be paid for at the stated price including, but not limited to, work under the following:

    a. All or portions of Division 01 specifications, as applicable.

    b. Section 31 20 00 - Earthwork

    c. Includes, but is not limited to: All products, materials, equipment, tools, labor, overhead and profit, fees, and incidentals required for provision and placement of Riprap Type A. Filter materials are incidental. Clearing and grubbing for riprap installation is included in a separate bid item.

2. Measurement: This item shall be measured by the ton. The Contractor shall furnish the Engineer with weight tickets from state-certified scales for each load of Riprap Type A installed in the Work, complete in place, and accepted.

3. Payment: Payment for this bid item will be made at the contract unit price per ton installed.

O. Base Bid Item No. 14 – Riprap Type B

1. Work associated with this item will be paid for at the stated price including, but not limited to, work under the following:

    a. All or portions of Division 01 specifications, as applicable.

    b. Section 31 20 00 - Earthwork

    c. Includes, but is not limited to: All products, materials, equipment, tools, labor, overhead and profit, fees, and incidentals required for provision and placement of Riprap Type B. Filter materials are incidental. For soil-filled applications, provision and installation of salvaged soil is incidental. Clearing and grubbing for riprap installation and disposal of contaminated soils are included in separate bid items.

2. Measurement: This item shall be measured by the ton. The Contractor shall furnish the Engineer with weight tickets from state-certified scales for each load of Riprap Type B installed in the Work, complete in place, and accepted.

3. Payment: Payment for this bid item will be made at the contract unit price per ton installed.

P. Base Bid Item No. 15 – Riprap Type C

1. Work associated with this item will be paid for at the stated price including, but not limited to, work under the following:
    a. All or portions of Division 01 specifications, as applicable.
    b. Section 31 20 00 - Earthwork
    c. Includes, but is not limited to: All products, materials, equipment, tools, labor, overhead and profit, fees, and incidentals required for provision and placement of Riprap Type A. Filter materials are incidental. Clearing and grubbing for riprap installation is included in a separate bid item.
2. Measurement: This item shall be measured by the ton. The Contractor shall furnish the Engineer with weight tickets from state-certified scales for each load of Riprap Type C installed in the Work, complete in place, and accepted.
3. Payment: Payment for this bid item will be made at the contract unit price per ton installed.

Q. Base Bid Item No. 16 – Riprap Type D

1. Work associated with this item will be paid for at the stated price including, but not limited to, work under the following:
    a. All or portions of Division 01 specifications, as applicable.
    b. Section 31 20 00 - Earthwork
    c. Includes, but is not limited to: All products, materials, equipment, tools, labor, overhead and profit, fees, and incidentals required for provision and placement of Riprap Type A. Filter materials are incidental. Clearing and grubbing for riprap installation is included in a separate bid item.
2. Measurement: This item shall be measured by the ton. The Contractor shall furnish the Engineer with weight tickets from state-certified scales for each load of Riprap Type D installed in the Work, complete in place, and accepted.
3. Payment: Payment for this bid item will be made at the contract unit price per ton installed.

R. Base Bid Item No. 17 – Streambed Material Type A

1. Work associated with this item will be paid for at the stated price including, but not limited to, work under the following:
    a. All or portions of Division 01 specifications, as applicable.
    b. Section 31 20 00 - Earthwork
    c. Includes, but is not limited to: All products, materials, equipment, tools, labor, overhead and profit, fees, and incidentals required for provision and placement of Streambed Material Type A. After fish passage flow testing, minor adjustments streambed material placement may be necessary. Adjustments shall be incidental to this item.
2. Measurement: This item shall be measured by the ton. The Contractor shall furnish the Engineer with weight tickets from state-certified scales for each load of Streambed Material Type A installed in the Work, complete in place, and accepted.
3. Payment: Payment for this bid item will be made at the contract unit price per ton installed.

a. Payment will be made only for placement of streambed material to the lines, grades, and thicknesses indicated in the Contract Documents, or as directed by the Engineer.

S. Base Bid Item No. 18 – Streambed Material Type B

1. Work associated with this item will be paid for at the stated price including, but not limited to, work under the following:

   a. All or portions of Division 01 specifications, as applicable.

   b. Section 31 20 00 - Earthwork

   c. Includes, but is not limited to: All products, materials, equipment, tools, labor, overhead and profit, fees, and incidentals required for provision and placement of Streambed Material Type B. After fish passage flow testing, minor adjustments streambed material placement may be necessary. Adjustments shall be incidental to this item.

2. Measurement: This item shall be measured by the ton. The Contractor shall furnish the Engineer with weight tickets from state-certified scales for each load of Streambed Material Type B installed in the Work, complete in place, and accepted.

3. Payment: Payment for this bid item will be made at the contract unit price per ton installed.

T. Base Bid Item No. 19 – Weir Boulders

1. Work associated with this item will be paid for at the stated price including, but not limited to, work under the following:

   a. All or portions of Division 01 specifications, as applicable.

   b. Section 31 20 00 - Earthwork

   c. Includes, but is not limited to: All products, materials, equipment, tools, labor, overhead and profit, fees, and incidentals required for provision and placement of Weir Boulders. After fish passage flow testing, minor adjustments boulder placement may be necessary. Adjustments shall be incidental to this item.

2. Measurement: This item shall be measured by the number of boulders meeting the specified size requirements installed in the Work, complete in place, and accepted. The Contractor shall furnish the Engineer with trip tickets with the number of boulders identified for each load of Weir Boulders installed in the Work.

3. Payment: Payment for this bid item will be made at the contract unit price per boulder installed.

U. Base Bid Item No. 20 – Habitat Boulders

1. Work associated with this item will be paid for at the stated price including, but not limited to, work under the following:

   a. All or portions of Division 01 specifications, as applicable.

   b. Section 31 20 00 - Earthwork

   c. Includes, but is not limited to: All products, materials, equipment, tools, labor, overhead and profit, fees, and incidentals required for provision and placement

of Habitat Boulders. After fish passage flow testing, minor adjustments boulder placement may be necessary. Adjustments shall be incidental to this item.

2. Measurement: This item shall be measured by the number of Habitat Boulders meeting the specified size requirements installed in the Work, complete in place, and accepted. The Contractor shall furnish the Engineer with trip tickets with the number of boulders identified for each load of Habitat Boulders installed in the Work.

3. Payment: Payment for this bid item will be made at the contract unit price per Habitat Boulder installed.

V. Base Bid Item No. 21 – Fabric Encapsulated Soil (FES) Lifts

1. Work associated with this item will be paid for at the stated price including, but not limited to, work under the following:

   a. All or portions of Division 01 specifications, as applicable.

   b. Section 31 20 00 – Earthwork

   c. Section 31 32 00 – Bioengineering Soil Stabilization

   d. Includes, but is not limited to: All products, materials, equipment, tools, labor, overhead and profit, fees, and incidentals required for construction of FES Lifts, including forms, fabric, stakes, and staples. Trenching to secure fabrics is incidental. Subgrade preparation, backfilling with salvaged soil, and seeding are included in separate bid items.

2. Measurement: This item shall be measured on the basis of lineal face foot of lift installed as measured parallel to the channel centerline, complete in place, and accepted.

3. Payment: Payment for this bid item will be made at the contract unit price per face foot of FES Lift installed as estimated by the Contractor and accepted by the Engineer.

W. Base Bid Item No. 22 – Surface Fabric Treatment

1. Work associated with this item will be paid for at the stated price including, but not limited to, work under the following:

   a. All or portions of Division 01 specifications, as applicable.

   b. Section 31 20 00 – Earthwork

   c. Section 31 32 00 – Bioengineering Soil Stabilization

   d. Includes, but is not limited to: All products, materials, equipment, tools, labor, overhead and profit, fees, and incidentals required to install surface fabric, including fabric, stakes, and staples. Trenching to secure fabrics is incidental. Seeding is included in a separate bid item.

2. Measurement: This item shall be measured on the basis of square yard of fabric installed and exposed (overlapping fabric and buried fabric are not included in measurement), complete in place, and accepted.

3. Payment: Payment for this bid item will be made at the contract unit price per square yard of fabric installed as estimated by the Contractor and accepted by the Engineer.

X. Base Bid Item No. 23 – Logs with Rootwads

1. Work associated with this item will be paid for at the stated price including, but not limited to, work under the following:
    a. All or portions of Division 01 specifications, as applicable.
    b. Section 31 20 00 – Earthwork
    c. Section 31 38 00 – Large Wood
    d. Includes, but is not limited to: All products, materials, equipment, tools, labor, overhead and profit, fees, and incidentals required to install Logs with Rootwads. Excavation, subgrade preparation, and furnishing and installing anchoring hardware are included.
2. Measurement: This item shall be measured on the basis of each Log with Rootwad installed in the Work, complete in place, and accepted.
3. Payment: Payment for this bid item will be made at the contract unit price per Log with Rootwad installed as estimated by the Contractor and accepted by the Engineer.

Y. Base Bid Item No. 24 – Logs

1. Work associated with this item will be paid for at the stated price including, but not limited to, work under the following:
    a. All or portions of Division 01 specifications, as applicable.
    b. Section 31 20 00 – Earthwork
    c. Section 31 38 00 – Large Wood
    d. Includes, but is not limited to: All products, materials, equipment, tools, labor, overhead and profit, fees, and incidentals required to install Logs. Excavation, subgrade preparation, and furnishing and installing anchoring hardware are included.
2. Measurement: This item shall be measured on the basis of each Log installed in the Work, complete in place, and accepted.
3. Payment: Payment for this bid item will be made at the contract unit price per Log installed as estimated by the Contractor and accepted by the Engineer.

Z. Base Bid Item No. 25 – Logs for Timber Piles

1. Work associated with this item will be paid for at the stated price including, but not limited to, work under the following:
    a. All or portions of Division 01 specifications, as applicable.
    b. Section 31 20 00 – Earthwork
    c. Section 31 38 00 – Large Wood
    d. Includes, but is not limited to: All products, materials, equipment, tools, labor, overhead and profit, fees, and incidentals required to install Logs for Timber Piles. Excavation, subgrade preparation, and furnishing and installing anchoring hardware are included.
2. Measurement: This item shall be measured on the basis of each Log for Timber Pile installed in the Work, complete in place, and accepted.

3. Payment: Payment for this bid item will be made at the contract unit price per Log for Timber Pile installed as estimated by the Contractor and accepted by the Engineer.

AA. Base Bid Item No. 26 – Concrete Retaining Wall A

1. Work associated with this item will be paid for at the stated price including, but not limited to, work under the following:
    a. All or portions of Division 1 specifications, as applicable
    b. Section 03 30 00 – Cast-in-Place Concrete
    c. Section 31 20 00 – Earthwork
    d. Section 31 50 00 – Excavation Support and Protection
    e. Includes, but is not limited to: All products, materials, equipment, tools, labor, overhead and profit, fees, and incidentals required to furnish and install Concrete Retaining Wall A, including temporary support of excavation, subgrade preparation, formwork, formliner, reinforcing steel, cast-in-place concrete, dampproofing, backfilling, and testing. Excavation and off-site disposal are included in a separate pay item.
2. Measurement: This item will not be measured for payment but will be pro-rated with the Contractor's progress of work as accepted by Engineer.
3. Payment: Payment for this bid item will be made on a lump sum basis based on a percentage of completion as estimated by the Contractor and accepted by the Engineer.

BB. Base Bid Item No. 27 - Decorative Metal Fence (5' ht.)

1. Work associated with this item will be paid for at the stated price including, but not limited to, work under the following:
    a. All or portions of Division 1 specifications, as applicable
    b. Section 32 31 19 – Decorative Metal Fences and Gates
    c. Includes, but is not limited to: All products, materials, equipment, tools, labor, overhead and profit, fees, and incidentals required to furnish and install Decorative Metal Fence (5' ht.), including post setting.
2. Measurement: This item shall be measured on the basis of linear feet installed, complete in place, and accepted.
3. Payment: Payment for this bid item will be made at the contract unit price for Decorative Metal Fence (5' ht.) as estimated by the Contractor and accepted by the Engineer.

CC. Base Bid Item No. 28 - Decorative Metal Fence (4' ht.)

1. Work associated with this item will be paid for at the stated price including, but not limited to, work under the following:
    a. All or portions of Division 1 specifications, as applicable
    b. Section 32 31 19 – Decorative Metal Fences and Gates

c. Includes, but is not limited to: All products, materials, equipment, tools, labor, overhead and profit, fees, and incidentals required to furnish and install Decorative Metal Fence (4' ht.), including post setting.

2. Measurement: This item shall be measured on the basis of linear feet installed, complete in place, and accepted.

3. Payment: Payment for this bid item will be made at the contract unit price for Decorative Metal Fence (4' ht.) as estimated by the Contractor and accepted by the Engineer.

DD. Base Bid Item No. 29 - Black Vinyl Coated Chain Link Fence (6' ht.) for Retaining Wall A

1. Work associated with this item will be paid for at the stated price including, but not limited to, work under the following:

a. All or portions of Division 1 specifications, as applicable

b. Section 32 32 13 – Chain Link Fences and Gates

c. Includes, but is not limited to: All products, materials, equipment, tools, labor, overhead and profit, and incidentals required to furnish, install, and clean Black Coated Chain Link Fence (6' ht.) for Retaining Wall A.

2. Measurement: This item shall be measured on the basis of linear feet installed, complete in place, and accepted.

3. Payment: Payment for this bid item will be made at the contract unit price for Black Vinyl Coated Chain Link Fence (6' ht.) for Retaining Wall A as estimated by the Contractor and accepted by the Engineer.

EE. Base Bid Item No. 30 – Metal Guardrail

1. Work associated with this item will be paid for at the stated price including, but not limited to, work under the following:

a. All or portions of Division 1 specifications, as applicable.

b. Includes, but is not limited to: All products, materials, equipment, tools, labor, overhead and profit, fees, and incidentals required to furnish and install Metal Guardrail, including rounded terminal end sections.

2. Measurement: This item will not be measured for payment but will be pro-rated with the Contractor's progress of work as accepted by Engineer.

3. Payment: Payment for this bid item will be made on a lump sum basis based on a percentage of completion as estimated by the Contractor and accepted by the Engineer.

FF. Base Bid Item No. 31 – Concrete Retaining Wall B

1. Work associated with this item will be paid for at the stated price including, but not limited to, work under the following:

a. All or portions of Division 1 specifications, as applicable

b. Section 03 30 00 – Cast-in-Place Concrete

c. Section 31 20 00 – Earthwork

d. Section 31 50 00 – Excavation Support and Protection

e. Includes, but is not limited to: All products, materials, equipment, tools, labor, overhead and profit, fees, and incidentals required to furnish and install Concrete Retaining Wall B, including temporary excavation, subgrade preparation, formwork, reinforcing steel, cast-in-place concrete, dampproofing, backfilling, and testing. Excavation and off-site disposal are included in a separate pay item.

2. Measurement: This item will not be measured for payment but will be pro-rated with the Contractor's progress of work as accepted by Engineer.

3. Payment: Payment for this bid item will be made on a lump sum basis based on a percentage of completion as estimated by the Contractor and accepted by the Engineer.

GG. Base Bid Item No. 32 - Black Vinyl Coated Chain Link Fence (6' ht.) for Retaining Wall B

1. Work associated with this item will be paid for at the stated price including, but not limited to, work under the following:

a. All or portions of Division 1 specifications, as applicable

b. Section 32 32 13 – Chain Link Fences and Gates

c. Includes, but is not limited to: All products, materials, equipment, tools, labor, overhead and profit, and incidentals required to furnish, install, and clean Black Coated Chain Link Fence (6' ht.) for Retaining Wall B.

2. Measurement: This item shall be measured on the basis of linear feet installed, complete in place, and accepted.

3. Payment: Payment for this bid item will be made at the contract unit price for Black Vinyl Coated Chain Link Fence (6' ht.) for Retaining Wall B as estimated by the Contractor and accepted by the Engineer.

HH. Base Bid Item No. 33 – 24 Inch Reinforced Concrete Pipe

1. Work associated with this item will be paid for at the stated price including, but not limited to, work under the following:

a. All or portions of Division 1 specifications, as applicable.

b. Includes, but is not limited to: All products, materials, equipment, tools, labor, overhead and profit, fees, and incidentals required to furnish and install 24 Inch Reinforced Concrete Pipe.

2. Measurement: This item shall be measured on the basis of linear feet installed, complete in place, and accepted.

3. Payment: Payment for this bid item will be made at the contract unit price 24 Inch Reinforced Concrete Pipe as estimated by the Contractor and accepted by the Engineer.

II. Base Bid Item No. 34 – 24 Inch Reinforced Concrete Pipe Flared End

1. Work associated with this item will be paid for at the stated price including, but not limited to, work under the following:

a. All or portions of Division 1 specifications, as applicable.

b. Includes, but is not limited to: All products, materials, equipment, tools, labor, overhead and profit, fees, and incidentals required to furnish and install 24 Inch Reinforced Concrete Pipe Flared End.

2. Measurement: This item shall be measured on the basis of each 24 Inch Reinforced Concrete Pipe Flared End installed in the Work, complete in place, and accepted.

3. Payment: Payment for this bid item will be made at the contract unit price per 24 Inch Reinforced Concrete Pipe Flared End installed as estimated by the Contractor and accepted by the Engineer.

JJ. Base Bid Item No. 35 – Conservation Grade Trees

1. Work associated with this item will be paid for at the stated price including, but not limited to, work under the following:

a. All or portions of Division 1 specifications, as applicable

b. Section 32 93 00 – Plantings

c. Includes, but is not limited to: All products, materials, equipment, tools, labor, overhead and profit, fees, and incidentals required to furnish and install Conservation Grade Trees, including it excavation, planting soil, testing, mulching, cleanup, protection, disposal, warranty, and maintenance.

2. Measurement: This item shall be measured on the basis of each Conservation Grade Tree installed in the Work, complete in place, and accepted.

3. Payment: Payment for this bid item will be made at the contract unit price per Conservation Grade Tree installed as estimated by the Contractor and accepted by the Landscape Architect.

KK. Base Bid Item No. 36 – Conservation Grade Shrubs

1. Work associated with this item will be paid for at the stated price including, but not limited to, work under the following:

a. All or portions of Division 1 specifications, as applicable

b. Section 32 93 00 – Plantings

c. Includes, but is not limited to: All products, materials, equipment, tools, labor, overhead and profit, fees, and incidentals required to furnish and install Conservation Grade Shrubs, including pit excavation, planting soil, testing, mulching, cleanup, protection, disposal, warranty, and maintenance.

2. Measurement: This item shall be measured on the basis of each Conservation Grade Shrub installed in the Work, complete in place, and accepted.

3. Payment: Payment for this bid item will be made at the contract unit price per Conservation Grade Shrub installed as estimated by the Contractor and accepted by the Landscape Architect.

LL. Base Bid Item No. 37 – Tubelings

1. Work associated with this item will be paid for at the stated price including, but not limited to, work under the following:

a. All or portions of Division 1 specifications, as applicable

b. Section 32 93 00 – Plantings

c. Includes, but is not limited to: All products, materials, equipment, tools, labor, overhead and profit, fees, and incidentals required to furnish and install Tubelings, including cleanup, protection, disposal, warranty, and maintenance.

2. Measurement: This item shall be measured on the basis of each Tubeling installed in the Work, complete in place, and accepted.

3. Payment: Payment for this bid item will be made at the contract unit price per Tubeling installed as estimated by the Contractor and accepted by the Landscape Architect.

MM. Base Bid Item No. 38 - Conservation Seed Mix

1. Work associated with this item will be paid for at the stated price including, but not limited to, work under the following:

a. All or portions of Division 1 specifications, as applicable

b. Section 32 92 19 - Seeding

c. Includes, but is not limited to: All products, materials, equipment, tools, labor, overhead and profit, fees, and incidentals required to furnish and install Conservation Seed Mix. Warranty and maintenance, including invasive species control, are included.

2. Measurement: This item shall be measured on the basis of acres of Conservation Seed Mix installed in the Work, complete in place, and accepted.

3. Payment: Payment for this bid item will be made at the contract unit price per acre of Conservation Seed Mix installed as estimated by the Contractor and accepted by the Landscape Architect.

NN. Base Bid Item No. 39 – Upland/Park Seed Mix

1. Work associated with this item will be paid for at the stated price including, but not limited to, work under the following:

a. All or portions of Division 1 specifications, as applicable

b. Section 32 92 19 - Seeding

c. Includes, but is not limited to: All products, materials, equipment, tools, labor, overhead and profit, fees, and incidentals required to furnish and install Upland/Park Seed Mix. Warranty and maintenance, including invasive species control, are included.

2. Measurement: This item shall be measured on the basis of acres of Upland/Park Seed Mix installed in the Work, complete in place, and accepted.

3. Payment: Payment for this bid item will be made at the contract unit price per acre of Upland/Park Seed Mix installed as estimated by the Contractor and accepted by the Landscape Architect.

OO. Base Bid Item No. 40 – Floating Safety Boom and Anchors

1. Work associated with this item will be paid for at the stated price including, but not limited to, work under the following:
    a. All or portions of Division 1 specifications, as applicable.
    b. Section 32 05 23 – Cement and Concrete for Exterior Improvements
    c. Section 32 39 00 – Manufactured Site Specialties
    d. Includes, but is not limited to: All products, materials, equipment, tools, labor, overhead and profit, fees, and incidentals required to furnish and install Floating Safety Boom, including floating safety boom, anchor, anchor foundation, and hardware.
2. Measurement: This item will not be measured for payment.
3. Payment: Payment for this bid item will be made on a lump sum basis upon completion and acceptance by the Engineer.

PP. Base Bid Item No. 41 – Permanent Signs

1. Work associated with this item will be paid for at the stated price including, but not limited to, work under the following:
    a. All or portions of Division 1 specifications, as applicable.
    b. Section 10 14 00 - Signage
    c. Section 32 05 23 – Cement and Concrete for Exterior Improvements
    d. Includes, but is not limited to: All products, materials, equipment, tools, labor, overhead and profit, fees, and incidentals required to furnish and install Permanent Signs as shown on the Contract Drawings, including posts, footings, panels, mounting, and hardware.
2. Measurement: This item will not be measured for payment.
3. Payment: Payment for this bid item will be made on a lump sum basis upon completion and acceptance by the Engineer.

3.2 LIST OF ALTERNATE BID ITEMS

A. Add Alternate Item No. A1 – Scour Protection Rip Rap Type A (MBTA Bridge)

1. Payment shall be as for Base Bid Item No. 13.

B. Add Alternate Item No. B1 – Walkway Retaining Structure

1. Work associated with this item will be paid for at the stated price including, but not limited to, work under the following:
    a. All or portions of Division 1 specifications, as applicable
    b. Section 03 30 00 – Cast-in-Place Concrete
    c. Section 31 20 00 – Earthwork
    d. Section 31 50 00 – Excavation Support and Protection
    e. Section 32 12 16 – Asphalt Paving

f. Includes, but is not limited to: All products, materials, equipment, tools, labor, overhead and profit, fees, and incidentals required to furnish and install Walkway Retaining Structure, including excavation and off-site disposal, temporary support of excavation, subgrade preparation, formwork, formliner, reinforcing steel, cast-in-place concrete, dampproofing, backfilling, testing, trench drain, and asphalt.

2. Measurement: This item will not be measured for payment but will be pro-rated with the Contractor's progress of work as accepted by Engineer.

3. Payment: Payment for this bid item will be made on a lump sum basis based on a percentage of completion as estimated by the Contractor and accepted by the Engineer.

C. Add Alternate Item No. B2 – Pedestrian Bridge

1. Work associated with this item will be paid for at the stated price including, but not limited to, work under the following:

a. All or portions of Division 1 specifications, as applicable

b. Section 03 30 00 – Cast-in-Place Concrete

c. Section 31 20 00 – Earthwork

d. Section 31 50 00 – Excavation Support and Protection

e. Section 31 63 33 – Drilled Micropiles

f. Section 32 34 13 – Fabricated Pedestrian Bridge

g. Includes, but is not limited to: All products, materials, equipment, tools, labor, overhead and profit, fees, and incidentals required to furnish and install Pedestrian Bridge, including excavation and off-site disposal, subgrade preparation, abutments (formwork, reinforcing steel, cast-in-place concrete, dampproofing, backfilling), micropiles, testing, proper disposal of drilling spoil, and fabricated pedestrian bridge. This item includes the structural design of the pedestrian bridge. Temporary support of excavation is included in Add Alternate Item A1 – Walkway Retaining Structure.

2. Measurement: This item will not be measured for payment but will be pro-rated with the Contractor's progress of work as accepted by Engineer.

3. Payment: Payment for this bid item will be made on a lump sum basis based on a percentage of completion as estimated by the Contractor and accepted by the Engineer.

D. Add Alternate Item No. B3 – Asphalt Walking Trail

1. Work associated with this item will be paid for at the stated price including, but not limited to, work under the following:

a. All or portions of Division 1 specifications, as applicable.

b. Section 01 57 13 – Temporary Erosion and Sedimentation Control

c. Section 31 10 00 – Site Clearing

d. Section 31 20 00 – Earthwork

e. Section 32 12 16 - Asphalt Paving

f. Section 32 17 23 – Pavement Markings

g. Includes, but is not limited to: All products, materials, equipment, tools, labor, overhead and profit, fees, and incidentals required to furnish and place asphalt, including subgrade preparation; all courses, compaction, and testing; and pavement striping. Clearing and grubbing for the trail and provision and installation of silt sock are included in this item.

2. Measurement: This item shall be measured on the basis of square feet installed, complete in place, and accepted. Material quantities above the thicknesses shown on the Drawings shall not be considered for payment.

3. Payment: Payment for this bid item will be made at the contract unit price for Asphalt Walking Trail as estimated by the Contractor and accepted by the Engineer.

E. Add Alternate Item No. B4 – Modular Concrete Block Wall

1. Work associated with this item will be paid for at the stated price including, but not limited to, work under the following:

a. All or portions of Division 1 specifications, as applicable.

b. Section 31 20 00 – Earthwork

c. Section 32 32 23 – Segmental Retaining Walls

d. Includes, but is not limited to: All products, materials, equipment, tools, labor, overhead and profit, fees, and incidentals required to furnish and install Modular Concrete Block Wall, including excavation and off-site disposal, wall units, soil reinforcement, drainage, backfilling, and leveling pad. Wall design and mockup are included in this item.

2. Measurement: This item shall be measured on the basis of face feet installed, complete in place, and accepted.

3. Payment: Payment for this bid item will be made at the contract unit price for Modular Concrete Block Wall as estimated by the Contractor and accepted by the Engineer.

F. Add Alternate Item No. B5 – Riprap Type C

1. Work associated with this item will be paid for at the stated price including, but not limited to, work under the following:

a. All or portions of Division 01 specifications, as applicable.

b. Section 31 20 00 - Earthwork

c. Includes, but is not limited to: All products, materials, equipment, tools, labor, overhead and profit, fees, and incidentals required for provision and placement of Riprap Type A. Filter materials are incidental. Clearing and grubbing for riprap installation is included in a separate bid item.

2. Measurement: This item shall be measured by the ton. The Contractor shall furnish the Engineer with weight tickets from state-certified scales for each load of Riprap Type C installed in the Work, complete in place, and accepted.

3. Payment: Payment for this bid item will be made at the contract unit price per ton installed.

G. Add Alternate Item No. B6 - Decorative Metal Fence (3.5' ht.)

1. Work associated with this item will be paid for at the stated price including, but not limited to, work under the following:
    a. All or portions of Division 1 specifications, as applicable
    b. Section 32 31 19 – Decorative Metal Fences and Gates
    c. Includes, but is not limited to: All products, materials, equipment, tools, labor, overhead and profit, fees, and incidentals required to furnish and install Decorative Metal Fence (3.5' ht.), including post setting.
2. Measurement: This item shall be measured on the basis of linear feet installed, complete in place, and accepted.
3. Payment: Payment for this bid item will be made at the contract unit price for Decorative Metal Fence (3.5' ht.) as estimated by the Contractor and accepted by the Engineer.

H. Add Alternate Item No. B7 - Black Vinyl Coated Chain Link Fence (6' ht.)

1. Work associated with this item will be paid for at the stated price including, but not limited to, work under the following:
    a. All or portions of Division 1 specifications, as applicable
    b. Section 32 32 13 – Chain Link Fences and Gates
    c. Includes, but is not limited to: All products, materials, equipment, tools, labor, overhead and profit, and incidentals required to furnish, install, and clean Black Coated Chain Link Fence (6' ht.).
2. Measurement: This item shall be measured on the basis of linear feet installed, complete in place, and accepted.
3. Payment: Payment for this bid item will be made at the contract unit price for Black Vinyl Coated Chain Link Fence (6' ht.) as estimated by the Contractor and accepted by the Engineer.

I. Add Alternate Item No. B8 – Trail Crossing for Stormwater Outfall

1. Work associated with this item will be paid for at the stated price including, but not limited to, work under the following:
    a. All or portions of Division 1 specifications, as applicable.
    b. All or portions of Division 31 and 32 specifications, as applicable
    c. Includes, but is not limited to: All products, materials, equipment, tools, labor, overhead and profit, fees, and incidentals required to design, furnish, and install Trail Crossing for Stormwater Outfall as indicated on the Contract Drawings.
2. Measurement: This item will not be measured for payment.
3. Payment: Payment for this bid item will be made on a lump sum basis upon completion and acceptance by the Engineer.

J. Add Alternate Item No. B9 – Semi-Shade Seed Mix

1. Work associated with this item will be paid for at the stated price including, but not limited to, work under the following:
    a. All or portions of Division 1 specifications, as applicable
    b. Section 32 92 19 - Seeding
    c. Includes, but is not limited to: All products, materials, equipment, tools, labor, overhead and profit, fees, and incidentals required to furnish and install Semi-Shade Seed Mix. Warranty and maintenance, including invasive species control, are included.
2. Measurement: This item shall be measured on the basis of acres of Semi-Shade Seed Mix installed in the Work, complete in place, and accepted.
3. Payment: Payment for this bid item will be made at the contract unit price per acre of Semi-Shade Seed Mix installed as estimated by the Contractor and accepted by the Landscape Architect.

K. Add Alternate Item No. C1 – Overlook Plaza

1. Work associated with this item will be paid for at the stated price including, but not limited to, work under the following:
    a. All or portions of Division 1 specifications, as applicable
    b. Section 32 14 00 – Unit Pavers and

       Section 32 33 00 – Site Furnishings
    c. Includes, but is not limited to: All products, materials, equipment, tools, labor, overhead and profit, fees, and incidentals required to furnish and install as indicated on the Contract Drawings including permeable pavers, salvaged boulders, monolithic granite stone benches, engraved granite monument stone, salvaged stone wall, and all other incidentals required to finish the work, complete and accepted by the Engineer.
2. Measurement: This item will not be measured for payment but will be pro-rated with the Contractor's progress of work as accepted by Engineer.
3. Payment: Payment for this bid item will be made on a lump sum basis based on a percentage of completion as estimated by the Contractor and accepted by the Engineer.

L. Add Alternate Item No. C2 – Cement Concrete Sidewalk and Curbing

1. Work associated with this item will be paid for at the stated price including, but not limited to, work under the following:
    a. All or portions of Division 1 specifications, as applicable
    b. Section 03 30 00 – Cast-in-Place Concrete and

       Section 23 16 44 – Curbing
    c. Includes, but is not limited to: All products, materials, equipment, tools, labor, overhead and profit, and incidentals required to furnish and install sidewalk and curbing as indicated on the Contract Drawings including all other incidentals required to finish the work, complete and accepted by the Engineer.

2. Measurement: This item will not be measured for payment but will be pro-rated with the Contractor's progress of work as accepted by Engineer.

3. Payment: Payment for this bid item will be made on a lump sum basis based on a percentage of completion as estimated by the Contractor and accepted by the Engineer.

M. Add Alternate Item No. C3 – Timber Post Guardrail

1. Work associated with this item will be paid for at the stated price including, but not limited to, work under the following:

    a. All or portions of Division 1 specifications, as applicable.

    b. Includes, but is not limited to: All products, materials, equipment, tools, labor, overhead and profit, fees, and incidentals required to furnish and install Timber Post Guardrail, including trailing anchorage and rounded terminal end sections.

2. Measurement: This item will not be measured for payment but will be pro-rated with the Contractor's progress of work as accepted by Engineer.

3. Payment: Payment for this bid item will be made on a lump sum basis based on a percentage of completion as estimated by the Contractor and accepted by the Engineer.

N. Add Alternate Item No. C4 – Shade Tree 2-2.5" cal.

1. Work associated with this item will be paid for at the stated price including, but not limited to, work under the following:

    a. All or portions of Division 1 specifications, as applicable

    b. Section 32 93 00 – Plantings

    c. Includes, but is not limited to: All products, materials, equipment, tools, labor, overhead and profit, fees, and incidentals required to furnish and install trees, including it excavation, planting soil, testing, mulching, cleanup, protection, disposal. Warranty and maintenance, including invasive species control, are included.

2. Measurement: This item shall be measured on the basis of each Shade Tree 2-2.5" cal. installed in the Work, complete in place, and accepted.

3. Payment: Payment for this bid item will be made at the contract unit price per Shade Tree 2-2.5" cal. installed as estimated by the Contractor and accepted by the Landscape Architect.

O. Add Alternate Item No. C5 – Ornamental Tree 1-1.5" cal.

1. Work associated with this item will be paid for at the stated price including, but not limited to, work under the following:

    a. All or portions of Division 1 specifications, as applicable

    b. Section 32 93 00 – Plantings

    c. Includes, but is not limited to: All products, materials, equipment, tools, labor, overhead and profit, fees, and incidentals required to furnish and install trees, including it excavation, planting soil, testing, mulching, cleanup, protection, disposal. Warranty and maintenance, including invasive species control, are included.

2. Measurement: This item shall be measured on the basis of each Ornamental Tree 1-1.5" cal. installed in the Work, complete in place, and accepted.

3. Payment: Payment for this bid item will be made at the contract unit price per Ornamental Tree 1-1.5" cal. installed as estimated by the Contractor and accepted by the Landscape Architect.

P. Add Alternate Item No. C6 – Shrubs 3 gal.

1. Work associated with this item will be paid for at the stated price including, but not limited to, work under the following:

    a. All or portions of Division 1 specifications, as applicable

    b. Section 32 93 00 – Plantings

    c. Includes, but is not limited to: All products, materials, equipment, tools, labor, overhead and profit, fees, and incidentals required to furnish and install shrubs, including it excavation, planting soil, testing, mulching, cleanup, protection, disposal. Warranty and maintenance, including invasive species control, are included.

2. Measurement: This item shall be measured on the basis of each Shrub 3 gal. installed in the Work, complete in place, and accepted.

3. Payment: Payment for this bid item will be made at the contract unit price per Shrub 3 gal. installed as estimated by the Contractor and accepted by the Landscape Architect.

Q. Add Alternate Item No. C7 – Perennials

1. Work associated with this item will be paid for at the stated price including, but not limited to, work under the following:

    a. All or portions of Division 1 specifications, as applicable

    b. Section 32 93 00 – Plantings

    c. Includes, but is not limited to: All products, materials, equipment, tools, labor, overhead and profit, fees, and incidentals required to furnish and install perennials, including it excavation, planting soil, testing, mulching, cleanup, protection, disposal. Warranty and maintenance, including invasive species control, are included.

2. Measurement: This item will not be measured for payment but will be pro-rated with the Contractor's progress of work as accepted by Landscape Architect.

3. Payment: Payment for this bid item will be made on a lump sum basis based on a percentage of completion as estimated by the Contractor and accepted by the Landscape Architect.

R. Add Alternate Item No. C8 – Wood Guardrail

1. Work associated with this item will be paid for at the stated price including, but not limited to, work under the following:

    a. All or portions of Division 1 specifications, as applicable.

    b. Section 32 30 51- Wood Guardrail

c. Includes, but is not limited to: All products, materials, equipment, tools, labor, overhead and profit, fees, and incidentals required to furnish and install Wood Guardrail.

2. Measurement: This item shall be measured on the basis of linear feet installed, complete in place, and accepted.

3. Payment: Payment for this bid item will be made at the contract unit price for Wood Guardrail as estimated by the Contractor and accepted by the Engineer.

S. Add Alternate Item No. D1 – Kayak/Canoe Launch and Access Path

1. Work associated with this item will be paid for at the stated price including, but not limited to, work under the following:

a. All or portions of Division 1 specifications, as applicable

b. Section 32 33 00 – Site Furnishings and

Section 31 20 00 - Earthwork

c. Includes, but is not limited to: All products, materials, equipment, tools, labor, overhead and profit, fees, and incidentals required to furnish and install Kayak/Canoe Launch and Access Path, including excavation and grading, exposed aggregate kayak launch, timber handrail, boulder placement for retainage, backfilling, and all other elements incidental to the installation of the kayak/canoe launch and associated access pathway through Cashman Park.

2. Measurement: This item will not be measured for payment but will be pro-rated with the Contractor's progress of work as accepted by Landscape Architect.

3. Payment: Payment for this bid item will be made on a lump sum basis based on a percentage of completion as estimated by the Contractor and accepted by the Landscape Architect.

T. Add Alternate Item No. D2 – Reinforced Gravel Walkway

1. Work associated with this item will be paid for at the stated price including, but not limited to, work under the following:

a. All or portions of Division 1 specifications, as applicable

b. Section 32 14 43 – Porous Unit Paving

c. Section 31 20 00 - Earthwork

d. Includes, but is not limited to: All products, materials, equipment, tools, labor, overhead and profit, and incidentals required to furnish and install as indicated on the Contract Drawings including all other incidentals required to finish the work, complete and accepted by the Engineer.

2. Measurement: As measured for payment in Square Feet by the Contractor and accepted by the Engineer.

3. Payment: Reinforced Gravel Walkway will be paid for at the contract unit price per square foot as measured by the Contractor and accepted by the Engineer within the limits shown on the Contract Drawings and as stated on the Bid Form, complete and in place

U. Add Alternate Item No. D3 – Fishing Platform

1. Work associated with this item will be paid for at the stated price including, but not limited to, work under the following:
    a. All or portions of Division 1 specifications, as applicable
    b. Section 03 30 00 – Cast-in-Place Concrete and

       Section 32 33 00 – Site Furnishings and

       Section 31 20 00 - Earthwork
    c. Includes, but is not limited to: All products, materials, equipment, tools, labor, overhead and profit, fees, and incidentals required to furnish and install Fishing Platform, including excavation and grading, reinforced gravel gathering area, stacked stone blocks, granite steps, stone platforms, salvaged boulders, borrow and backfilling, and all other elements incidental to the installation of the Fishing Platform.
2. Measurement: This item will not be measured for payment but will be pro-rated with the Contractor's progress of work as accepted by Landscape Architect.
3. Payment: Payment for this bid item will be made on a lump sum basis based on a percentage of completion as estimated by the Contractor and accepted by the Landscape Architect.

V. Add Alternate Item No. D4 – Shade Tree 2-2.5" cal.

1. Payment shall be as for Add Alternate Item No. C4

W. Add Alternate Item No. D5 – Ornamental Tree 1-1.5" cal.

1. Payment shall be as for Add Alternate Item No. C5

X. Add Alternate Item No. D6 – Shrubs 3 gal.

1. Payment shall be as for Add Alternate Item No. C6

Y. Add Alternate Item No. D7 – Perennials

1. Payment shall be as for Add Alternate Item No. C7

Z. Add Alternate Item No. D8 – Showy Wildflower Seed Mix

1. Work associated with this item will be paid for at the stated price including, but not limited to, work under the following:
    a. All or portions of Division 1 specifications, as applicable
    b. Section 32 93 00 – Plantings
    c. Includes, but is not limited to: All products, materials, equipment, tools, labor, overhead and profit, fees, and incidentals required to furnish and install Showy Wildflower Seed Mix. Warranty and maintenance, including invasive species control, are included.
2. Measurement: This item shall be measured on the basis of acres of Showy Wildflower Seed Mix installed in the Work, complete in place, and accepted.

3. Payment: Payment for this bid item will be made at the contract unit price per acre of Showy Wildflower Seed Mix installed as estimated by the Contractor and accepted by the Landscape Architect.

AA. Add Alternate Item No. D9 – Semi-Shade Seed Mix

1. Payment shall be as for Add Alternate Item No. B9

END OF SECTION

SECTION 01 23 00 - ALTERNATES

PART 1 - GENERAL

1.1 Related Documents

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 Summary

A. Section includes administrative and procedural requirements for alternates.

1.3 Definitions

A. Alternate: An amount proposed by bidders and stated on the Bid Form for certain work defined in the bidding requirements that may be added to or deducted from the base bid amount if Owner decides to accept a corresponding change either in the amount of construction to be completed or in the products, materials, equipment, systems, or installation methods described in the Contract Documents.
   1. Alternates described in this Section are part of the Work only if enumerated in the Agreement.
   2. The cost or credit for each alternate is the net addition to the Contract Sum to incorporate alternate into the Work. No other adjustments are made to the Contract Sum.

1.4 Procedures

A. Coordination: Revise or adjust affected adjacent work as necessary to completely integrate work of the alternate into Project.
   1. Include as part of each alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation whether or not indicated as part of alternate.

B. Notification: Acceptance of alternates for this project is largely contingent on timing of receipt of funding for additional phases of work. Selection of alternates will not be finalized at time of award but authorization will be deferred for later consideration. Bidders should price alternates based on the assumption that construction will occur during the 2026 construction season.

C. Execute accepted alternates under the same conditions as other work of the Contract.

D. Schedule: A schedule of alternates is included at the end of this Section.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 Schedule Of Alternates

A. Alternate Item No. A – Scour Protection Rip Rap Type A (MBTA Bridge)
   1. Selection of this alternate shall include Add Alternate Pay Item No. A1
   2. Alternate: Selection of this alternate will add installation of rip rap under the MBTA bridge for added scour protection if determined to be necessary after observation of the area following drawdown of the impoundment. Work under this alternate shall consist of supply and placement of the rip rap as directed by the project engineer and includes all necessary labor, materials, and equipment to complete the work as shown on the Plans.

B. Alternate No. B – MBTA Trail and Pedestrian Bridge
   1. Selection of this alternate shall include Add Alternate Pay Items No. B1 through B9
   2. Alternate: Selection of this alternate will add to the work installation of a pedestrian bridge and approach trail from Cashman Park across Little River to the east side of the river, and installation of a paved walking trail following the east bank of the river southward between the river and the existing MBTA rail line to Stevens Street. This alternate shall incorporate all work depicted on the plans in association with both the bridge and the trail as depicted in the drawings and includes all necessary labor, materials, and equipment to complete the work as shown on the Plans. Specific alignment of the walking trail will be field-fit to minimize disturbance to mature trees.

C. Alternate No. C – Winter Street Overlook/Pocket Park
   1. Selection of this alternate shall include Add Alternate Pay Items No. C1 through C8
   2. Alternate: Selection of this alternate will add to the work installation of an overlook/pocket park at Winter Street, located primarily within what is currently the Sam's Food Store property at 89 Lafayette Square. The overlook consists of a permeable paver platform and landscape features including boulders, stone bench, fencing, and native plantings. This alternate also includes construction of a stretch of cement concrete sidewalk and curbing adjacent to the pocket park along Winter Street and installation of DOT-approved bridge rail and other protective measures for vehicles and pedestrians. This alternate shall incorporate all work depicted on the plans in association with the pocket park, as depicted in the drawings and includes all necessary labor, materials, and equipment to complete the work as shown on the Plans.

D. Alternate No. D – Cashman Park Improvements
   1. Selection of this alternate shall include Add Alternate Pay Items No. D1 through D9
   2. Alternate: Selection of this alternate will add to the work installation of community amenity improvements at Cashman Park, including a kayak/canoe launch, stone fishing platform, and associated paths and native plantings. This alternate shall incorporate all work depicted on the plans in association with the Cashman Park improvements as depicted in the

drawings and includes all necessary labor, materials, and equipment to complete the work as shown on the Plans. The path to the pedestrian bridge is not included in this alternate and is instead incorporated into Alternate No. B.

END OF SECTION

SECTION 01 26 00 - CONTRACT MODIFICATION PROCEDURES

PART 1 - GENERAL

1.1 Related Documents

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 Summary

A. Section includes administrative and procedural requirements for handling and processing Contract modifications.

1.3 Minor Changes In The Work

A. Designer will issue instructions authorizing minor changes in the Work, not involving adjustment to the Contract Sum or the Contract Time, on Work Change Directive.

1.4 Proposal Requests

A. Owner-Initiated Proposal Requests: Designer will issue a detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.
   1. Work Change Proposal Requests issued by Designer are not instructions either to stop work in progress or to execute the proposed change.
   2. Within 5 days after receipt of Proposal Request, submit a quotation estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change.
      a. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
      b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
      c. Include costs of labor and supervision directly attributable to the change.
      d. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
      e. Quotation Form: Use CSI Form 13.6D, "Proposal Worksheet Summary," and Form 13.6C, "Proposal Worksheet Detail."

B. Contractor-Initiated Proposals: If latent or changed conditions require modifications to the Contract, Contractor may initiate a claim by submitting a request for a change to Designer.

1. Include a statement outlining reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and the Contract Time.
2. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
3. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
4. Include costs of labor and supervision directly attributable to the change.
5. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
6. Proposal Request Form: Use CSI Form 13.6A, "Change Order Request (Proposal)," with attachments CSI Form 13.6D, "Proposal Worksheet Summary," and Form 13.6C, "Proposal Worksheet Detail."

1.5 Change Order Procedures

A. On Owner's approval of a Work Changes Proposal Request, Designer will issue a Change Order for signatures of Owner and Contractor.

1.6 Construction Change Directive

A. Work Change Directive: Designer may issue a Work Change Directive. Work Change Directive instructs Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.
   1. Work Change Directive contains a complete description of change in the Work. It also designates method to be followed to determine change in the Contract Sum or the Contract Time.

B. Documentation: Maintain detailed records on a time and material basis of work required by the Work Change Directive.
   1. After completion of change, submit an itemized account and supporting data necessary to substantiate cost and time adjustments to the Contract.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

WORK CHANGE DIRECTIVE NO.: ____

Owner:	City of Haverhill	Owner's Project No.:	
Engineer:	Fuss & O'Neill	Engineer's Project No.:	20170390.U40
Contractor:		Contractor's Project No.:	
Project:	Little River Dam Removal and River Restoration		
Contract Name:			
Date Issued:		Effective Date of Field Order:	

Contractor is directed to proceed promptly with the following change(s):

Description:

Attachments:

Purpose for the Work Change Directive:

Directive to proceed promptly with the Work described herein, prior to agreeing to change in Contract Price and Contract Time, is issued due to:

☐ Non-agreement on pricing of proposed change. ☐ Necessity to proceed for schedule or other reasons.

Estimated Change in Contract Price and Contract Times (non-binding, preliminary):

Contract Price: $ _____ **[increase] [decrease] [not yet estimated]**.

Contract Time: _____ days **[increase] [decrease] [not yet estimated]**.

Basis of estimated change in Contract Price:

☐ Lump Sum ☐ Unit Price ☐ Cost of the Work ☐ Other

	Recommended by Engineer	Authorized by Owner
By:	_____	_____
Title:	_____	_____
Date:	_____	_____

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(FOR DUPLEX PRINTING PURPOSES)

CHANGE ORDER NO.: ____

Owner:	City of Haverhill	Owner's Project No.:	
Engineer:	Fuss & O'Neill	Engineer's Project No.:	20170390.U40
Contractor:		Contractor's Project No.:	
Project:	Little River Dam Removal and River Restoration		
Contract Name:			
Date Issued:		Effective Date of Field Order:	

The Contract is modified as follows upon execution of this Change Order:
Description:

Attachments:

CHANGE IN CONTRACT PRICE	**CHANGE IN CONTRACT TIMES** *[note changes in Milestones if applicable]*
Original Contract Price: $_____	Original Contract Times: Substantial Completion: _____ Ready for Final Payment: _____ days or dates
[Increase] [Decrease] from previously approved Change Orders No. ___ to No. ___: $_____	[Increase] [Decrease] from previously approved Change Orders No. ___ to No. ___: Substantial Completion: _____ Ready for Final Payment: _____ Days
Contract Price prior to this Change Order: $_____	Contract Times prior to this Change Order: Substantial Completion: _____ Ready for Final Payment: _____ days or dates
[Increase] [Decrease] of this Change Order: $_____	[Increase] [Decrease] of this Change Order: Substantial Completion: _____ Ready for Final Payment: _____ days or dates
Contract Price incorporating this Change Order: $_____	Contract Times with all approved Change Orders: Substantial Completion: _____ Ready for Final Payment: _____ days or dates

RECOMMENDED:	ACCEPTED:	ACCEPTED:
By: _____	By: _____	By: _____
Engineer (if required)	Owner (Authorized	Contractor (Authorized
Title: _____	Title: _____	Title: _____
Date: _____	Date: _____	Date: _____

Approved by Funding Agency (if applicable)

By: _____ Title: _____ Date: _____

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(FOR DUPLEX PRINTING PURPOSES)

SECTION 01 29 00 - PAYMENT PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements necessary to prepare and process Applications for Payment.

1.3 SCHEDULE OF VALUES

A. Coordination: Coordinate preparation of the Schedule of Values for Bid items with preparation of Contractor's Construction Schedule.

1. Correlate line items in the Schedule of Values with other required administrative forms and schedules, including the Application for Payment forms with Continuation Sheets.
2. Submit three copies of the Schedule of Values to the Designer 10 days after the effective date of the Agreement. No payment will be made to the Contractor before the Schedule of Values has been submitted and Accepted by the Designer.

1.4 SCHEDULE OF PAYMENTS

A. Coordination: Coordinate preparation of the Schedule of Payments with preparation of Contractor's Construction Schedule and Schedule of Values.

1. Such schedule shall be broken down by monthly pay period through Project completion and reflect items listed in the Schedule of Values.
2. Submit three copies of the Schedule of Payments to Designer 10 days after effective date of Agreement.

1.5 APPLICATIONS FOR PAYMENT

A. Each Application for Payment shall be consistent with previous applications and payments as certified by Designer and paid for by Owner.

1. Initial/Monthly Application for Payment, Application for Payment at time of Substantial Completion, and final Application for Payment involve additional requirements.

B. Payment Application Times: The date for each progress payment is the 15th day of each month. The period covered by each Application for Payment starts on the day following the end of the preceding period and ends 15 days before the date for each progress payment. The Contractor shall submit its estimate for payment on or before the third day of each month.

C. Payment Application Forms: AIA Document G 702 in addition to a form to be transmitted after the bid is awarded.

D. Application Preparation: Complete every entry on form. Notarize and execute by a person authorized to sign legal documents on behalf of Contractor. Designer will return incomplete applications without action.

1. Entries shall match data on the Schedule of Values and Contractor's Construction Schedule. Use updated schedules if revisions were made.

2. Include amounts of Change Orders and Work Change Directives issued before last day of construction period covered by application.

3. Itemized data and format provided on continuation sheets shall include schedules, line items, values as stipulated in the Schedule of Values as accepted by Owner.

a. Continuation sheets shall include a total list of all scheduled component items of work with item number and scheduled dollar value for each item. Dollar values to be included in each column for each scheduled line item when Work has been performed or products stored. Round off values to nearest dollar or as may be specified for Schedule of Values.

b. List each Change Order executed prior to date of submission at end of continuation sheets. List by Change Order number and description as to original component item of Work.

E. Transmittal: Submit four (4) signed and notarized original copies of each Application for Payment to Designer

1. Transmit each copy with a transmittal form listing attachments and recording appropriate information about application.

2. Submit Applications to Designer by means ensuring receipt within 24 hours.

F. Ownership: All Work covered by Progress Payments shall, at the time of payment, become the property of Owner.

G. Processing: With each Application for Payment the Contractor shall certify such Application for Payment represents a just estimate of costs reimbursable to Contractor under terms of the Contract and shall certify there are no Mechanic's or Materialmen's Liens outstanding at the date of that Application for Payment, that all due and payable bills with respect to the Work have been paid to date or shall be paid from the proceeds of that Application for Payment, that there is no known basis for the filing of any Mechanic's or Materialmen's Lien against the Surety in connection with the Work, that Waivers and Bills Paid Affidavit forms from all Subcontractors and Materialmen have been, or will be, obtained in the form agreeable to Nantucket Conservation Foundation, and that amount of the contract remaining to be expended is sufficient to complete the project.

H. Initial/Monthly Application for Payment: Administrative actions and submittals that must precede or coincide with submittal of first Application for Payment include the following, which shall be updated for Monthly Applications for Payment, as applicable:

1. List of subcontractors with DBE forms, as applicable.

2. Schedule of Values.

3. Contractor's Construction Schedule (preliminary if not final), updated monthly.

4. Schedule of unit or add/deduct prices, if any.
5. Submittal schedule (preliminary if not final)
6. Name of Contractor Superintendent.
7. Any material stored off site must carry additional insurance stating Owner as insured. All material is to be inspected by Designer personnel before billing can be approved. Bill of Sale and receipts for items being billed at cost only are required and 25% retainage will be held for off-site stored materials. Paperwork must accompany request two weeks prior to billing to insure adequate time to schedule inspection.
8. Contractor's Health and Safety Plan (HASP).
9. Certificates of insurance and insurance policies.

I. Application for Payment at Substantial Completion: After issuing the Certificate of Substantial Completion, submit an Application for Payment showing 100 percent completion for portion of the Work claimed as substantially complete.

1. Include documentation supporting claim that the Work is substantially complete and a statement showing an accounting of changes to the Contract Sum.
2. Submit Warranties and maintenance agreements, as applicable.
3. This application shall reflect Certificates of Partial Substantial Completion issued previously for Owner occupancy of designated portions of the Work.

J. Final Payment Application: Submit final Application for Payment with releases and supporting documentation not previously submitted and accepted, including, but not limited, to the following:

1. Evidence of completion of Project closeout requirements.
2. Completion of items specified by the Designer for correction after Substantial Completion.
3. Required Project Records including permit drawings, as constructed drawings both on hard copy and in electronic format.
4. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid.
5. Updated final statement, accounting for final changes to the Contract Sum.
6. AIA Document G706, "Contractor's Affidavit of Payment of Debts and Claims."
7. AIA Document G706A, "Contractor's Affidavit of Release of Liens."
8. AIA Document G707, "Consent of Surety to Final Payment."
9. List of unsettled claims, if any.
10. Evidence that claims have been settled, if any.
11. Final, liquidated damages settlement statement, if any.
12. Removal of all temporary facilities and services
13. Removal of all surplus materials, rubbish, and similar elements.

K. CHANGE PROCEDURES

1. See Section 01 26 00 - Contract Modification Procedures.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 01 33 00 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other miscellaneous submittals.

B. Related Sections include the following:

1. Division 1 Section "Closeout Procedures" for submitting Project Record Documents.

1.3 DEFINITIONS

A. Action Submittals: Written and graphic information that requires Designer's responsive action.

B. Informational Submittals: Written information that does not require Designer's approval. Submittals may be rejected for not complying with requirements.

C. Addresses: Include mailing address, telephone number, facsimile number, and e-mail address.

1.4 SUBMITTAL PROCEDURES

A. Master List Submittal: Submit a master list of the required submittals with a proposed date for each item to be submitted. Show the date submittal was sent, days since submittal was sent, status of submittal, date submittal was received in return, and any date associated with resubmittals. Update master list with each submission and response. Issue copy of master list at least monthly to the Designer.

B. Method of Transmitting Submittals: Submittals should be transmitted electronically via email to Candice Constantine at CConstantine@fando.com.

C. Clarity: Provide neat, clean and legible printed materials that can be easily reproduced by normal photocopying. Illegible submittals will be returned unreviewed.

D. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.

1. Coordinate each submittal with fabrication, purchasing, delivery, other submittals, and related activities that require sequential activity.
2. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.

a. Designer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

E. Processing Time: Allow enough time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Designer's receipt of submittal.

1. Initial Review: Allow 10 working days for initial review of each submittal. Allow additional time if processing must be delayed to permit coordination with subsequent submittals. Designer will advise Contractor when a submittal being processed must be delayed for coordination.

2. Concurrent Review: Where concurrent review of submittals by Designer's consultants, the Owner, or other parties is required, allow 10 days for initial review of each submittal.

3. If intermediate submittal is necessary, process it in same manner as initial submittal.

4. Allow 10 calendar days for processing each resubmittal.

5. No extension of the Contract Time or claims for delay will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing.

F. Identification: Place a title block on each submittal for identification.

1. Indicate name of firm or entity that prepared each submittal on label or title block.

2. Include the following information on label for processing and recording action taken:

a. Project name.

b. Date.

c. Name and address of Designer.

d. Name and address of Contractor.

e. Name and address of subcontractor.

f. Name and address of supplier including name and telephone number of contact.

g. Name of manufacturer including name and telephone number of contact.

h. Unique identifier, including revision number.

i. Number and title of appropriate Specification Section.

j. Drawing number and detail references, as appropriate.

k. Other necessary identification.

G. Deviations: Highlight, encircle, or otherwise identify deviations from the Contract Documents on submittals. Provide list or narrative of deviations on Submittal Transmittal form.

H. Additional Copies: Unless additional copies are required for final submittal, and unless Designer observes noncompliance with provisions of the Contract Documents, initial submittal may serve as final submittal.

1. Submit one copy of submittal to concurrent reviewer in addition to specified number of copies to Designer.

2. Additional copies submitted for maintenance manuals will be marked with action taken and will be returned.

I. Transmittal: Package each submittal individually and appropriately for transmittal and handling. Transmit each submittal using a transmittal form. Designer will return submittals**,** without review, received from sources other than Contractor.

1. On an attached separate sheet, prepared on Contractor's letterhead, record relevant information, requests for data, revisions other than those requested by Designer on previous submittals, and deviations from requirements of the Contract Documents, including minor variations and limitations. Include the same label information as the related submittal.

2. Include Contractor's certification stating that information submitted complies with requirements of the Contract Documents.

J. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.

K. Use for Construction: Use only final submittals with mark indicating action taken by Designer in connection with construction.

PART 2 - PRODUCTS

2.1 ACTION SUBMITTALS

A. General: Prepare and submit Action Submittals required by individual Specification Sections.

B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.

1. If information must be specially prepared for submittal because standard printed data are not suitable for use, submit as Shop Drawings, not as Product Data.

2. Mark each copy of each submittal to show which products and options are applicable.

3. Include the following information, as applicable:

a. Manufacturer's written recommendations.

b. Manufacturer's product specifications.

c. Manufacturer's installation instructions.

d. Standard color charts.

e. Manufacturer's catalog cuts.

f. Standard product operating and maintenance manuals.

g. Compliance with recognized trade association standards.

h. Notation of coordination requirements.

C. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.

1. Preparation: Include the following information, as applicable:

a. Dimensions.

b. Identification of products.

c. Fabrication and installation drawings.

d. Roughing-in and setting diagrams.

e. Shopwork manufacturing instructions.

f. Templates and patterns.

g. Schedules.

h. Design calculations.

i. Compliance with specified standards.

j. Notation of coordination requirements.

k. Notation of dimensions established by field measurement.

2. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches but no larger than 30 by 40 inches.

D. Samples: Prepare physical units of materials or products, including the following:

1. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.

a. Include cost and wearing capability of each color and pattern.

2. Preparation: Mount, display, or package Samples in manner specified to facilitate review of qualities indicated. Prepare Samples to match Designer's sample where so indicated. Attach label on unexposed side that includes the following:

a. Generic description of Sample including type, quality or grade designation.

b. Product name or name of manufacturer.

c. Sample source.

d. Name of Project.

e. Name of Contractor or subcontractor.

3. Additional Information: On an attached separate sheet, prepared on Contractor's letterhead, provide the following:

a. Size limitations.

b. Compliance with recognized standards.

c. Availability.

d. Delivery time.

4. Submit Samples for review of kind, color, pattern, and texture for a final check of these characteristics with other elements and for a comparison of these characteristics between final submittal and actual component as delivered and installed.

a. If variation in color, pattern, texture, or other characteristic is inherent in the product represented by a Sample, submit at least two sets of paired units that show approximate limits of the variations.

b. Refer to individual Specification Sections for requirements for Samples that illustrate workmanship, fabrication techniques, detail's of assembly, connections, operation, and similar construction characteristics.

5. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.

a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.

b. Samples not incorporated into the Work, or otherwise not designated as the Owner's property, are the property of Contractor.

E. Product Schedule or List: Prepare a written summary indicating types of products required for the Work and their intended location.

F. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:

1. Name, address, and telephone number of entity performing subcontract or supplying products.

2. Number and title of related Specification Section(s) covered by subcontract.

3. Drawing number and detail references, as appropriate, covered by subcontract.

2.2 INFORMATIONAL SUBMITTALS

A. General: Prepare and submit Informational Submittals required by other Specification Sections.

1. Certificates and Certifications: Provide a notarized statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.

B. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, names and addresses of Designers and the Owner's, and other information specified.

C. Installer Certificates: Prepare written statements on manufacturer's letterhead certifying that Installer complies with requirements and, where required, is authorized for this specific Project.

D. Manufacturer Certificates: Prepare written statements on manufacturer's letterhead certifying that manufacturer complies with requirements. Include evidence of manufacturing experience where required.

E. Material or Product Certificates: Prepare written statements on manufacturer's letterhead certifying that material or product complies with requirements. Use attached sample Material Certificate, or provide certificate that includes the following information.

1. Project to which material is consigned.

2. Name of contractor receiving material.

3. Item number and description of material.
4. Quantity of material represented by the certificate.
5. Means of identifying consignment including label, marking, or lot number.
6. Date and method of shipment.
7. Signature of Supplier's authorized agent.
8. Notarization of certificate.

F. Manufacturer's Instructions: Prepare written or published information that documents manufacturer's recommendations, guidelines, and procedures for installing or operating a product or equipment. Include name of product and name, address, and telephone number of manufacturer. Include the following, as applicable:

1. Preparation for installation.
2. Sequence of installation or erection.
3. Required installation tolerances.
4. Required adjustments.
5. Recommendations for cleaning, maintenance, and protection.

G. Insurance Certificates and Bonds: Prepare written information indicating current status of insurance or bonding coverage. Include name of entity covered by insurance or bond, limits of coverage, amounts of deductibles, if any, and term of the coverage.

H. Maintenance Data: Prepare written and graphic instructions and procedures for operation and normal maintenance of products and equipment. Comply with requirements in Division 01 Section "Closeout Procedures."

PART 3 - EXECUTION

3.1 CONTRACTOR'S REVIEW

A. Review each submittal and check for compliance with the Contract Documents. Note corrections and field dimensions. Mark each copy of each submittal with approval stamp before submitting to Designer.

B. Approval Stamp: Stamp each submittal with a uniform approval stamp.

C. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents. See attached Submittal Transmittal for sample of statement.

3.2 DESIGNER'S ACTION

A. General: Designer will not review submittals that do not bear Contractor's approval stamp and submittal transmittal and will return them without action.

1. Designer may elect not to review partial or incomplete submittals and will return such submittals with no action taken.

B. Action Submittals: Designer will review each submittal, make marks to indicate corrections or modifications required, and return it. Designer will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action taken, as follows:

1. Furnish as Submitted: Submittal appears to conform to Contract Documents and Contractor may proceed with ordering and installation.

2. Furnish as Noted: Same as "Furnish as Submitted" accept that the Contractor must comply with modifications or notes added to the submittal by the Designer.

3. Rejected: Submittal must be revised and resubmitted.

C. Informational Submittals: Designer will review each submittal and will not return it, or will reject and return it if it does not comply with requirements. Designer will forward each submittal to appropriate party.

D. Submittals not required by the Contract Documents will not be reviewed and may be discarded.

END OF SECTION

To: Fuss & O'Neill, Inc.
1550 Main Street, Suite 400
Springfield, MA 01103
ATTN: Candice Constantine, PhD, PE

From:

PROJECT: _____

SUBMITTAL NO.: _____
(List Section No., Article No., Paragraph)

_____

_____

_____
(Revision: 1st, 2nd, 3rd, etc.)

Transmitted herewith for review and comment are the following:

Copies	Dwg.	No.	Description

MANUFACTURER / SUPPLIER

Name: _____

Address: _____

Telephone No.: _____ Facsimile No.: _____

For Additional Information, Contact: _____

E-mail Address: _____

I hereby certify that I have carefully examined the enclosed submittal and have determined and verified all field measurements, construction criteria, materials, catalog numbers and similar data, coordinated the submittal with other submissions and the work of other trades and contractors, and that to the best of my knowledge and belief, the enclosed submittal is in full compliance with the Contract Documents, except for the following deviations:

BY:
Signature: _____

Title: _____

- - SAMPLE - - MATERIALS CERTIFICATE - - SAMPLE - -

(Submit on Manufacturer's letterhead)

Date: _____

WE HEREBY CERTIFY THAT _____

(Description, Kind of Material, Product Name, Model No.)

FURNISHED TO _____

(Name of Contractor) (Prime or Subcontractor)

FOR USE ON _____

(Project Name)

OWNER _____

(Project Owner)

IDENTIFIED BY: _____

(Label, Marking, Seal No., Consignment, or Waybill No.)

SHIPPED VIA: _____

(Method of Shipment, Car No., Truck No.)

SHIPPED ON: _____ DELIVERED ON: _____

MEETS THE REQUIREMENTS OF THE CONTRACT DOCUMENTS FOR THE SUBJECT PROJECT IN ALL RESPECTS. PROCESSING, PRODUCT TESTING AND INSPECTION CONTROL OF RAW MATERIALS ARE IN CONFORMANCE WITH APPLICABLE SPECIFICATIONS, DRAWINGS AND STANDARDS OF ARTICLES FURNISHED. ARTICLES FURNISHED COMPLY WITH THE FOLLOWING STANDARD SPECIFICATIONS:

_____

_____

_____

_____

All records and documents pertinent to this certificate and not submitted herewith will be maintained available by the undersigned for a period of not less than 3 years from the date of this certificate.

_____
(Name of Manufacturer)

_____
(Authorized Representative's Signature)

_____
(Title)

- - SAMPLE - - EQUIPMENT RECORD SHEET - - SAMPLE - -

PROJECT: _____

_____

_____

SUBMITTAL NO.: _____
(list Section No., Article No., and Paragraph)

_____
(Revision: 1st, 2nd, 3rd, etc.)

EQUIPMENT MANUFACTURER

_____

_____

_____

_____

SERVICE REPRESENTATIVE

_____

_____

_____

_____

TYPE _____ Motor Mfr. _____

MODEL NO. _____ Motor Size _____

SERIAL NO. _____ Volts _____ Amps _____

CAPACITY _____ at _____ Phase _____ Cycles _____ RPS _____

SPECIAL NOTES AND REMARKS:

_____

_____

_____

_____

_____

_____

_____

_____

SECTION 01 35 13 – SPECIAL CONDITIONS

PART 1 - GENERAL

1.1 DEFINITIONS

A. "Owner" – City of Haverhill

B. "Engineer" or "Designer" or "Landscape Architect" or "LSP" – Fuss & O'Neill, Inc.

1.2 PRECONSTRUCTION CONFERENCE

A. A preconstruction conference shall be held at the project site within 3 weeks after award of the Contract. The Owner will notify the Contractor of the date and time of the conference upon award of the contract. The Contractor's Project Manager and Project Superintendent, Owner, Designer, and Contractor's Subcontractor Representatives (if any) shall attend. Project design intent, materials requirements, construction approach and sequencing, materials sources, construction methods, and scheduling will be reviewed and any questions or procedures will be clarified.

B. The agenda of the preconstruction meeting shall incorporate the following items:

1. Distribution and discussion of:
    a. List of Subcontractors.
    b. Projected Construction Schedules.
2. Critical work sequencing.
3. Project coordination:
    a. Designation of responsible personnel.
4. Procedures and processing of the following:
    a. Submittals.
    b. Work Change Directives.
    c. Requests for Information.
    d. Deactivation Requests.
    e. Change Orders.
    f. Applications for Payment.
5. Permit Requirements.
6. Excavation Support Systems
    a. Review geotechnical report.
    b. Review existing utilities and subsurface conditions.
    c. Review coordination for interruption, shutoff, capping, and continuation of utility services.
    d. Review proposed excavations.
    e. Review proposed equipment.
    f. Review monitoring of excavation support and protection system.
    g. Review coordination with waterproofing.
    h. Review abandonment or removal of excavation support and protection system.
7. Adequacy of distribution of Contract Documents.
8. Procedures for maintaining Record Documents.

9. Use of premises:
    a. Office, work and storage areas.
    b. Owner's requirements
10. Construction facilities and construction aids.
11. Temporary utilities.
12. Safety and first-aid procedures.
13. Housekeeping procedures.

1.3 ACCESS AND SEQUENCING CONSTRAINTS AND DEPENDENCIES

A. Access to the project site for work contained in the Base Bid shall be from Cashman Park, Winter Street (via the abutting convenience store property), or G&C Concrete, as shown on the Drawings.

B. For work on MBTA property associated with the Add-Alternate, access must be coordinated with MBTA in accordance with their standard requirements and policies. The Contractor is responsible for adherence to all MBTA requirements, including flaggers, safety training for personnel, etc.

1.4 AIR, LAND AND WATER POLLUTION

A. Permits already received for the project include 1) Restoration Order of Conditions obtained for the dam removal and river restoration work, 2) Order of Conditions for construction of the adjacent community amenities. 3) Verification Letter from the Army Corps of Engineers, 4) Chapter 253 Dam Safety Permit, 5) Chapter 91 Waterways License, 6) 401 Water Quality Certification. Copies of all approved permits are included in the Specifications. The Contractor is fully responsible for compliance with all terms and conditions of these permits.

B. The Contractor is responsible for submitting an application for and receiving coverage under the USEPA's National Pollutant Discharge Elimination System (NPDES) General Permit for Stormwater Discharges from Construction Activities for this Project. Also see 31 25 00 - Erosion, Pollution, and Water Control.

C. The Contractor shall prevent, control, and abate pollution of air, land, and water by operations under this Contract, in accordance with the rules, regulations, and standards adopted and established by the Massachusetts Department of Environmental Protection, the United States Environmental Protection Agency and in accordance with the aforementioned project permits.

D. Temporary and permanent erosion and sediment controls shall be furnished, installed, and maintained by the Contractor as described in 31 25 00 - Erosion, Pollution, and Water Control and shown in the Drawings, in accordance with the provisions of US EPA's NPDES General Permit for Stormwater Discharges from Construction Activities.

E. The Contractor shall apply for and receive coverage under the above-mentioned permit by submitting a Notice of Intent for Storm Water Discharges Associated with Construction Activity Under an NPDES General Permit, coordinating Owner signatures, paying the application fee, and implementing the permit.

F. The Contractor shall be solely responsible for complying with the requirements of the General Permit.

G. The Contractor shall be responsible for providing all inspections, documentation, maintenance, corrective action, and repairs required by the permit. The word "Permittee" shall refer to the "Contractor". The Contractor shall use standard forms for logging all required inspection and maintenance activities, and forms shall be turned over to the Designer in accordance with the inspection schedule outlined in the General Permit.

H. The Contractor shall post the permits on site and have all inspection reports and documentation on site for Designer's review. The Contractor shall immediately address any deficiencies noted by the Designer. All meetings with state agencies or local authorities shall be attended by both the Designer and the Contractor.

I. The Contractor shall not start work required by said entities without approval from the Designer.

J. The Designer shall be notified immediately by the Contractor of any site visits by Permitting Authorities performed in accordance with US EPA's NPDES General Permit for Stormwater Discharges from Construction Activities.

K. If the Contractor fails to perform the required actions listed in the applicable permits, the Designer will issue a Work Order detailing the required action. Within twenty-four (24) hours of receipt of the Work Order, the Contractor shall start the required action and continue the required action until the Project is brought into compliance with the permit. Should the Contractor fail to perform the required action as specified, they shall be subject to a $1,000/calendar day deduction.

L. The Contractor shall review and adhere to the instructions in the permit package. The Contractor shall provide compensation and exempt the Owner from responsibility for any fines or sanctions caused by the Contractor's actions or inactions regarding compliance with the permit or erosion control provisions of the Contract Documents.

1.5 PROJECT SIGNS

A. Provide and install the Contractor's standard sign approved by the Owner in a location approved by the Owner.

B. Prior to commencement of any construction activity, including access, the Contractor shall install two 3 foot by 4 foot, color project information signs: one near the location of the proposed overlook/pocket park at Winter Street, and one at Cashman Park adjacent to the existing sidewalk. Sign shall include recognition of all project partners: Owner, Massachusetts Executive Office of Environmental Affairs MVP Program, Designer, Contractor, and all project funders.
   1. The Designer shall provide logos for all partners and images for use on the signs to the Contractor.
   2. The Contractor shall develop and provide the sign layout to the Owner for review in electronic format of a quality suitable for printing.
   3. The Contractor shall produce and erect the sign utilizing durable materials and construction methods to withstand all weather conditions, including potential inundation.

C. Prior to commencement of any construction activity, including access, the Contractor shall display a sign at the site with dimensions not less than two square feet or more than three square feet in size bearing the words, "Massachusetts Department of Environmental Protection [or, "MassDEP"] File Numbers #33-1551 and #33-1552."

D. Signs not listed in the Contract Documents shall be permitted only upon approval by the Owner.

1.6 SUBMITTALS

A. Construction Schedule
   1. Prior to the preconstruction conference, the Contractor shall submit to the Designer and Owner for approval a schedule of the anticipated start date and duration of each of the major work tasks. The schedule should describe construction phasing in a manner that will enable effective project coordination. After approval, the Contractor shall be required to update the construction schedule as necessary to accurately reflect the progress and pace of the Project.

B. Schedule of Expected Submittals
   1. Prior to the preconstruction conference, the Contractor shall submit to the Designer and Owner for approval a schedule of expected submittals.

C. Schedule of Values
   1. Prior to the preconstruction conference, the Contractor shall submit to the Designer and Owner for approval a schedule of values.

D. The Contractor shall provide the following submittals to the Owner and the Designer prior to mobilization:
   1. Construction Operations Plan
   2. Control of Water Plan
   3. Storm Water Pollution PreventionPlan (SWPPP)
   4. Spill Prevention Plan
   5. Dredged Material Dewatering Plan
   6. Water Control and Diversion Plan
   7. Flood Response Plan
   8. Invasive Species Control Plan

1.7 SURVEY CONTROL

A. Survey control has been established at the site and is noted on the Drawings. All subsequent surveying needed for or incidental to the layout or construction staking shall be the responsibility of the Contractor. Stakes and markers shall be provided by the Contractor as necessary to control the Work and assure construction is in conformance to the Drawings and Specifications, and as otherwise directed by the Designer. Following staking of the Work, the Designer may make field-based adjustments to the layout as necessary to meet current site conditions. Full compensation for conforming to the requirements of this section shall be considered as included in the prices paid for the various Contract items of Work involved and no additional compensation will be made therefore.

1.8 PROJECT MEETINGS

A. The Designer shall conduct construction meetings involving:
   1. Contractor's project manager.
   2. Contractor's project superintendent.
   3. Owner's designated representative(s).
   4. Designer's designated representative(s).
   5. Contractor's subcontractor(s) as appropriate to the Work in progress.
   6. Local, state, and federal agency staff as appropriate to the Work in progress.

B. Conduct meetings weekly.

C. The Designer shall record meeting minutes and disseminate copies to participants and designated recipients identified at the Preconstruction Conference. The Designer shall note any corrections, additions, or deletions to the minutes and address them at the following meeting.

1.9 SPECIAL CONSIDERATIONS

A. The Contractor shall be responsible for negotiations of any waivers or arrangements required to transport materials to the site.

B. The Contractor shall maintain the condition of access roads to the site such that access is not hindered by construction-related deterioration.

C. The Contractor shall abide by the following time-of-year restrictions included in the permits issued for the project.
   1. In-water, silt-producing work is prohibited from March 1st through June 30th.
   2. In-water work is to be completed during the low flow period between July 1 and October 31st.

D. The Contractor shall monitor water levels and weather forecasts to protect equipment and the site from flooding.

E. Invasive plant species are present within the limits of work. The Contractor shall make every effort to prevent the import or spread of invasive plants in accordance with the project permits and these specifications.

F. If there is a conflict between the permit conditions and the Specifications and/or Drawings, the Contractor shall adhere to the permit conditions.

1.10 ADDRESSES

A. All notices and communications directed to the Owner shall be addressed and delivered to the City of Haverhill, Attn: John Pettis, City Engineer, City Hall Room 300, 4 Summer Street, Haverhill, MA 01830-5885. When any hard copies of documents are sent to the Owner via a postal service, notice shall also be sent via email.

B. All notices and communications directed to the Engineer shall be addressed and delivered to Fuss & O'Neill, Inc., Attn: Julianne Busa, 1550 Main Street, Suite 400, Springfield, MA 01103 or in electronic format to Julianne Busa at Fuss & O'Neill, Inc., julianne.busa@fando.com.

C. The business address of the Contractor given in the Bid Form and the Contractor's office at the site of the Work are hereby designated as the places to which all notices and other communications directed to the Contractor shall be delivered. The business address shall be used for mail.

D. The Owner, Designer, or Contractor may change its address at any time via written notice delivered to the other two.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 41 00 - TESTING LABORATORY SERVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for laboratory testing services.

1.3 GENERAL REQUIREMENTS

A. Contractor shall employ and pay for the services of an Independent Testing Laboratory to perform specified testing of work and materials at the Project Site or at point of manufacture.

1. Contractor shall cooperate with the testing laboratory to facilitate the execution of its required services.
2. Testing on additional samples may be requested by the Engineer to verify that the material meets the specifications. The Contractor shall be responsible for the costs of additional test(s) that fail to meet the specifications.

1.4 QUALIFICATIONS OF LABORATORIES

A. Meet "Recommended Requirements for Independent Laboratory Qualification," published by American Council of Independent Laboratories.

B. Comply with the following requirements, as applicable:

1. ANSI/ASTM D3740: Practice for Evaluation of Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.
2. ANSI/ASTM E329: Standard Recommended Practice for Inspection and Testing for Concrete, Steel, and Bituminous Materials as Used in Construction.

C. Licensed to operate in the State of Massachusetts.

D. Submit copy of report of inspection of facilities made by Materials Reference Laboratory of National Bureau of Standards during the most recent tour of inspection, with memorandum of remedies of any deficiencies reported by the inspection.

E. Testing Equipment:

1. Calibrated at reasonable intervals by devices of accuracy traceable to either:
    a. National Bureau of Standards.
    b. Accepted values of natural physical constants.

F. Employment of testing laboratory shall in no way relieve Contractor of obligation to perform Work in accordance with requirements of Contract Documents.

1.5 LABORATORY DUTIES

A. Cooperate with Designer and Contractor; provide qualified personnel after due notice from Contractor.

B. Perform specified inspections, sampling and testing of materials and methods of construction:

1. Comply with specified standards.
2. Ascertain compliance of materials with requirements of Contract Documents.

C. Promptly notify Designer and Contractor of observed irregularities or deficiencies of work or products.

D. Promptly submit written report of each test and inspection: one (1) copy each to Designer, and Contractor. Each report shall include:

1. Date issued.
2. Project title and number.
3. Testing laboratory name, address and telephone number.
4. Name and signature of laboratory inspector.
5. Date and time of sampling or inspection.
6. Record of temperature and weather conditions.
7. Date of test.
8. Identification of product.
9. Location of sample or test in the Project.
10. Type of inspection or test.
11. Results of tests and compliance with Contract Documents.
12. Interpretation of test results, when requested by Designer.

E. Perform additional tests as required by the Designer or Owner.

1.6 LIMITATIONS OF AUTHORITY OF TESTING LABORATORY

A. Laboratory is not authorized to:

1. Release, revoke, alter or enlarge on requirements of Contract Documents.
2. Approve or accept any portion of the Work.
3. Perform any duties of the Contractor.
4. Stop the Work.

1.7 CONTRACTOR'S RESPONSIBILITIES

A. Cooperate, together with laboratory personnel, to provide access to the point/location of the Work.

B. Secure and deliver to laboratory at designated location(s) adequate quantities of representational material proposed to be used and which require testing together with applicable proposed design mixes.

C. Provide to the laboratory the preliminary design mix and other material mixes which required control by the testing laboratory.

D. Furnish copies of Product test reports to the Designer as required.

E. Furnish incidental labor and facilities:

1. To provide access to Work to be tested.
2. To obtain and handle samples at the Project Site or at the source of the product to be tested.
3. To facilitate inspections and tests.
4. For storage and curing of test samples.

F. Notify laboratory 24 hours in advance of operations to allow for laboratory assignment of personnel and scheduling of tests.

1. When tests or inspections cannot be performed after such notice, reimburse owner for laboratory personnel and travel expenses incurred due to Contractor's negligence on inability to perform the Work at the scheduled time.

G. Make arrangements with laboratory and pay for services to perform inspections, sampling and testing required:

1. When not specified to be paid by the Owner.
2. For the Contractor's convenience.
3. When the initial tests or inspections indicate Work does not comply with Contract Documents (i.e., re-tests).

1.8 SOURCE OF MATERIALS

A. Source of supply of each of materials required shall be acceptable to Designer before delivery is started.

B. Representative samples shall be used for inspection or tests.

C. Designer or Owner may test materials proposed to be used at any time during preparation and use.

D. If it is found that sources of supply, which have been approved, do not furnish product of uniform quality, or if product from any source proves unacceptable at any time, Contractor shall furnish approved material from another source without additional cost to Owner or delay in completion date.

1.9 IDENTIFICATION

A. Required samples submitted by Contractor shall be properly labeled for identification.

B. Materials and/or equipment that have been inspected and/or tested shall be stored in a controlled area with suitable identification referencing tests and certifications.

C. Continuous inventory shall be kept of all items in this area controlled by log in and log out with receiving and disbursing signatures.

D. Copies of receiving or disbursing actions shall be sent to Designer on a daily basis.

E. Disbursing records shall show final destination and installation.

1.10 MATERIAL STORAGE

A. Materials shall be stored so as to ensure preservation of their quality and fitness for Work.

1.11 SCHEDULE OF INSPECTIONS AND TESTS

A. Refer to each individual Section of the Project Manual for specific testing requirements, or as otherwise required by Contract Documents or applicable regulatory agency.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 01 50 00 - TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, MASSDOT Standard Specifications for Highways and Bridges and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes requirements for temporary facilities and controls, including temporary utilities, support facilities, and security and protection facilities.

B. Support facilities include, but are not limited to, the following:

1. Constructing and restoring temporary contractor accesses.
2. Temporary construction and staging areas.
3. Field office.
4. Waste disposal facilities.
5. Construction aids and miscellaneous services and facilities.

C. Temporary utilities include, but are not limited to, the following:

1. Drainage.
2. Water.
3. Electric power service.
4. Lighting.
5. Telephone service.

D. Security and protection facilities include, but are not limited to, the following:

1. Barricades, warning signs, and lights.
2. Temporary construction fencing.
3. First aid.

E. Related Sections include the following:

1. Section 01 57 13 "Temporary Erosion and Sediment Control" for construction and maintenance of construction accesses.
2. Section 31 10 00 "Site Clearing" for selective clearing and trimming to facilitate access to Project Site.
3. Section 10 14 00 "Signage" for temporary signage.

1.3 USE CHARGES

A. General: Cost or use charges for temporary facilities are not chargeable to Property or Contract Owner or Engineer and shall be included in the Contract Sum. Allow other entities to use temporary services and facilities without cost, including, but not limited to, the following:

1. Occupants of Project.
2. Engineer.
3. Testing agencies.
4. Personnel of authorities having jurisdiction.

B. Electric Power Service: Pay electric power service use charges, whether metered or otherwise, for electricity used by all entities engaged in construction activities at Project site.

1.4 QUALITY ASSURANCE

A. Where "Standard Specifications" is used, it shall mean MASSDOT Standard Specifications for Highways and Bridges and issued supplements.

B. Standards: Comply with ANSI A10.6, NECA's "Temporary Electrical Facilities," and NFPA 241.

1. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.

C. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.

D. Comply with all applicable code, laws and regulations.

E. Where "MASSDOT Standard Specifications" is used, it shall mean "Commonwealth of Massachusetts Department of Transportation Standard Specifications for Highways and Bridges, 2022 Edition" and issued supplements.

F. MUTCD: Manual for Uniform Traffic Control Devices, 2009 edition including all revisions.

1.5 PROJECT CONDITIONS

A. Conditions of Use: The following conditions apply to use of temporary services and facilities by all parties engaged in the Work:

1. Keep temporary services and facilities clean and neat.
2. Relocate temporary services and facilities as required by progress of the Work.

1.6 TEMPORARY OFFICES

A. The Contractor shall provide and maintain suitable field offices at or near the Project Site at a location agreeable to the Owner. Temporary field offices must have internet, desk space for Engineer's representative, and heating and cooling.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Provide new materials. Undamaged, previously used materials in serviceable condition may be used if approved by Engineer. Provide materials suitable for use intended and meet the minimum requirements noted below as needed to complete the Work.

B. Crushed Stone: Comply with Section 01 57 13 "Temporary Erosion and Sediment Control."

C. Geosynthetic Reinforcements: Geosynthetic fabric and/or geogrid materials to reinforce existing ground areas where construction access routes and staging areas are to be established. Such materials shall be evaluated and determined adequate for existing ground conditions and proposed vehicle/equipment track/wheel loads and trip volume during respective phases of the work, and depth of overlying crushed stone to be placed for route base and surfacing.

D. Swamp Mat: Structural mat fabricated/manufactured for the intended use of supporting construction equipment over weak subgrade areas without excessive settlement or damage to existing site features. Completely removable at end of work.

1. Required for access route section within flagged wetlands, up to locations where crushed stone is to be placed along the left riverbank.

E. Stabilization materials for temporary construction/staging area within river channel in accordance with delegated design submittal provided by Contractor and as accepted by Engineer.

F. Water: Potable

G. Topsoil and Seed: Comply with Section 32 92 19 "Seeding."

H. Chain-Link Fencing: Minimum 2-inch , 0.148-inch- thick, galvanized-steel, chain-link fabric fencing; minimum 6 feet high with galvanized-steel pipe posts; minimum 2-3/8-inch- OD line posts and 2-7/8-inch- OD corner and pull posts, with 1-5/8-inch- OD top rails.

I. Portable Chain-Link Fencing: Minimum 2-inch , 0.148-inch- thick, galvanized-steel, chain-link fabric fencing; minimum 6 feet high with galvanized-steel pipe posts; minimum 2-3/8-inch- OD line posts and 2-7/8-inch- OD corner and pull posts, with 1-5/8-inch- OD top and bottom rails. Provide galvanized-steel bases for supporting posts.

J. Traffic Management /Control Devices: for each product shown on the Traffic Management Plans.

2.2 EQUIPMENT

A. General: Provide equipment suitable for use intended.

B. Fire Extinguishers: Hand carried, portable, UL rated. Provide class and extinguishing agent as indicated or a combination of extinguishers of NFPA-recommended classes for exposures.

1. Comply with NFPA 10 and NFPA 241 for classification, extinguishing agent, and size required by location and class of fire exposure.

C. Self-Contained Toilet Units: Single-occupant units of chemical, aerated recirculation, or combustion type; vented; fully enclosed with a glass-fiber-reinforced polyester shell or similar nonabsorbent material.

D. Drinking-Water Fixtures: Containerized, tap-dispenser, bottled-water drinking-water units, including paper cup supply.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required.

B. Provide each facility ready for use when needed to avoid delay. Maintain and modify as required. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

3.2 TEMPORARY UTILITY INSTALLATION

A. General: Engage appropriate local utility company to install temporary service or connect to existing service. Where utility company provides only part of the service, provide the remainder with matching, compatible materials and equipment. Comply with utility company recommendations.

1. Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.
2. Provide adequate capacity at each stage of construction. Before temporary utility is available, provide trucked-in services.
3. Obtain easements to bring temporary utilities to Project site where Owner's property or easements cannot be used for that purpose.

B. Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking-water fixtures. Comply with regulations and health codes for type, number, location, operation, and maintenance of fixtures and facilities.

1. Disposable Supplies: Provide toilet tissue, paper towels, paper cups, and similar disposable materials for each facility. Maintain adequate supply. Provide covered waste containers for disposal of used material.
2. Toilets: Install self-contained toilet units. Shield toilets to ensure privacy.

C. Electric Power Service: Provide weatherproof, grounded electric power service and distribution system of sufficient size, capacity, and power characteristics during construction period. Include meters, transformers, overload-protected disconnecting means, automatic ground-fault interrupters, and main distribution switchgear.

1. Install electric power service underground unless overhead service must be used.
2. Install power distribution wiring overhead and rise vertically where least exposed to damage.

D. Electric Distribution: Provide receptacle outlets adequate for connection of power tools and equipment.

1. Provide waterproof connectors to connect separate lengths of electrical power cords if single lengths will not reach areas where construction activities are in progress. Do not exceed safe length-voltage ratio.

2. Provide warning signs at power outlets other than 110 to 120 V.

3. Provide metal conduit, tubing, or metallic cable for wiring exposed to possible damage. Provide rigid steel conduits for wiring exposed on grades, floors, decks, or other traffic areas.

4. Provide metal conduit enclosures or boxes for wiring devices.

5. Provide 4-gang outlets, spaced so 100-foot extension cord can reach each area for power hand tools and task lighting. Provide a separate 125-V ac, 20-A circuit for each outlet.

6. Provide outlets with GFI protection.

E. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations and traffic conditions.

1. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.

2. Install exterior-yard site lighting that will provide adequate illumination for construction operations, traffic conditions, and signage visibility when the Work is being performed.

3.3 SUPPORT FACILITIES INSTALLATION

A. General: Comply with the following:

1. Locate storage sheds, sanitary facilities, and other temporary construction and support facilities for easy access within Project Limits in location agreed upon by the Property Owner.

2. Provide incombustible construction for temporary field offices, shops, and sheds located within construction area or within 30 feet of building lines in location agreed upon by the Property Owner. Comply with NFPA 241.

B. Maintain support facilities until near Substantial Completion. Remove before Substantial Completion. Temporary Access: Construct and maintain temporary access routes and construction accesses adequate to support vehicle/equipment loads throughout the Contract Times in all weather conditions without causing temporary or permanent damage to adjacent vegetation (outside the contract limits of disturbance) to remain. Locate temporary access routes where shown on the Contract Drawings. Extend temporary routes and staging areas within construction limits of disturbance indicated, only as necessary for construction operations.

1. Coordinate elevations of temporary accesses to maintain drainage function from upgradient areas. Routes and associated work shall not result in ponding or other diversion of flow onto adjacent areas or properties that causes scouring or excessive flooding. Drainage patterns shall match patterns existing prior to construction.

2. Prepare subgrade for temporary construction accesses according to the Contract Drawings.

3. Place fabric and crushed stone according to Section 01 57 13 "Temporary Erosion and Sediment Control."

4. Restore construction access routes after temporary use to original condition or better.

C. Temporary Construction and Staging Areas

1. Construct temporary construction/staging area within project limits as indicated on the Drawings. Restore to original conditions or better by the removal of imported materials subsequent to temporary use.

2. Restore/recondition construction/staging area after temporary use in accordance with specifications. Restore any damaged paved areas to original condition or better.

D. Project Identification and Temporary Signs: Prepare Project identification and other signs in sizes indicated. Install signs where indicated to inform public and persons seeking entrance to Project. Do not permit installation of unauthorized signs.

1. Engage an experienced sign painter to apply graphics for Project identification signs. Comply with details indicated.

2. Prepare temporary signs to provide directional information to construction personnel and visitors.

3. Construct signs of exterior-type Grade B-B high-density concrete form overlay plywood in sizes and thicknesses indicated. Support on posts or framing of preservative-treated wood or steel.

4. Paint sign panel and applied graphics with exterior-grade alkyd gloss enamel over exterior primer.

E. Waste Disposal Facilities: Provide waste-collection containers in sizes adequate to handle waste from construction operations. Containerize and clearly label hazardous, dangerous, or unsanitary waste materials separately from other waste.

1. If required by authorities having jurisdiction, provide separate containers, clearly labeled, for each type of waste material to be deposited.

3.4 SECURITY AND PROTECTION FACILITIES INSTALLATION

A. Coordinate with property owner(s) prior to and through project duration to maintain secure access at chain link gates to respective project site areas east and west of the Little River. Contractor shall be responsible for securing/locking gates when work is not actively being conducted at the site to protect the public and prevent unauthorized persons from trespassing on these private properties.

1. Contractor shall ensure all access routes are clear of obstructions that could prevent or otherwise delay, inhibit or restrict emergency vehicles access to properties and facilities.

B. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during construction.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. All work within public roads shall conform to City and/or MassDOT's Standard Specifications.

2. Provide temporary construction signage and other traffic management control devices (during construction) in accordance with the Contract Drawings and as directed by the Engineer.

C. Barricades, Warning Signs, and Lights: Comply with the Traffic Management Plan and the MUTCD.

D. Temporary Fire Protection: Until fire-protection needs are supplied by permanent facilities, install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241.

3.5 OPERATION, TERMINATION, AND REMOVAL

A. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.

B. Maintenance: Maintain facilities in good operating condition until removal. Protect from damage caused by freezing temperatures and similar elements.

1. Maintain operation of temporary enclosures and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.

2. Prevent water-filled piping from freezing. Maintain markers for underground lines. Protect from damage during excavation operations.

C. Termination and Removal: Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.

1. Materials and facilities that constitute temporary facilities are the property of Contractor.

2. Remove temporary construction accesses. Where area is intended for landscape development, remove soil and aggregate fill that do not comply with requirements for fill or subsoil. Remove materials contaminated with road oil, asphalt and other petrochemical compounds, and other substances that might impair growth of plant materials or lawns. Repair or replace street paving, curbs, and sidewalks at temporary entrances, as required by authorities having jurisdiction.

3. At Substantial Completion, clean and renovate permanent facilities used during construction period.

END OF SECTION

SECTION 01 57 13 – TEMPORARY EROSION AND SEDIMENTATION CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, MASSDOT Standard Specifications for Highways and Bridges, and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes furnishing, placing, and maintaining erosion and sedimentation control measures as required by permits and shown on the Drawings, as directed by the Engineer, and where necessary to reduce sediment content of runoff. Measures include, but may not be limited to, the following:

1. Turbidity curtain
2. Silt fence
3. Straw bales
4. Sediment soil dewatering basin
5. Stabilized construction access/entrances
6. Perimeter sediment controls
7. Dust control
8. Temporary seeding, erosion control blanketing, and mulching
9. Crushed stone sump
10. Filter/dewatering bags
11. Catch basin inlet protection
12. Silt sock

B. Related Sections

1. Section 31 20 00 – Earthwork
2. Section 31 23 19 – Control of Water
3. Section 32 92 19 – Seeding
4. Section 32 19 00 - Plantings

1.3 SUBMITTALS

A. Dredged Material Dewatering Plan

1. Plan shall include but may not be limited to the type of containment, method of dewatering, method of collecting the dewatered effluent, and method of disposal.

B. Product Data

1. Turbidity curtain
2. Silt fence
3. Straw bales
4. Filter fabric
5. Perimeter sediment control products
6. Dust control
7. Dewatering bags
8. Temporary seeding, erosion control blanketing, and mulching
9. Catch basin inlet protection
10. Silt sock

C. Certificates of Compliance:

1. Crushed stone
2. Silt fence

1.4 QUALITY ASSURANCE

A. Sedimentation and erosion control measures shall be installed and maintained in accordance with the "Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas".

B. Sediment and erosion control measures shall comply with all permit requirements.

1.5 DEFINITIONS

A. Control System: Single or group of practices that prevent detachment and interrupt the transport of soil by rainfall, stormwater runoff, melting snow, or ice.

PART 2 - PRODUCTS

2.1 CONTROL SYSTEM

A. Turbidity Curtain

1. Type III barrier capable of passing flow velocities up to 5 feet per second

B. Silt Fence

1. Synthetic Filter Fabric
    a. Woven geotextile, 36 inches maximum height, conforming to Section M9.50.0 of the Standard Specifications.
2. Posts
    a. Hardwood Studs: 2 inches by 2 inches by 54 inches minimum
    b. Steel: 0.5 pounds per linear foot by 48 inches long minimum, with projections for fastening
3. Wire Backing: 14 gage minimum, mesh 4 inches by 4 inches maximum
4. Fasteners: Staples, tie wires or hog rings, as recommended by manufacturer
    a. Staples: Heavy-duty wire, 1-inch-long minimum
5. Prefabricated silt fence in lieu of field-fabricated fence may be used, when approved by the Engineer.

C. Straw Bales
1. Bales: Straw, weighing 40 to 120 lbs per bale
2. Bales shall be free of seeds and weeds.
3. Stakes: Wood, minimum 1 inch by 1 inch by minimum 36 inches long

D. Sediment Dewatering Basin
1. Filter Fabric
    a. Nonwoven geotextile conforming to Section M9.50.0 of the Standard Specifications and as indicated on the Drawings
2. Silt Fence
    a. Shall be in accordance with Section 2.1B of this Section.
3. Straw Bales
    a. Shall be in accordance with Section 2.1C of this Section.
4. Dewatering Bag: As indicated on the Drawings
5. Filter Stone: As indicated on the Drawings

E. Stabilized Construction Access/Entrance
1. Crushed Stone: As indicated on the Drawings
2. Filter Fabric: As indicated on the Drawings

F. Dust Control
1. Calcium Chloride: ASTM D98, Type 1 or Type 2
2. Water: Potable

G. Seeding, erosion control blanket, mulch: As indicated on the Drawings

H. Crushed Stone Sump: As indicated on the Drawings

I. Catch Basin Inlet Protection: As indicated on the Drawings

J. Silt Sock

1. Sock: Burlap and 100% biodegradable
2. Filler: Mixture of compost and wood filler material that is 100% biodegradable and free of seeds, weeds, and pests.

PART 3 - EXECUTION

3.1 GENERAL

A. Minimize environmental damage during construction. Prevent exposure of fuel, oil, lubricants, other fluids, and construction debris.

B. Install erosion and sediment control measures prior to clearing, demolition or construction.

C. Install the erosion and sediment control measures shown on the Drawings. Inform parties engaged on the construction site of the requirements and objectives of the plan.

D. Install, inspect, and maintain erosion and sediment control measures in accordance with the Massachusetts Department of Environmental Protection Permit.

1. Attend a preconstruction meeting with the Engineer, to review permit conditions and construction methods.
2. Provide additional sedimentation and erosion controls if deemed necessary by the Engineer, City, or State to address field conditions.
3. Inspect site weekly and prior to any anticipated rain event. Ensure that erosion controls are properly maintained and functioning.
4. Supply a 24-hour contact name and number as part of the erosion control plan.

E. Install additional control measures, if deemed necessary by the permitting agencies, City, or Engineer.

F. Remove and dispose of sediment from control structures.

G. Conduct construction operations and activities to minimize the creation and dispersion of dust. If the Engineer determines that water and or calcium chloride is required for more effective dust control, provide such measures at no additional cost.

H. Control dust and wind erosion. Control dust to prevent a hazard to traffic on adjacent roadways. Dust control includes, but is not limited to, sprinkling of water, uniform application of calcium chloride, mulch and/or crushed stone on exposed soils and haul roads.

I. Areas shall be swept and kept clean to minimize the creation and dispersion of dust.

J. Within 7 days of completing slope construction, stabilize slopes with seeding and mulching to minimize exposure.

K. Stockpiles

1. Side Slopes: 2:1 maximum
2. Surround stockpiles by silt fence or straw bales.
3. Stabilize stockpiles left bare for more than 15 days with temporary vegetation or mulch.

L. Final Grading

1. If final grading is delayed for more than 30 days after land disturbances cease, stabilize soils with temporary vegetation or mulch.

3.2 CONTROL SYSTEM

A. Silt Fence

1. Install fencing at locations indicated on the Drawings or where directed by the Engineer. Maintain pitch of 2 to 20 degrees, with inclination toward potential silt source.
2. Install bottom 6 inches of fabric by trenching and burying the fabric into the notched ground.
3. Drive posts into ground a minimum of 12 inches.
4. Locate fabric splices at posts only. Provide 6-inch overlap and seal.

B. Straw Bales

1. Install as indicated on the Drawings.

C. Sediment Dewatering Basin

1. Install as indicated on the Drawings.

D. Stabilized Construction Access/Entrance

1. Install as indicated on the Drawings.

E. Crushed Stone Sump

1. Install as indicated on the Drawings.

F. Catch Basin Inlet Protection

1. Install as indicated on the Drawings.

G. Silt Sock

1. Install as indicated on the Drawings.

H. Turbidity Curtain

1. Install as indicated on the Drawings.

3.3 MAINTENANCE

A. Control System

1. Inspect control system immediately after each rainfall and daily during prolonged rainfall. Make repairs immediately.

2. Remove and dispose of accumulated sediments when sediment reaches approximately one-third the height of the control system, or when directed by the Engineer.

3. Replace control system promptly if fabric decomposes or system becomes ineffective prior to the expected usable life.

4. Maintain or replace system until no longer necessary for the intended purpose.

B. Stabilized Construction Access/Entrance

1. Maintain in good condition throughout construction period.

2. Sweep adjacent roadways daily to remove tracked material from pavement.

3.4 REMOVAL

A. Unless otherwise specified, remove and dispose of control systems after area stabilizes with new growth or as directed by the Engineer.

B. Remove silt sock stakes at the end of the two-year warranty for planting and seeding.

END OF SECTION

SECTION 01 71 13 – MOBILIZATION AND DEMOBILIZATION

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes preparatory work and operations including, but not limited to, those necessary for the movement of personnel, equipment, supplies, and incidentals to and from the project site.

1.2 SUBMITTALS

A. Not used.

1.3 QUALITY ASSURANCE

A. Not used.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 SAFETY

A. The Contractor shall comply with all requirements of the most recent version of the Occupational Safety and Health Act (OSHA).

B. When any support system is used that requires design by an engineer, copies of the design stamped by a Professional Engineer registered in the State of Massachusetts shall be submitted to the Designer.

C. The Contractor has full responsibility to comply with all provisions of the State of Massachusetts Department of Labor Standards. Any fines levied against the Contractor for violations shall be the Contractor's responsibility.

3.2 PROTECTION

A. The Contractor shall assume full responsibility for the protection of all public or private buildings, structures and utilities in the streets, gas pipes, water pipes, hydrants, sewers, drains, electric and telephone cables, and any other improvements whether or not they are shown on the Drawings. The Contractor shall carefully support and protect all such structures and utilities from damage of every description and any such damage thereto shall be repaired or otherwise made good by the Contractor, at the Contractor's expense, in a manner acceptable to the Designer.

B. All open excavations shall be adequately safeguarded by providing temporary barricades, caution signs, lights, and other means to prevent accidents to persons and damage to property. The Contractor shall, at the Contractor's own expense, provide suitable and safe bridges and other

crossings for accommodating travel by pedestrians and workers. The length or size of excavation will be controlled by the particular surrounding conditions, but shall always be confined to the limits prescribed by the Designer.

END OF SECTION

SECTION 01 77 00 - CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:

1. Substantial Completion procedures.
2. Final completion procedures.
3. Final cleaning.

B. Related Sections:

1. Division 1 Section "Project Record Documents" for submitting Record Drawings, Record Specifications, and Record Product Data.

1.3 SUBSTANTIAL COMPLETION

A. Preliminary Procedures: Before requesting inspection for determining date of Substantial Completion, complete the following. List items below that are incomplete with request.

1. Prepare a list of items to be completed and corrected (punch list), the value of items on the list, and reasons why the Work is not complete.
2. Advise Owner of pending insurance changeover requirements.
3. Submit specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
4. Obtain and submit releases permitting Owner unrestricted use of the Work.
5. Prepare and submit Project Record Documents, operation and maintenance manuals, final completion construction photographic documentation, damage or settlement surveys, property surveys, and similar final record information.
6. Deliver tools, spare parts, extra materials, and similar items to location designated by Owner. Label with manufacturer's name and model number where applicable.
7. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
8. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.
9. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.

B. Inspection: Submit a written request for inspection for Substantial Completion. On receipt of request, Designer will either proceed with inspection or notify Contractor of unfulfilled

requirements. Designer will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Designer, that must be completed or corrected before certificate will be issued.

1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

2. Results of completed inspection will form the basis of requirements for final completion.

1.4 FINAL COMPLETION

A. Preliminary Procedures: Before requesting final inspection for determining final completion, complete the following:

1. Submit a final Application for Payment according to Division 1 Section "Payment Procedures."

2. Submit certified copy of Designer's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Designer. The certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.

3. Submit evidence of final, continuing insurance coverage complying with insurance requirements.

4. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems.

B. Inspection: Submit a written request for final inspection for acceptance. On receipt of request, Designer will either proceed with inspection or notify Contractor of unfulfilled requirements. Designer will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.

1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.5 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

A. Organization of List: Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.

1. Organize items applying to each major element.

2. Include the following information at the top of each page:

a. Project name.

b. Date.

c. Name of Designer.

d. Name of Contractor.

e. Page number.

3. Submit list of incomplete items in the following format:

a. PDF electronic file.

b. Three paper copies of product schedule or list, unless otherwise indicated. Designer will return one copy.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

PART 3 - EXECUTION

3.1 FINAL CLEANING

A. General: Perform final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.

B. Cleaning: Comply with manufacturer's written instructions.

1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a portion of Project:

a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.

b. Sweep paved areas broom clean. Remove spills, stains, and other foreign deposits.

c. Remove tools, construction equipment, machinery, and surplus material from Project site.

d. Remove labels that are not permanent.

C. Construction Waste Disposal: Dispose of all waste material legally.

END OF SECTION

SECTION 01 78 01 - PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for project record documents, including the following:

1. Record Drawings.
2. Record Product Data.

B. Related Sections:

1. Division 1 Section "Closeout Procedures" for general closeout procedures.

1.3 CLOSEOUT SUBMITTALS

A. Record Drawings: Comply with the following:

1. Number of Copies: Submit one paper set and one electronic set of marked-up record drawings.

B. Record Product Data: Submit one paper copy and annotated PDF electronic files and directories of each submittal.

1. Where record Product Data are required as part of operation and maintenance manuals, submit duplicate marked-up Product Data as a component of manual.

PART 2 - PRODUCTS

2.1 RECORD DRAWINGS

A. Record Prints: Maintain one set of marked-up paper copies of the Contract Drawings and Shop Drawings.

1. Preparation: Mark record prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.

a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.

b. Accurately record information in an acceptable drawing technique.

c. Record data as soon as possible after obtaining it.

d. Record and check the markup before enclosing concealed installations.

e. Cross-reference record prints to corresponding archive photographic documentation.

2. Content: Types of items requiring marking include, but are not limited to, the following:

a. Dimensional changes to Drawings.

b. Revisions to details shown on Drawings.

c. Locations and depths of underground utilities.

d. Changes made following Designer's written orders.

e. Details not on the original Contract Drawings.

f. Field records for variable and concealed conditions.

g. Record information on the Work that is shown only schematically.

3. Mark the Contract Drawings and Shop Drawings completely and accurately. Utilize personnel proficient at recording graphic information in production of marked-up record prints.

4. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.

5. Mark important additional information that was either shown schematically or omitted from original Drawings.

6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.

B. Record Digital Data Files: Immediately before inspection for Certificate of Substantial Completion, review marked-up record prints with Designer. When authorized, prepare a full set of corrected digital data files of the Contract Drawings, as follows:

1. Format: Same digital data software program, version, and operating system as the original Contract Drawings.

2. Format: DWG.

3. Format: Annotated PDF electronic file.

4. Incorporate changes and additional information previously marked on record prints. Delete, redraw, and add details and notations where applicable.

5. Refer instances of uncertainty to Designer for resolution.

6. Designer will furnish Contractor one set of digital data files of the Contract Drawings for use in recording information.

a. Designer will provide data file layer information. Record markups in separate layers.

C. Format: Identify and date each record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.

1. Record Prints: Organize record prints and newly prepared record Drawings into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.

2. Format: Annotated PDF electronic file.

3. Record Digital Data Files: Organize digital data information into separate electronic files that correspond to each sheet of the Contract Drawings. Name each file with the sheet identification. Include identification in each digital data file.

4. Identification: As follows:

   a. Project name.

   b. Date.

   c. Designation "PROJECT RECORD DRAWINGS."

   d. Name of Designer.

   e. Name of Contractor.

2.2 RECORD PRODUCT DATA

A. Preparation: Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.

   1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.

   2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.

   3. Note related Change Orders and record Drawings where applicable.

B. Format: Submit record Product Data as scanned PDF electronic file(s) of marked up paper copy of Product Data.

   1. Include record Product Data directory organized by specification section number and title, electronically linked to each item of record Product Data.

PART 3 - EXECUTION

3.1 RECORDING AND MAINTENANCE

A. Recording: Maintain one copy of each submittal during the construction period for project record document purposes. Post changes and modifications to project record documents as they occur; do not wait until the end of Project.

B. Maintenance of Record Documents and Samples: Store record documents and Samples in the field office apart from the Contract Documents used for construction. Do not use project record documents for construction purposes. Maintain record documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to project record documents for Designer's reference during normal working hours.

END OF SECTION

SECTION 02 41 19 – SELECTIVE DEMOLITION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, MASSDOT Standard Specifications for Highways and Bridges, and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes:
   1. Partial demolition of the existing Little River Dam and adjacent stone masonry wall.
   2. Salvaging and stockpiling granite blocks and boulders for incorporation into the Work or reuse by the City at a later date.
   3. Off-site disposal of demolition waste.

B. Related Sections:
   1. Section 01 50 00 - Temporary Facilities and Controls
   2. Section 01 57 13 - Temporary Erosion and Sedimentation Control
   3. Section 31 10 00 - Site Clearing
   4. Section 31 20 00 - Earthwork
   5. Section 31 23 19 - Control of Water

1.3 DEFINITIONS

A. Dam: Dam structure, including the spillway, outlet structures, earthen embankments, and all appurtenances.

B. Remove: Detach items from existing construction and legally dispose of them off-site unless indicated for removal and salvage.

C. Remove and Salvage: Carefully disassemble or detach from existing construction, in a manner to prevent damage to items to be salvaged, and stockpile on site.

1.4 MATERIALS OWNERSHIP

A. Unless otherwise indicated, demolition waste becomes property of the Contractor.

1.5 SUBMITTALS

A. Demolition Plan, submitted and accepted prior to commencing the Work in this section, that includes:
   1. Detailed sequence of demolition work and water control, with starting and ending dates for each activity;

2. Means and methods of demolition;
3. Extents of demolition, including demolition of below-grade construction;
4. List of items to be salvaged and stockpiled; and
5. Material disposal location.

B. Pre-demolition photographs to document existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by demolition operations. Submit prior to the start of work in this section.

1.6 QUALITY ASSURANCE

A. The Contractor shall attend a pre-demolition conference to:
1. Inspect and discuss condition and extents of construction to be demolished.
2. Review and finalize protection requirements.
3. Review procedures for noise and dust control.
4. Review items to be salvaged and stockpiled.

1.7 PROJECT CONDITIONS

A. Hazardous Materials: It is not expected that hazardous materials will be encountered in the work described in this section.
1. If materials suspected of containing hazardous materials are encountered during demolition operations, do not disturb; immediately notify the Engineer and Owner. Hazardous materials will be removed by Owner under a separate contract.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Review Project Record Documents of existing construction provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents or on the Drawings. The Contractor is responsible for understanding the existing conditions at the site.
B. Ground-truth the existing conditions and correlate with project requirements to determine extent of dam and wall demolition required.
C. Inventory and record the condition of items to be removed and salvaged. Provide photographs of conditions that might be misconstrued as damage caused by demolition operations.
D. If unanticipated mechanical, electrical, or structural elements are encountered, investigate and measure the nature and extent of the element. Notify the Engineer to coordinate a resolution prior to continuing with the work.

3.2 PREPARATION

A. Salvaged Items: Comply with the following:
   1. Clean salvaged items of dirt and demolition debris.
   2. Transport items to on-site stockpile areas indicated on the Drawings.
   3. Protect items from damage during transport and storage.

3.3 PROTECTION

A. Existing Facilities: Protect adjacent buildings, bridges, roadways, walkways, utilities, and other structures and improvements during demolition operations.

B. Temporary Protection: Erect temporary protection, such as fences and railings, where required by authorities having jurisdiction and as indicated.
   1. Protect adjacent facilities from damage due to demolition activities.
      a. Protect existing site improvements, appurtenances, and landscaping to remain.
   2. Erect a plainly visible fence around drip line of individual trees or around perimeter drip line of groups of trees to remain.
   3. Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.

C. Remove temporary barriers and protections when hazards no longer exist. Where open excavations or other hazardous conditions remain, leave temporary barriers and protections in place.

D. Monitor weather conditions and weather forecast. Demolition work shall not proceed if weather conditions present a hazard to safety or the Project. Refer to Section 31 23 19 – Control of Water.

E. Monitor adjacent buildings, bridges, roadways, walkways, utilities, and other structures and improvements for damage or movement caused by demolition. If damage is detected, notify the Engineer to coordinate a resolution prior to continuing with the work.

3.4 DEMOLITION, GENERAL

A. Fully demolish and remove the dam and wall within the limits shown on the Drawings. Use methods required to complete the demolition work within limitations of governing regulations and the project permits.

B. Conduct demolition and debris removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

C. Conduct demolition and debris removal operations in a manner that will not result in degradation or impairment of existing natural resources or environmental quality, including but not limited to water, soil, or air quality.
   1. Use water mist and other suitable methods to limit the spread of dust and dirt. Comply with governing environmental protection regulations. Do not use water when it may damage adjacent construction or create hazardous or objectionable conditions, such as ice, flooding, or pollution.

D. Use of explosives is not permitted.

E. Granite blocks and boulders encountered during demolition shall be salvaged and stockpiled for incorporation into the Work as indicated on the Drawings.

F. Below-Grade Construction:

1. Demolish the dam, foundation walls, and other below-grade construction within the limits shown on the Drawings.

3.5 REMOVAL AND DISPOSAL

A. Remove and legally dispose of demolition waste materials and excess salvaged materials off site.

1. Salvaged granite blocks and boulders may be required for Add Alternates that are not authorized as part of the contracted work. In this case, they shall be stockpiled off site at the Haverhill Public Works Department, located at 500 Primrose Street, Haverhill, MA for future use in completion of the Add Alternates at a later date.
2. Do not allow demolished materials to accumulate on site.
3. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

B. Do not burn demolished materials.

3.6 SITE RESTORATION

A. Below-Grade Areas:

1. Fill below-grade areas and voids resulting from demolition operations as indicated on the Drawings or according to backfill requirements in Section 31 20 00 "Earthwork".

B. Site Grading: Unless otherwise noted on the Drawings, uniformly rough grade area of demolished construction to a smooth surface, free from irregular surface changes. Provide a smooth transition between adjacent existing grades and new grades.

C. Damage to adjacent buildings, bridges, roadways, walkways, utilities, and other structures and improvements caused by demolition shall be repaired to the satisfaction of the Owner and at the Contractor's own expense.

D. Clean adjacent structures and improvements of dust, dirt, and debris caused by demolition operations. Return adjacent areas to condition existing before demolition operations began.

1. Clean roadways of debris caused by debris transport.

END OF SECTION

SECTION 03 30 00 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, MASSDOT Standard Specifications for Highways and Bridges, and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section specifies cast-in-place concrete, including formwork, reinforcement, concrete materials, mix design, placement procedures, and finishes.

B. This section applies to:

1. Channel retaining walls – footings and cantilever retaining walls
2. Pedestrian bridge abutments – pile caps, abutment stems, retaining walls, and backwall
3. Pedestrian walkway retaining structure – footings and cantilever retaining walls
4. Damproofing buried concrete to the limits show in the plans
5. Waterproofing the wall footing/stem transition to the plan limits shown in the plans

C. Related Sections include the following:

1. Section 31 20 00 – Earthwork
2. Section 31 50 00 – Excavation Support and Protection

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume.

B. Marine Environment: Any area that will be in contact with or subject to submersion, tidal variations, splash, or spray from both fresh and salt water in bodies of water or navigable waterways.

C. Marine Concrete: concrete that will be in contact with or subject to submersion, tidal variations, splash, or spray from water in navigable waterways.

1.4 SUBMITTALS

A. Product Data: For each type of manufactured material and product indicated, including but not limited to:

1. Technical data sheets and manufacturer's installation procedure for drill and grout anchors.
2. PVC and hydrophilic waterstop product data.

B. Design Mixes: For each concrete mix. Include alternate mix designs when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments.

1. Submit copies of test reports by independent test labs conforming to ASTM C 1077 showing that the mixture has been successfully tested to produce concrete with the properties specified.

2. Do not add water to concrete during delivery, at Project site, or during placement, unless included in the mix design and approved by the Engineer.

a. Procedure for adding and calculating amount of water to be added at the Project site shall be submitted with the mix design if water is to be added at the Project site.

C. Steel Reinforcement Shop Drawings: Details of fabrication, bending, and placement, prepared according to ACI 315, "Details and Detailing of Concrete Reinforcement." Include material, grade, bar schedules, stirrup spacing, bent bar diagrams, arrangement, and supports of concrete reinforcement. Include special reinforcement required for openings through concrete structures.

1. Do not scale dimensions from structural drawings to determine lengths of reinforcing bars.

D. Welding Certificates: Copies of certificates for welding procedures and personnel.

E. Material Certificates: Signed by manufacturers certifying that each of the following items complies with requirements:

1. Cementitious materials and aggregates
2. Form materials and form-release agents
3. Steel reinforcement and reinforcement accessories
4. Admixtures
5. Waterstops
6. Curing materials
7. Membrane waterproofing
8. Bonding agents
9. Adhesive anchors
10. Preformed Expansion Joint-filler
11. Closed cell foam
12. Shims
13. Integral concrete color additives
14. Dampproofing
15. Waterproofing

F. Samples for color selection: Submit manufacturer's samples in the colors indicated, including pigment number and required dosage rate for each color.

G. Minutes of preinstallation conference.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed concrete Work similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

B. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for formwork and shoring and reshoring installations that are similar to those indicated for this Project in material, design, and extent.

C. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products complying with ASTM C 94 requirements for production facilities and equipment.

1. Manufacturer must be certified according to the National Ready Mixed Concrete Association's Certification of Ready Mixed Concrete Production Facilities.

D. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 to conduct the testing indicated, as documented according to ASTM E 548.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.

E. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, each aggregate from one source, and each admixture from the same manufacturer.

F. Welding: Qualify procedures and personnel according to AWS D1.4, "Structural Welding Code--Reinforcing Steel."

G. ACI Publications: Comply with the following, unless more stringent provisions are indicated:

1. ACI 301, "Specification for Structural Concrete."
2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
3. ACI 305R, "Hot Weather Concreting"
4. ACI 306.1, "Standard Specifications for Cold Weather Concreting"

H. Pre-installation Conference: Conduct conference at Project site.

1. Before submitting design mixes, review concrete mix design and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
    a. Contractor's superintendent.
    b. Independent testing agency responsible for concrete design mixes.
    c. Ready-mix concrete producer
    d. Concrete subcontractor

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle steel reinforcement to prevent bending and damage. Protect from contaminants such as grease, oil, and dirt. Ensure materials can be accurately identified after bundles are broken and tags are removed.

1. Avoid damaging coatings on steel reinforcement.

2. Repair damaged epoxy coatings on steel reinforcement according to ASTM D 3963/D 3963M.

PART 2 - PRODUCTS

2.1 FORM-FACING MATERIALS

A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.

1. To be used during casting of wing wall stems, barriers, and headwalls.

2. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:

a. High-density overlay, Class 1, or better.

B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

1. To be used during casting of all other concrete components contained in the work not covered by Section 2.1-A of this specification.

C. Chamfer Strips: Wood, metal, PVC, or rubber strips, 1 inch by 1 inch (19 by 19 mm), minimum.

D. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

1. Formulate form-release agent with rust inhibitor for steel form-facing materials.

2. Comply with local regulations controlling use of volatile organic compounds (VOCs).

3. Available Products: GCC-100 FRW water based or approved equivalent.

E. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.

1. Furnish ties that, when removed, will leave holes not larger than 1 inch (25 mm) in diameter in concrete surface.

2. Patch holes left by the removal of form ties in an appropriate manner.

2.2 FORMLINER

A. Architectural Formliner System: Imprinting tool for texturing freshly placed concrete, in pattern and texture to achieve required surface profile and design. Removable, preformed plastic formliner,

tight fitting, stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished surfaces.

1. Increte Stone-Crete architectural wall system as manufactured by Euclid Chemical, 19215 Redwood Road, Cleveland, OH 44110, 800-321-7628, info@euclidchemical.com, or approved equal.
2. Pattern:
    a. 18-inch Split Faced Granite
    b. Liner Size: 8 feet x 1.5 feet
    c. Liner Thickness: 5 inches
    d. Relief: 4 inches
    e. Rock Sizes: 24 inches to 48 inches

B. Release Agent: Bond breaker compound capable of releasing stamping forms from concrete without creating surface defects or leaving any residue; type as recommended by stamping/formliner manufacturer; compatible with concrete, form materials, and specified coloring agents.

2.3 COLOR ADDITIVES

A. Concentrated color admixture pigment specifically intended for mixing into concrete and complying with ASTM C979.

1. Increte Color-Crete as manufactured by Euclid Chemical, 19215 Redwood Road, Cleveland, OH 44110, 800-321-7628, info@euclidchemical.com, or approved equal.
2. Color: Natural Brown – Dark (2 bags/1 Yard)

2.4 STEEL REINFORCEMENT

A. Epoxy-Coated Reinforcing Bars: Conform to Section M8.01.7 of the MassDOT Standard Specifications, ASTM A 775 / A 775M, and as follows:

1. Steel Reinforcement: ASTM A615/A615M, Grade 60, deformed.

B. Epoxy-Coated Wire: ASTM A884/A884M, Class A coated, plain-steel wire

C. Epoxy-Coated Welded Wire Fabric: ASTM A884/A884M, Class A, plain steel

2.5 REINFORCEMENT ACCESSORIES

A. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete, and as follows:

1. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer coated wire bar supports.

B. Epoxy-Coated Joint Dowel Bars: ASTM A 775/A 775M, Grade 60 (Grade 420). Cut bars true to length with ends square and free of burrs.

C. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating; compatible with epoxy coating on reinforcement and complying with ASTM A 775/A 755M.

2.6 CONCRETE MATERIALS

A. Portland Cement Concrete Materials: Materials including cementitious materials, aggregates and water conforming to the requirements of Section M4.06.1 of the MassDOT Standard Specifications as applicable for production of The Massachusetts Department of Transportation standard concrete mixes as indicated in this specification and on the Drawings.

2.7 ADMIXTURES

A. Admixtures and additives conforming to the requirements of Section M4.06.1 of the Standard Specifications.

2.8 WATERSTOPS

A. Flexible PVC Waterstops: CE CRD-C 572, US Army Corps specification for polyvinylchloride waterstop, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes per the manufacturer's instructions using manufacturer's recommended or required devices and products.

1. Profile: Provide the following waterstop profiles:

   a. "Ribbed Flat" for construction joints and joints where little to no movement is anticipated.

      1) 6" minimum width

      2) 3/8" minimum thickness with 1/8" ribs on both faces

   b. "Ribbed with Center Bulb" for expansion joints and joints where movement is anticipated.

      1) 6" minimum width

      2) 3/8" minimum thickness with 1/8" ribs on both faces

      3) Center bulb with ½" I.D. and 1" O.D.

B. Hydrophilic Waterstop: For placement on existing surfaces prior to the placement of new concrete:

1. Profile: Provide a hydrophilic waterstop with a minimum width of 1" and minimum thickness of 3/8".

   a. Provide adhesive recommended or required by the waterstop manufacturer for attaching waterstop to existing surface.

2.9 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) dry. Cover shall not have been used as a container for sugar or other substances deleterious to concrete and shall be in good condition, free from holes, tears or other defects that would render it unsuitable for curing concrete. It shall be furnished in strips not less than 3 feet nor more than 6 feet in width and not more than 2-1/2 feet longer than the width of the pavement slab.

B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

C. Water: Potable.

D. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, 18 to 22 percent solids

2.10 RELATED MATERIALS

A. Preformed Expansion Joint-Filler: ASTM D 1751, asphalt-saturated cellulosic fiber, or ASTM D 1752, cork or self-expanding cork.

B. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

C. Epoxy-Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class and grade to suit requirements, and as follows:

1. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

2.11 CONCRETE MIXES

A. Prepare design mixes for each type and strength of concrete determined by either laboratory trial mix or field test data bases, as follows:

1. Proportion normal-weight concrete according to ACI 211.1 and ACI 301.

B. Use a qualified independent testing agency for preparing and reporting proposed mix designs for the laboratory trial mix basis.

C. Calcium nitrite corrosion inhibitors shall conform to AASHTO M 194M/M 194.

1. The calcium nitrite solution shall contain 30 ± 2% calcium nitrite by weight. The calcium nitrite material shall have neutral set characteristics.

2. The calcium nitrite shall be added at a rate of 3 gal per yd^3 of concrete in order to increase the active corrosion threshold to 9.9 lb of chloride per yd^3 of concrete at the reinforcing bar level.

D. Concrete for Project: Proportion normal-weight concrete mix as follows:

1. Compressive Strength (28 Days): 4000 psi (34.5 MPa).

2. Minimum Cementitious Materials Content: 585 lb/cu. yd.

3. Nominal Maximum Aggregate Size: 3/4 in.

4. Minimum Slump: 2 inches (50 mm).

5. Maximum Slump: 6 inches (100 mm).

6. Maximum Water-Cementicious Material Ratio: 0.40

E. Cementitious Materials: Limit percentage, by dry weight, of cementitious materials other than Portland cement in concrete as follows:

1. Silica Fume: 6 percent ±1%
2. Fly Ash (in lieu of slag cement): 15 percent.
3. Slag Cement (in lieu of fly ash): 25 percent to 40 percent.

F. Maximum Water-Cementitious Materials Ratio: As required by the MassDOT Standard Specifications.

G. Air Content: Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content as follows within a tolerance of plus 1 or minus 1.5 percent, unless otherwise indicated.

H. Retain applicable air-entrainment percentages from subparagraphs below or revise to suit Project. Percentages are from ACI 301 default values based on severe-exposure service conditions. Air content of concrete may be reduced by 1 to 1.5 percent for moderate exposure and 2.5 to 3 percent for mild exposure.

1. Air Content: 6.5 for 3/4 inch nominal maximum aggregate size

I. Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use water-reducing admixture or high-range water-reducing admixture (superplasticizer) in concrete, as required, for placement and workability.
2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.

2.12 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.13 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94, and furnish batch ticket information.

2.14 ADHESIVE ANCHORS

A. An adhesive anchor shall consist of threaded or reinforcing bar insert and adhesive formula compatible with a marine environment. Threaded inserts shall meet the minimum requirements of ASTM A193 Grade B8M (Type 316 Stainless Steel). Reinforcing bar inserts shall meet the minimum requirements of ASTM A615 Grade 60 or ASTM A706 Grade 60. For exterior exposure the insert shall be stainless steel. Inserts in contact with preservative-treated and fire-retardant-treated wood shall be zinc coated in accordance with ASTM A153 Class C or D or stainless steel or demonstrated through tests to be equivalent to the coatings described.

B. Adhesive anchors shall be designed in accordance with ACI 318 Chapter 17 as amended by the specific design provisions of ICC-ES AC308. Adhesive anchors shall have an evaluation report issued by ICC-ES and have been tested and qualified for performance in cracked and uncracked concrete in accordance ICC-ES AC308.

C. The embedded anchorage must be sufficient to develop at least 125% of the yield strength of the dowel (either threaded anchor rod or reinforcing bar).

D. Adhesives shall be injectable, two-component, cartridge-type systems dispensed and mixed through a static mixing nozzle supplied by the manufacturer. Acceptable installation and performance temperature ranges shall be verified with manufacturer's literature prior to installation.

2.15 SHIMS

A. Shall be carbon steel.

2.16 DAMPPROOFING

A. Damproofing shall meet the requirements of MassDOT M9.09.2

2.17 WATERPROOFING

A. Waterproofing membrane shall meet the requirements of MassDOT M9.08.0

PART 3 - EXECUTION

3.1 FORMWORK

A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until concrete structure can support such loads.

B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.

C. Limit concrete surface irregularities, designated by ACI 347R as abrupt or gradual, as follows:

1. Class A, 1/8 inch (3 mm) for wing wall stems, barriers and headwalls.
2. Class C, 1/2 inch (13 mm) for all other concrete components not listed under Class A.
3. Gradual: Class B, 1/4 inch

D. Construct forms tight enough to prevent loss of concrete mortar.

E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical. Kerf wood inserts for forming keyways, reglets, recesses, and the like, for easy removal.

1. Do not use rust-stained steel form-facing material.

F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.

G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.

H. Chamfer exterior corners and edges of permanently exposed concrete.

I. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.

J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.2 FORMLINER PREPARATION

A. Before placing concrete, verify lines and levels of formwork and formliner patters are within allowable tolerances.

B. Clean formliner before each use. Replace damaged formliner whose continued use or repair would negatively impact the aesthetics of the concrete finish.

C. Apply form release agent at a rate recommended by the manufacturer. Attempt to schedule concrete placement soon after application of form release agent to avoid precipitation, dust, and debris. Protect reinforcing steel from exposure to release agents.

3.3 FORMLINER INSTALLATION

A. A. Seal formliner joints, rustication/chamfer joints, and tie holes to prevent cement paste from bleeding.

B. Provide solid backing at formliner joints where unsupported by formwork to prevent deflection.

C. Construct formliner and chamfers to sizes, shapes, lines and dimensions shown.

D. Provide openings, offsets, keyways, recesses, chamfers, blocking, and screeds as required to achieve architectural concrete textured finish.

E. Drill or pierce formliner to accommodate form ties.

F. Fasten formliner to formwork 12" to 24" on center. Increase spacing as necessary to accommodate form stripping pressures without damaging formliner intended for multiple use.

G. Install backup strips as required to prevent deflection of the formliner due to form pressures.

3.4 EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use Setting Drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

1. Install inserts for rail transitions, accurately located, to elevations required

3.5 REMOVING AND REUSING FORMS

A. General: Formwork, for sides of beams, walls, columns, and similar parts of the Work, that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F (10 deg C) for 24 hours after placing concrete provided concrete is hard enough to not be damaged by form-removal operations and provided curing and protection operations are maintained.

B. Forms shall be removed in such a manner as not to impair safety and serviceability of the structure. Concrete exposed by form removal shall have sufficient strength not to be damaged by removal operation.

C. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.

D. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by the Engineer.

3.6 STEEL REINFORCEMENT

A. General: Comply with Section 901 of the MassDOT Standard Specifications.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials.

C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.

D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

E. Epoxy-Coated Reinforcement: Use epoxy-coated steel wire ties to fasten epoxy-coated reinforcement. Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D 3963/D 3963M.

F. Adhesive Anchors:

1. Refer to and comply with the manufacturer's safety data sheet and all local regulations.
2. Inspect all areas involved in the work to establish the extent of work, access and need for protection of surrounding construction.
3. Do not begin installation until base materials have been properly prepared.

4. Install only if environmental conditions are conducive to manufacturer's recommendations for installation conditions.

5. Do not drill holes in concrete until concrete has achieved full design strength.

6. Perform anchor installation in accordance with manufacturer instructions.

3.7 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by the Engineer.

1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.

2. Form from preformed galvanized steel, plastic keyway-section forms, or bulkhead forms with keys, unless otherwise indicated. Embed keys at least 1-1/2 inches (38 mm) into concrete unless specified otherwise on the Drawings.

3. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

C. Dowel Joints: Install dowel sleeves and dowels or dowel bar and support assemblies at joints where indicated.

1. General: Comply with Section 901 and Section M8 of the MassDOT Standard Specifications.

2. Use dowel sleeves or lubricate or asphalt-coat one-half of dowel length to prevent concrete bonding to one side of joint.

3.8 WATERSTOPS

A. Hydrophilic Waterstops: Install on the embedded sheet piling as indicated on the plans to form a continuous diaphragm. Install in longest lengths practicable. Support and protect exposed waterstops during progress of Work. Field-fabricate joints in waterstops according to manufacturer's written instructions.

B. PVC Waterstops: Install in construction joints as indicated on the plans. Waterstops shall be installed in continuous sections with no joints, unless approved by the Engineer.

3.9 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.

B. Do not add water to concrete during delivery, at Project site, or during placement, unless included in the mix design and approved by the Engineer.

1. Do not add water to concrete after adding high-range water-reducing admixtures to mix.

C. Deposit concrete continuously or in layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as specified. Deposit concrete to avoid segregation.

D. Deposit concrete in forms in horizontal layers no deeper than 24 inches (600 mm) and in a manner to avoid inclined construction joints. Place each layer while preceding layer is still plastic, to avoid cold joints.

1. Consolidate placed concrete with mechanical vibrating equipment. Use equipment and procedures for consolidating concrete recommended by ACI 309R.

2. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations no farther than the visible effectiveness of the vibrator. Place vibrators to rapidly penetrate placed layer and at least 6 inches (150 mm) into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mix constituents to segregate.

E. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. Any concrete placed during cold weather shall be placed at the Contractor's risk and any damaged or unsatisfactory concrete shall be removed and replaced at the Contractor's expense. Concrete mixed or placed when the air temperature is below 40 deg F will be considered cold weather concrete and will required special treatment.

2. No concrete shall be placed when the atmospheric temperature in the shade and away from artificial heat is below 35 deg F or when the temperature may be expected to drop below 30 deg F within 24 hours, except upon permission in writing by the Engineer, which shall not be granted until satisfactory provisions have been made to protect the work.

3. If the air temperature in the shade and away from artificial heat may be expected to reach 40 deg F or lower at any time during the day or night of the 24 hours following the placing of the concrete, protective cover, heating or protective cover and heating will be required on all exposed surfaces. When the air in the shade and away from the artificial heat is 40 deg F or lower temperature, the mixing water and/or aggregates may be heated (prior to cement being added) by approved methods so that the temperature of the aggregates and water mixture is not less than 70 deg F nor more than 140 deg F. The temperature of the concrete shall not be less than 60 deg F nor more than 90 deg F at the time of placing it in the forms. The heating shall be done in a manner to preclude the occurrence of overheated areas which might result in damage to the materials.

4. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.

5. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators, unless otherwise specified and approved in mix designs.

F. Hot-Weather Placement: Place concrete according to recommendations in ACI 305R and as follows, when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F (32 deg C) at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.10 FINISHING FORMED SURFACES

A. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defective areas. Remove fins and other projections exceeding 1/8 inch (3 mm) in height.

1. Apply to concrete surfaces of wing wall stems, barriers, and headwalls or to surfaces to be covered with a coating or covering material applied directly to concrete, such as waterproofing, damp proofing, veneer plaster, or painting.

B. Rubbed Finish: Apply the following to smooth-formed finished concrete.

1. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.

C. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

3.11 MISCELLANEOUS CONCRETE ITEMS

A. Filling In: Fill in holes and openings left in concrete structures, unless otherwise indicated, after work of other trades is in place. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete Work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

3.12 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and with recommendations in ACI 305R for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing by one or a combination of the following methods:

D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces, by one or a combination of the following methods:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

   a. Water

   b. Continuous water-fog spray

   c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

3.13 MEMBRANE WATERPROOFING

A. Installed in the locations indicated on the plans.

B. Shall be installed in accordance with manufacturer's written instructions and the provisions set forth in Section 965 of the MassDOT Standard Specifications.

3.14 JOINT FILLING

A. Prepare, clean, and install joint filler according to manufacturer's written instructions.

1. Defer joint filling until concrete has aged at least six months. Do not fill joints until construction traffic has permanently ceased.

B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.

C. Install semirigid epoxy joint filler full depth in saw-cut joints and at least 2 inches (50 mm) deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

3.15 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas as directed by the Engineer. Remove and replace concrete that cannot be repaired and patched to the Engineer's approval.

B. Patching Mortar: Mix dry-pack patching mortar, consisting of one part Portland cement to two and one-half parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.

C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.

1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension in solid concrete but not less than 1 inch in depth. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.

2. Repair defects on surfaces exposed to view by blending white Portland cement and standard Portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.

3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by the Engineer.

D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.

1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.

2. After concrete has cured at least 14 days, correct high areas by grinding.

3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.

4. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of ¼ inch to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.

5. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least ¾ inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mix as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.

6. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

E. Perform structural repairs of concrete, subject to the Engineer's approval, using epoxy adhesive and patching mortar.

F. Repair materials and installation not specified above may be used, subject to the Engineer's approval.

3.16 DAMPROOFING

A. Damproofing of installed concrete surfaces shall be to the limits shown in the plans. Install dampproofing in accordance with MassDOT 970.40 – 970.61. Damproofing shall not be measured separately for payment.

3.17 WATERPROOFING

A. Waterproof the wall footing/stem transition as shown in the plans. Installation of waterproofing shall as detailed in MassDOT 965.41 through 965.47. Waterproofing shall not be measure separately for payment.

3.18 FIELD QUALITY CONTROL

A. Testing Agency: Contractor shall engage a qualified independent testing and inspecting agency to sample materials, perform tests, and submit test reports during concrete placement according to requirements specified in this Article.

B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:

1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mix exceeding 2 cu. yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.

    a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mix, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C 143; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mix. Perform additional tests when concrete consistency appears to change.

3. Air Content: ASTM C 231, pressure method, for normal-weight concrete; ASTM C 173, volumetric method, for structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mix.

4. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F (4.4 deg C) and below and when 80 deg F (27 deg C) and above, and one test for each composite sample.

5. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of six standard cylinder specimens for each composite sample.

    a. Cast and field cure one set of six standard cylinder specimens for each composite sample.

6. Compressive-Strength Tests: ASTM C 39; test two laboratory-cured specimens at 7 days and two at 28 days.

a. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at age indicated.

b. Test two field-cured specimens at 7 days and two at 28 days. Keep two specimen in reserve.

C. Strength of each concrete mix will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi (3.4 MPa).

D. Test results shall be reported in writing to the Engineer, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7-and 28-day tests.

E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by the Engineer but will not be used as sole basis for approval or rejection of concrete.

F. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by the Engineer. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42 or by other methods as directed by the Engineer.

END OF SECTION

SECTION 04 43 03 –STONE MASONRY WALLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, MASSDOT Standard Specifications for Highways and Bridges, and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes providing stone masonry walls with dry joints and mortared center as required for wall stability.

B. Related Sections:
   1. Section 31 20 00 - Earthwork

1.3 SUBMITTALS

A. Product Data: For each variety of stone, stone accessory, and manufactured product.

B. Samples for Verification:
   1. For each stone type indicated. Include at least three samples in each set and show the full range of color and other visual characteristics in completed Work.

C. Qualification Data: For Installer.

D. List of Materials Used in Constructing Mockups: List generic product names together with manufacturers, manufacturers' product names, supply sources, and other information as required to identify materials used. Include mix proportions for mortar and source of aggregates.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: A qualified Installer who employs experienced stonemasons and stone fitters.

B. Source Limitations for Stone:
   1. Reuse salvaged boulders where possible.
   2. Obtain stone from one quarry or source with resources to provide materials of consistent quality in appearance and physical properties.

C. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.

D. Mockups: Build mockups to demonstrate aesthetic effects and set quality standards for materials and execution.
   1. Build mockup of typical wall area as shown on the Drawings for approval by the Landscape Architect.
   2. Protect approved mockups from the elements with weather-resistant membrane.
   3. Approval of mockups is for color, texture, and blending of stone; relationship of mortar and sealant colors to stone colors; tooling of joints; and aesthetic qualities of workmanship.
   4. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

B. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

A. Deliver pre-blended, dry mortar mix in moisture-resistant containers designed for use with dispensing silos. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, in a dry location, or in covered weatherproof dispensing silos.

B. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.6 PROJECT CONDITIONS

A. Stain Prevention: Immediately remove mortar and soil to prevent them from staining stone masonry face.
   1. Protect base of walls from rain-splashed mud and mortar splatter using coverings spread on the ground and over the wall surface.

B. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace stone masonry damaged by frost or freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

PART 2 - PRODUCTS

2.1 STONE

A. General
   1. Reuse salvaged boulders where possible.
   2. For supplemental stone, quarry stone, field stone or rock fragments that are hard, sound and durable; resistant to weathering action; reasonably fine grained; and free from seams, cracks,

and other structural defects that would impair the strength or durability of the stone. Do not use stones with defects that have been repaired with cement or other materials.

B. Stone Qualities: Match existing for overall size and shape.
   1. Shape: Straight edges without re-entrant angles. Flat faces that are not necessarily rectangular in shape.
      a. When set in the wall, provide stone face dimensions of 8 inches, minimum.
      b. Stretchers:
         1) Depth in wall at least 1.5 times the rise.
         2) Length in wall at least twice the rise.
      c. Headers: Length on face at least equal to the rise.
   2. Color: Match existing stone as closely as possible, and as acceptable to the Landscape Architect.

C. Source
   1. Existing: Reuse salvaged boulders where possible.
   2. Imported: Obtain from a quarry known to be of satisfactory quality.

2.2 MORTAR

A. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.
   1. Low-Alkali Cement: Not more than 0.60 percent total alkali when tested according to ASTM C 114.

B. Sand: Manufactured or natural sand; ASTM D 448, Size 10, with 100 percent passing a 3/8-inch (9.5-mm) sieve, 10 to 30 percent passing a No. 100 (0.15-mm) sieve, and 3 percent passing No. 200 (0.075-mm) sieve; complying with deleterious substance limits of ASTM C 33 for fine aggregates.

2.3 WATER

A. Water: ASTM C 94 and potable.

2.4 MORTAR MIXES

A. Mortar for Stone Masonry: Comply with ASTM C 270.
   1. Mortar for Setting Stone: Softer than stone.

PART 3 - EXECUTION

3.1 GENERAL

A. Build stone walls to the match line, thickness, and dimension of existing walls or as shown on the Drawings.

3.2 EXAMINATION

A. Examine surfaces indicated to receive stone masonry, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 PREPARATION

A. Clean dirty or stained stone surfaces by removing soil, stains, and foreign materials before setting. Clean stone by thoroughly scrubbing with fiber brushes and then drenching with clear water. Use only mild cleaning compounds that contain no caustic or harsh materials or abrasives.

3.4 SETTING OF STONE MASONRY, GENERAL

A. Sort stone before it is placed in wall to remove stone that does not comply with requirements relating to aesthetic effects, physical properties, or fabrication, or that is otherwise unsuitable for intended use.

B. Arrange stones in uncoursed rubble pattern with joint widths within tolerances indicated. Insert small stones into spaces between larger stones as needed to produce joints as uniform in width as practical.

3.5 DRY LAYING STONE

A. Perform dressing or shaping of stone before laying stone in wall. No dressing or hammering that will loosen stone will be permitted after placement.

B. Roughly square and dress stones at angles or at ends of walls to the required lines.

C. Lay stones in courses, roughly leveled up. Use large, selected stones for bottom or foundation courses with bearing beds parallel to the natural bed of the material.
   1. Mortaring: Clean and thoroughly saturate stone with water before setting in fresh mortar bed. Do not drop or slide stone over the wall. Provide full mortared joints and beds no more than 1-1/2 inches thick.

D. Face Joints: 1-1/2 inch width, maximum.

E. Ensure that stone bears at not less than three separate points on underlying courses.

F. Chink open joints with spalls, fitted to take firm bearing on top and bottom surfaces.

3.6 CHOKING STONE

A. Choke exposed face of walls with appropriately sized and placed stones to provide a tightly jointed masonry structure.

1. Hand fill voids, first by placing the largest stones that fit into a void, then by placing progressively smaller stones into the void and gap. Hand place stones no smaller than 3/4-inches in smallest dimension around the previously placed larger stones.

3.7 ADJUSTING AND CLEANING

A. Replace in a manner that results in stone masonry matching approved samples and mockups, complying with other requirements, and showing no evidence of replacement.

B. In-Progress Cleaning: Clean stone masonry as work progresses. Remove mortar fins and smears before tooling joints.

C. After mortar is thoroughly set and cured, clean stone masonry as follows:
   1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.

3.8 EXCESS MATERIALS AND WASTE

A. Excess Stone: Stack excess stone where directed by Owner for Owner's use.

B. Disposal as Fill Material: Upon approval by the Engineer, dispose of clean masonry waste, including mortar and excess or soil-contaminated sand, by crushing and mixing with fill material as fill is placed.
   1. Crush masonry waste to less than 4 inches (100 mm) in greatest dimension.
   2. Mix masonry waste with at least two parts of specified fill material for each part of masonry waste. Fill material is specified in Section 31 20 00 "Earthwork."
   3. Do not dispose of masonry waste as fill within 18 inches (450 mm) of finished grade.

C. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above, and other waste, and legally dispose of off Owner's property.

END OF SECTION

SECTION 05 12 00 - STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, MASSDOT Standard Specifications for Highways and Bridges, and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This section includes:
   1. Structural steel for building foundation wall bracing

B. Related Requirements
   1. None

C. Related Sections
   1. Section 03 30 00 - Cast-in-Place Concrete

1.3 DEFINITIONS

A. Structural Steel: Elements of the structural frame indicated on the Drawings and as described in AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."

1.4 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

1.5 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at project site.

1.6 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Laboratory Test Reports for Credit IEQ 4.2: For primers, documentation indicating that products comply with the testing and product requirements of the California Department of

Public Health's (formerly, the California Department of Health Services') "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

B. Shop Drawings: Show fabrication of structural-steel components.
   1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
   2. Include embedment drawings.
   3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.
   4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Retain "Welding Procedure Specifications (WPSs) and Procedure Qualification Records (PQRs)" Paragraph below for "High-Seismic Applications" as defined in AISC 360. AISC 341 requires that WPSs be submitted for review.

C. Welding Procedure Specifications (WPSs) and Procedure Qualification Records (PQRs): Provide according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for each welded joint qualified by testing, including the following:
   1. Power source (constant current or constant voltage).
   2. Electrode manufacturer and trade name, for demand critical welds.

1.7 SUBMITTALS

A. Qualification Data: For Installer, fabricator, professional engineer, and testing agency.

B. Welding certificates

C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

D. Mill test reports for structural steel, including chemical and physical properties.

E. Product Test Reports: For the following:
   1. Bolts, nuts, and washers including mechanical properties and chemical analysis.
   2. Direct-tension indicators.
   3. Tension-control, high-strength, bolt-nut-washer assemblies.
   4. Shear stud connectors.
   5. Shop primers.

F. Survey of existing conditions

G. Source quality-control reports

H. Field quality-control reports

1.8 QUALITY ASSURANCE

A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category STD.

B. Installer Qualifications: A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category ACSE.

C. Shop-Painting Applicators: Qualified according to AISC's Sophisticated Paint Endorsement P1 or to SSPC-QP 3, "Standard Procedure for Evaluating Qualifications of Shop Painting Applicators."

D. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
   1. Welders and welding operators performing work on bottom-flange, demand-critical welds shall pass the supplemental welder qualification testing, as required by AWS D1.8/D1.8M. FCAW-S and FCAW-G shall be considered separate processes for welding personnel qualification.

E. Comply with applicable provisions of the following specifications and documents:
   1. AISC 303.
   2. AISC 341 and AISC 341s1.
   3. AISC 360.
   4. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

1.9 DELIVERY, STORAGE, AND HANDLING

A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.
   1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

B. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.
   1. Fasteners may be repackaged provided Owner's testing and inspecting agency observes repackaging and seals containers.
   2. Clean and relubricate bolts and nuts that become dry or rusty before use.
   3. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F 1852 fasteners and for retesting fasteners after lubrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Connections: Provide details of simple shear connections required by the Contract Documents to be selected or completed by structural-steel fabricator, to withstand loads indicated and comply with other information and restrictions indicated.
   1. Select and complete connections using schematic details indicated and AISC 360.
   2. Use Load and Resistance Factor Design; data are given at factored-load level.

2.2 STRUCTURAL-STEEL MATERIALS

A. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of pre-consumer recycled content is not less than the following:
   1. W-Shapes: 60 percent.
   2. Channels, Angles: 60 percent.
   3. Plate and Bar: 25 percent.
   4. Cold-Formed Hollow Structural Sections: 25 percent.

B. W-Shapes: ASTM A 992/A 992M.

C. Channels, Angles ASTM A 36/A 36M.

D. Plate and Bar: ASTM A 36/A 36M.

E. Welding Electrodes: Comply with AWS requirements.

2.3 BOLTS, CONNECTORS, AND ANCHORS

A. High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade C, heavy-hex carbon-steel nuts; and ASTM F 436, Type 1, hardened carbon-steel washers; all with plain finish.
   1. Direct-Tension Indicators: ASTM F 959, Type 325, compressible-washer type with plain finish.

B. Shear Connectors: ASTM A 108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.

C. Headed Anchor Rods: ASTM F 1554, Grade 55, weldable, straight.
   1. Nuts: ASTM A 563 heavy-hex carbon steel.
   2. Plate Washers: ASTM A 36/A 36M carbon steel.
   3. Washers: ASTM F 436, Type 1, hardened carbon steel.
   4. Finish: Plain.

D. Threaded Rods: ASTM A 572/A 572M, Grade 50.
   1. Nuts: ASTM A 563 heavy-hex carbon steel.
   2. Washers: ASTM F 436, Type 1, hardened carbon steel.
   3. Finish: Plain.

E. Eye Bolts and Nuts: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1030.

F. Sleeve Nuts: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1018.

2.4 PRIMER

A. Low-Emitting Materials: Paints and coatings shall comply with the testing and product requirements of the California Department of Public Health's (formerly, the California Department of Health Services') "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

B. Primer: Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.

2.5 GROUT

A. Metallic, Shrinkage-Resistant Grout: ASTM C 1107/C 1107M, factory-packaged, metallic aggregate grout, mixed with water to consistency suitable for application and a 30-minute working time.

B. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107/C 1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.6 FABRICATION

A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC 303, "Code of Standard Practice for Steel Buildings and Bridges," and to AISC 360.
   1. Camber structural-steel members where indicated.
   2. Fabricate beams with rolling camber up.
   3. Identify high-strength structural steel according to ASTM A 6/A 6M and maintain markings until structural steel has been erected.
   4. Mark and match-mark materials for field assembly.
   5. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.

B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.
   1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1/D1.1M.

C. Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.

D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.

E. Cleaning: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 2, "Hand Tool Cleaning."

F. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.

G. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel members.
   1. Cut, drill, or punch holes perpendicular to steel surfaces.
   2. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
   3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.7 SHOP CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
   1. Joint Type: Snug tightened.

B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
   1. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in AISC 303 for mill material.

2.8 SHOP PRIMING

A. Shop prime steel surfaces except the following:
   1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
   2. Surfaces to be field welded.
   3. Surfaces of high-strength bolted, slip-critical connections.
   4. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
   5. Galvanized surfaces.
   6. Surfaces enclosed in interior construction.

B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:
   1. SSPC-SP 2, "Hand Tool Cleaning."

C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5

mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
2. Apply two coats of shop paint to surfaces that are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.

2.9 SOURCE QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform shop tests and inspections.
   1. Provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections.

B. Bolted Connections: Inspect shop-bolted connections according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

C. Welded Connections: Visually inspect shop-welded connections according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:
   1. Liquid Penetrant Inspection: ASTM E 165.
   2. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
   3. Ultrasonic Inspection: ASTM E 164.
   4. Radiographic Inspection: ASTM E 94.

D. In addition to visual inspection, test and inspect shop-welded shear connectors according to requirements in AWS D1.1/D1.1M for stud welding and as follows:
   1. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
   2. Conduct tests according to requirements in AWS D1.1/D1.1M on additional shear connectors if weld fracture occurs on shear connectors already tested.

E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify, with certified steel erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.
   1. Prepare a certified survey of existing conditions. Include bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated.
   1. Do not remove temporary shoring supporting composite deck construction until cast-in-place concrete has attained its design compressive strength.

3.3 ERECTION

A. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.

B. Baseplates Bearing Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.
   1. Set plates for structural members on wedges, shims, or setting nuts as required.
   2. Weld plate washers to top of baseplate.
   3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
   4. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure.

C. Maintain erection tolerances of structural steel within AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."

D. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that are in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
   1. Level and plumb individual members of structure.
   2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.

E. Splice members only where indicated.

F. Do not use thermal cutting during erection.

G. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

H. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.

3.4 FIELD CONNECTIONS

A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
   1. Joint Type: Snug tightened.

B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
   1. Comply with AISC 303 and AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.
   2. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.
   3. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in AISC 303, "Code of Standard Practice for Steel Buildings and Bridges," for mill material.

3.5 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:
   1. Verify structural-steel materials and inspect steel frame joint details.
   2. Verify weld materials and inspect welds.
   3. Verify connection materials and inspect high-strength bolted connections.

B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

C. Bolted Connections: Inspect bolted connections according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

D. Welded Connections: Visually inspect field welds according to AWS D1.1/D1.1M.
   1. In addition to visual inspection, test and inspect field welds according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:
      a. Liquid Penetrant Inspection: ASTM E 165.
      b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
      c. Ultrasonic Inspection: ASTM E 164.
      d. Radiographic Inspection: ASTM E 94.

E. In addition to visual inspection, test and inspect field-welded shear connectors according to requirements in AWS D1.1/D1.1M for stud welding and as follows:

1. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
2. Conduct tests according to requirements in AWS D1.1/D1.1M on additional shear connectors if weld fracture occurs on shear connectors already tested.

3.6 REPAIRS AND PROTECTION

A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing and repair galvanizing to comply with ASTM A 780/A 780M.

B. Touchup Painting: Immediately after erection, clean exposed areas where primer is damaged or missing and paint with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
   1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.

END OF SECTION

SECTION 10 14 00 - SIGNAGE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, MASSDOT Standard Specifications for Highways and Bridges and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This section includes the furnishing and installing signage and posts or other required supports with attaching hardware for the following:

1. Temporary warning signs
2. Permanent warning signs
3. Interpretive signs

B. Related Sections:

1. Section 31 23 19 – Control of Water
2. Section 32 39 00 – Manufactured Site Specialties

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop drawings for all signs, including:

1. Dimensions and materials of project signs, including details of copy (letters, colors, graphics), border, and mounting holes
2. Signpost and mounting details

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Provide new materials. Undamaged, previously used materials in serviceable condition may be used if approved by the Engineer. Provide materials suitable for use intended.

B. Unless otherwise specified, materials shall be:

1. Sign Panel and Finish: ¾-inch thick plywood, APA rated A-B grade – Exterior
2. Posts: Pressure-treated, 4-inch by 4-inch southern yellow pine
3. Fasteners: Galvanized 5/16-inch steel nuts, bolts and washers
4. Finish: Good grade of outdoor enamel paint. Two coats of white oil base undercoat primer on all sides, and one finish coat of white on sign face.

2.2 TEMPORARY WARNING SIGNAGE

A. Temporary warning signage shall read "WARNING - DOWNSTREAM CONSTRUCTION HAZARD." in clear type, color and 3-inch letter height with graphic pictogram similar to below.

1. Size: 4 feet by 3 feet.

2. Layout:

2.3 PERMANENT WARNING SIGNAGE

A. As indicated on the Drawings ("Danger Sign").

2.4 INTERPRETIVE SIGNAGE

A. As indicated on the Drawings.

PART 3 - EXECUTION

3.1 FABRICATION

A. Sign blanks shall be free of buckles, warps, dents, cockles, burrs and defects. Cut to size and shape and punch mounting holes prior to application of reflective sheeting.

3.2 INSTALLATION, GENERAL

A. Sign locations shall be staked or otherwise marked in the field for review and approval by the Engineer prior to installation.

B. Erect project signs and temporary warning signs at locations approved by the Engineer and Owner at least 14 days prior to the start of in-water work.

C. Engage an experienced sign painter to apply graphics for signs. Comply with specified details.

D. Unless otherwise specified, secure signs with four bolts per post.

E. Unless otherwise specified, paint sign panels and applied graphics with exterior-grade alkyd gloss enamel over exterior primer.

F. Install posts vertically to a minimum depth of 3 feet. Install such that top of sign is at or above eye level.

G. Do not allow unauthorized signage.

3.3 INSTALLATION, MAINTENANCE AND REMOVAL

A. Maintain all signs and barriers for the duration of the project to meet their intended purpose (warning and notification).

B. Remove and dispose of all signs, posts, anchors and other hardware for temporary signage upon completion of Work, unless otherwise directed by the Engineer.

END OF SECTION

SECTION 31 10 00 – SITE CLEARING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, MASSDOT Standard Specifications for Highways and Bridges, and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes, but is not limited to, the following:

1. Protecting existing trees and vegetation, utilities, and other items to remain within and outside limits of disturbance/contract limit lines.
2. Clearing and grubbing.
3. Selective clearing trimming of trees and vegetation.
4. Removing existing trees, stumps, brush, other vegetation and rubbish.
5. Stripping, screening, and stockpiling topsoil.
6. Invasive plant species control.
7. Off-site disposal of above item items.

B. Limits of Work: Minimize disturbance within clearing limits. Perform only as much clearing as required to complete the Work.

C. Related Sections:

1. Section 01 57 13 – Temporary Erosion and Sediment Control
2. Section 31 00 00 - Earthwork
3. Section 32 92 19 - Seeding
4. Section 32 93 00 – Plantings

1.3 DEFINITIONS

A. Existing Topsoil: Natural or cultivated surface-soil layer containing organic matter and sand, silt, and clay particles; friable, pervious, and black or a darker shade of brown than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 2 inches (50 mm) in diameter; and free of subsoil and weeds, roots, toxic materials, or other non-soil materials.

B. Tree Protection Zone (TPZ): Area surrounding individual trees or groups of trees to be protected during construction, and defined by the drip line of individual trees or the perimeter drip line of groups of trees, unless otherwise indicated.

C. Site Improvements: Miscellaneous structures and site elements including structures, walls, pavement, driveway surfaces, fences, railings, poles, and wires.

1.4 MATERIAL OWNERSHIP

A. Except for stripped topsoil or other materials indicated to remain within the project limits, all material removed from the site shall become the property of the Contractor, who shall bear all responsibility for its proper disposal in accordance with this Section.

1.5 SUBMITTALS

A. Photographs or videotape, sufficiently detailed, of existing conditions of trees and plantings, adjoining construction, and site improvements that might be misconstrued as damage caused by site clearing.

B. Written plan for storage and on-site placement/disposal of trunks, stumps and branches cleared from site in accordance with this specification.

C. Invasive Species Control Plan

1. The plan shall describe pre-construction conditions and strategies for minimizing the import or spread of invasive plan species.
2. The plan shall include, but may not be limited to:
    a. Description of treatment areas, including identification of targeted invasive plant species, locations, approximate size of areas, and digital photos with time/date stamp.
    b. Delineation of treatment areas with polygons outlining their perimeter or locations of individual plants. A free-hand sketch drawn on construction plans or on an aerial photograph may be used.
    c. Proposed methods of treatment for each species or area, such as manual removal, cutting, or herbicides. If herbicides are proposed, the plan shall include the product label, including application methods and rates of each. Material safety data sheets shall be provided for each herbicide.
    d. Proposed time of treatment based on target plan species and construction schedule.
    e. Method for disposing of invasive plant materials.
    f. General monitoring schedule.
    g. Preliminary re-treatment schedule. Re-treatment shall be based on assessment of initial results and time of year.
    h. Proposed performance metrics, or measures of treatment success, which shall be agreed upon with the Haverhill Conservation Commission.
3. Implementation of the plan shall begin immediately upon initiation of construction and shall continue for five (5) years.

1.6 QUALITY ASSURANCE

A. Preconstruction Meeting: Conduct meeting with Engineer and on-site supervisor and review the following:

1. Clearing limits.

2. Trees and other on-site improvements to be protected.
3. Location of tree protection zones.
4. Tree removal marking system and requirements.
5. Invasive species control.

1.7 PROJECT CONDITIONS

A. The following practices are prohibited within protection zones:

1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Foot traffic.
4. Erection of sheds or structures.
5. Impoundment of water.
6. Excavation or other digging unless otherwise indicated.
7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

B. Equipment Operations

1. Operate equipment with care to prevent injury to overhanging branches and limbs of trees to remain within limits of disturbance, and in areas adjacent to the secondary access drive and downstream raceway area (area for temporary inundation) where selective clearing is indicated on the Contract Drawings.

C. Traffic: Minimize interference with adjoining roads, streets, walks, driveways, and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. All work, including traffic control measures installed within Winter Street Right-of-Way, shall conform to City of Haverhill and/or MASSDOT Standard Specifications.
2. Maintain owners' and emergency vehicle access to respective properties adjacent to the river throughout the period of work during working and non-working hours.

D. Protect-In-Place Existing Site Improvements: Support and protect in place existing site features to remain or otherwise designated by the Engineer to be preserved in place or to remain. Items include but are not limited to utility structures, piping, poles, wires, walkways, fences, curbing, property line markers , and other structures to remain within the Project Limits and the Winter Street right-of-way.

1. Restore items promptly; do not leave until end of construction. Restore items damaged by the Contractor, at a minimum, to the condition in which the item was found immediately before beginning the Work. Restore items promptly; do not leave until end of construction.

E. Remove and Reset Existing Site Improvements: Remove and protect items to be reset upon completion of construction.

F. Utility Locator Service: Notify "Dig Safe" for area where Project is located before site clearing.

G. Do not commence site clearing operations until temporary erosion and sedimentation control measures are in place.

H. Restore items and finished surfaces that have been damaged by Contractor's operations to a condition at least equal to condition before work began.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. Satisfactory Soil Materials: Requirements for satisfactory soil materials are specified in Section 31 20 00 – Earthwork.

1. Obtain approved borrow soil materials off-site when satisfactory soil materials are not available on-site.

PART 3 - EXECUTION

3.1 GENERAL

A. Clearing, selective clearing, and tree trimming shall be limited to areas indicated on the Contract Drawings.

B. Remove existing above- and below-grade improvements as indicated and as necessary to facilitate new construction.

C. Erosion and Sedimentation Control: Examine the site to verify that temporary erosion- and sedimentation-control measures are in place. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

3.2 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Protect existing site improvements to remain from damage during construction.

1. Protect the mill building and other structures to remain along the boundary of the Little River as shown on the Contract Drawings.

C. Locate and clearly identify trees, shrubs, and other vegetation to remain. Flag each tree trunk at 54 inches (1372 mm) above the ground.

D. Locate and clearly identify invasive plant species treatment areas.

E. Selectively clear and carefully trim trees and vegetation in the locations indicated on the Contract Drawings.

3.3 TREE AND PLANT PROTECTION

A. Do not cut branches, limbs or roots except where approved by the Engineer or indicated on the Contract Drawings.

B. Repair or replace trees, shrubs, and other vegetation indicated to remain that are damaged by construction operations, in a manner approved by the Engineer.

3.4 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, grass, and other vegetation to permit installation of new construction.

1. Do not remove trees, shrubs, and other vegetation to remain.
2. Cut minor roots and branches of trees to remain in a clean and careful manner where such roots and branches obstruct installation of new construction in the locations indicated on the Contract Drawings
3. Completely remove stumps, roots, obstructions, and debris extending to a depth of 18 inches below the bottom of placed soil or proposed structures.
4. Use only hand methods for grubbing within drip line of remaining trees.
5. All trees and brush removed during the site clearing shall be stockpiled at a designated location immediately adjacent to the Contractor's staging area.
    a. Designated tree trunks and stumps shall be placed across the temporary bypass channel at intervals determined with the Engineer, stacked in arrangements to allow placement of compacted backfill soils without voids or areas of loose soil.
    b. Branches shall be placed as brush mats along the river channel or chipped and spread within the staging area or disposed off-site. Coordinate plans for management of branches with Engineer prior to cutting.
    c. Cleared materials containing invasive species plant materials shall be stockpiled according to the Contractor's Invasive Species Control Plan.

3.5 ROOT PRUNING

A. Prune roots that are affected by temporary and permanent construction. Prune roots as follows:

1. Cut roots manually by digging a trench and cutting exposed roots with sharp pruning instruments; do not break, tear, chop, or slant the cuts. Do not use a backhoe or other equipment that rips, tears, or pulls roots.
2. Cut Ends: Do not paint cut root ends.
3. Temporarily support and protect roots from damage until they are permanently redirected and covered with soil.
4. Cover exposed roots with burlap and water regularly.
5. Backfill as soon as possible according to requirements in Section 31 20 00 "Earthwork."

B. Root Pruning at Edge of Protection Zone: Prune roots 12 inches (300 mm) outside of the protection zone to facilitate construction of proposed structures, by cleanly cutting all roots to the depth of the required excavation as indicated on the Contract Drawings.

3.6 CROWN PRUNING

A. Prune branches that are affected by temporary and permanent construction. Prune branches as follows:

1. Prune trees to remain to compensate for root loss caused by damaging or cutting root system.
   a. Pruning Standards: Prune trees according to ANSI A300 (Part 1).
2. Cut branches with sharp pruning instruments; do not break or chop.
3. Do not apply pruning paint to wounds.

B. Chip removed branches and dispose of off site.

3.7 TOPSOIL STRIPPING

A. Strip topsoil to whatever depths are encountered in a manner to prevent intermingling with underlying subsoil or other waste materials.

B. Stockpile topsoil materials away from edge of excavations. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile separately unsuitable and suitable surplus topsoil to allow for re-spreading deeper topsoil.

3.8 DISPOSAL

A. Disposal: Remove, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off site.

1. Separate recyclable materials produced during site clearing from other non-recyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities.
2. Satisfactorily dispose of all cleared, invasive plant material (seeds, roots, woody vegetation, associated soils, etc.). The Contractor shall take measures to prevent viable, invasive plant materials from leading to further infestations while in transit or at final disposal locations.

END OF SECTION

SECTION 31 20 00 – EARTHWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, MASSDOT Standard Specifications for Highways and Bridges, and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes:

1. Excavation and salvage/reuse of satisfactory soils within the limits of work,
2. Excavation and off-site disposal of unsatisfactory soils, including contaminated soils as indicated on the Drawings,
3. Additional sediment sampling and characterization to refine the limits of required off-site disposal near sample location SED-19,
4. Excavation as required for the demolition of the Little River Dam and stone masonry wall,
5. Preparation of subgrades for structures, walks, pavements, and channel construction,
6. Excavation and backfill for structures,
7. Subbase course and backfill for walks and pavements,
8. Placement of rock and soil materials to achieve the lines and grades shown on the Drawings,
9. Off-site disposal of excavated soils and surplus suitable material not incorporated into the project.
10. Collection, removal, and disposal of trash and debris of every nature from within the limits of disturbance shown on the Drawings.

B. Related Sections

1. Section 01 35 13 – Special Conditions
2. Section 01 57 13 - Temporary Erosion and Sedimentation Control
3. Section 02 41 19 - Selective Demolition
4. Section 31 10 00 - Site Clearing
5. Section 31 23 19 - Control of Water
6. Section 31 32 00 - Bioengineering Soil Stabilization
7. Section 32 90 00 - Plantings

8. Section 32 92 19 - Seeding

1.3 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM):

1. ASTM 4318
2. ASTM D422
3. ASTM D1557
4. ASTM D4491
5. ASTM D4533
6. ASTM D4632
7. ASTM D4751
8. ASTM D6241

B. Environmental Protection Agency (EPA):

1. EPA Method 8010
2. EPA Method 8080
3. EPA Method 8260
4. EPA Method 8270

C. MassDEP "Reuse and Disposal of Contaminated Soils at Massachusetts Landfills, Policy COMM-97-01"

1.4 DEFINITIONS

A. A-axis: The longest axis of an individual rock.

B. B-axis: The intermediate axis of an individual rock that is neither the longest nor the shortest of the three mutually perpendicular sides of the rock.

C. Backfill: Earthen materials used to fill trench, structure, or pit excavations.

D. Borrow: Satisfactory soil imported from off-site for use as fill or backfill.

E. Excavation: Removal of material encountered above subgrade elevations.

1. Additional Excavation: Excavation below subgrade elevations as directed by Engineer. Additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.

2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated dimensions without direction by Engineer. Unauthorized excavation, as well as remedial work directed by Engineer, shall be without additional compensation.

F. Field Set: An element to be constructed with on-site observation from the Engineer to review the final layout, location, configuration, and/or alignment. The Contractor shall make field adjustments as guided by the Engineer and at no additional cost to the Owner. Final placements require acceptance by the Engineer.

G. Fill: Soil materials used to raise existing grades.

H. Structures: Footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

I. Subbase Course: Layer or layers placed between the subgrade and base course for hot mix asphalt paving, or layer placed between the subgrade and a concrete pavement or walk.

J. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.

K. Utilities include on-site underground or overhead pipes, conduits, ducts, and cables.

1.5 SUBMITTALS

A. Health and Safety Plan for handling of all sediment.

B. Disposal Plan with name and location of the upland licensed facilities accepting excavated material for disposal or reuse

C. Dredged Material Dewatering Plan, including but not limited to, the types of contaminants, method of dewatering, method of collecting the dewatered effluent, and method of disposal.

D. Excavation Support and Protection Plan comprising proposed system and design data, including certification by the qualified professional engineer responsible for their preparation.

E. Imported Soil Materials

1. Origin of material/ name of supplier
2. Classification in accordance with ASTM D2487
3. Laboratory compaction curve in accordance with ASTM D1557
4. Classification and laboratory compaction curve for on-site soil material, in accordance with the above requirements, when requested by the Engineer
5. Gradation in accordance with AASHTO T 311

6. Additional submittals for Compost

    a. List of vendors, including list of compost facilities and feedstock materials

    b. Certified results of regular periodic testing by an approved testing facility. Certification shall be per U.S. Composting Council Seal of Testing Assurance (STA) Program.

7. Additional submittals for Loam: One 25-lb representative sample per source and one additional 25-lb representative sample for each 1,000 cubic yard unit of soil

    a. Gradation in accordance with ASTM D422

    b. Organic content, pH, and salinity according to University of Massachusetts Agricultural Extension Service methods

8. Testing on additional samples may be requested by the Engineer to verify that the material meets the specifications. The Contractor shall be responsible for the costs of additional test(s) that fail to meet the specifications.

F. Salvaged Soil

1. Contractor shall mix a representative sample that achieves the definition of Salvaged Soil for review and acceptance by the Engineer prior to placement.

G. Aggregates

1. Name of supplier

2. Certification of test results indicating qualities that meet the specified material requirements for:

    a. Gradation in accordance with ASTM D422

    b. Abrasion in accordance with AASHTO T 96

H. Rock Materials

1. Rock source location, name of supplier, and supplier contact information

2. Photographs of representative samples

3. Certification of test results indicating qualities that meet the specified material requirements for:

    a. Gradation in accordance with ASTM D422

    b. Axis dimensions (Boulders)

    c. Specific gravity in accordance with ASTM C127 or ASHTO T 85

    d. Absorption in accordance with ASTM C127 or ASHTO T 85

    e. Abrasion in accordance with ASTM C535-03 or ASHTO T 96

    f. Resistance to breaking in accordance with ASTM C535-03

g. Freeze-thaw in accordance with ASTM D5312

4. Testing on additional samples may be requested by the Engineer to verify that the material meets the specifications. The Contractor shall be responsible for the costs of additional test(s) that fail to meet the specifications.

I. Soil to be Disposed Off-Site at the Haverhill Landfill

1. Below Cap: Daily cover and contouring soils to be placed under limits of new final cap at Haverhill Landfill:

a. For all such soils, the Engineer's Licensed Site Professional (LSP) licensed by the Commonwealth of Massachusetts shall submit a signed report that provides sufficient information and documentation to determine that the dredge materials and soils are adequately characterized and meet the COMM-97-001 Policy Unlined Landfill acceptance criteria. At a minimum, the required documentation is as follows:

1) Quantity of dredged materials and/or soils proposed to be accepted from the Project;

2) Description of the source and type of release and the associated contaminants;

3) Detailed description of current and historic Source Site uses;

4) Chemical characterization of the dredged materials and soils including any laboratory analytical data used to support the determination.

5) At a minimum, the Contractor shall provide analytical results of samples that represent those proposed for receipt at the Haverhill Landfill at a frequency of one sample for every 500 cubic yards of soils to be received. All samples presented that count towards the frequency sample shall be analyzed for the parameters required in the COMM-97-01 Policy with detection limits appropriate for comparison with the Unlined Landfill Acceptance Criteria.

6) Samples shall have been collected within one year of the date of the submittal for approval at the Haverhill Landfill.

7) Contaminants will not exceed the limits established in the COMM-97-001 Policy for Unlined Landfills. For contaminants or constituents for which acceptance criteria are not identified in MassDEP's COMM-97-001 Policy, the Engineer shall use RCS-2 notification criteria as established in the Massachusetts Contingency Plan (310 CMR 40.0000, MCP) as the maximum acceptable concentration;

8) All field screening data used to support the determination and the sampling program;

9) Any methods used to dewater or stabilize dredge sediments or wet soils;

10) Physical description of the COMM-97-001 soils and natural soils including the soil classification method used;

11) Draft copy of Material Shipping Record (MSR) or Bill of Lading (BOL) on the forms approved by MassDEP;

12) Statement from the Contractor as to whether any other releases or spills have occurred in the vicinity of the Source Site which may have affected the Source Site, including the types of oils and hazardous material spilled/released; and

13) Statement that the generator has used due diligence, as described in the MassDEP's Policy HW93-01 in characterizing the soil and as to whether or not the soil contains a listed hazardous waste and/or is itself a characteristic hazardous waste.

b. The Engineer for the closure of the Haverhill Landfill will review the submittal package from each Source Site and either request additional information from the LSP; reject the proposed soils; or approve them. Engineer for the Haverhill Landfill project has the sole discretion to reject or approve soils from a specific Source Site or to require additional testing or work.

2. Above Cap: Soils to be used above new final cap at Haverhill Landfill:

a. Prior to delivery to the Haverhill Landfill and as material is delivered, the Engineer shall provide the following tests to the Haverhill Landfill Engineer:

Geotechnical or Environmental Test Name	**Methodology**	**Frequency**
Sieve Analysis (to the #200 Sieve)	ASTM D422	1/500 cy delivered to Haverhill Landfill Site
Atterberg Limits	ASTM 4318	
Moisture Density	ASTM D1557	
MCP-14 Metals	EPA Method 8010	
Polychlorinated Biphenyls (PCBs)	EPA Method 8080	
Semi-Volatile Organic Compounds (SVOCs)	EPA Method 8270	
Volatile Organic Compounds (VOCs)	EPA Method 8260	
Extractable Petroleum Hydrocarbons (EPH) Ranges	MassDEP Method	
Volatile Petroleum Hydrocarbons (VPH) Ranges	MassDEP Method	

b. The results from the soil testing shall be furnished to the Haverhill Landfill Engineer at least seven calendar days prior to the delivery of such material to the Site. No soils shall be delivered to the Haverhill Landfill until an approval from the Haverhill Landfill Engineer is obtained.

J. Geotextiles

1. Product data

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: The Engineer shall use an independent testing agency qualified according to ASTM E329 to conduct soil materials and rock-definition testing, as documented according to ASTM D3740 and ASTM E548.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow materials when sufficient satisfactory materials are not available from excavations. Excavated materials not deemed satisfactory for reuse in the Work shall be deemed unsatisfactory and shall be legally disposed of off-site.

B. Satisfactory Soils and Borrow Materials: Free of debris, waste, chemical contaminants, frozen materials, stumps, vegetation, invasive plant species materials, clay and other deleterious matter; adequately graded and with a moisture condition suitable for satisfactory compaction.

1. Salvaged Fill: Satisfactory soils excavated from within the limits of grading.
2. Salvaged Soil: Satisfactory soils excavated from within the limits of grading and blended with compost. Salvaged Soil shall be free of stones greater than 2 inches in diameter, masses of roots, and individual roots more than 18 inches long and 1/2 inch in diameter. Salvaged soil shall be a well-blended mix of mineral (90%) and organic (10%) material, subject to acceptance by the Engineer.
3. Salvaged Streambed Material: Native mineral soil excavated from within the limits of grading and additionally free of masses of roots and individual roots more than 18 inches long and 1/2 inch in diameter.
4. Gravel Borrow: Gravel salvaged from on-site and approved for reuse by the engineer or imported borrow material conforming to the gradation requirements of Section M1.03.0 Type d of the Standard Specifications.
5. Gravel Borrow for Backfilling Structures and Pipes: Gravel salvaged from on-site and approved for reuse by the engineer or imported borrow material conforming to the gradation requirements of Section M1.03.0 Type b of the Standard Specifications.
6. Processed Gravel: Processed Gravel shall comply with the requirements for Processed Gravel for Subbase in Section M1.03.1 of the Standard Specifications.
7. Compacted Gravel Subbase: Subbase material of crusher run gravel shall comply with the requirements for Processed Gravel for Subbase in Section M1.03.1 of the Standard Specifications.
8. Compost: Imported organic soil additives used to meet the requirements of Salvaged Soil. Compost shall comply with the requirements for Compost Type 1 in Section M1.06.0 of the Standard Specifications.

9. Loam Borrow: Imported fertile, friable soil containing 10% organic matter and meeting the requirements for Loam for Roadsides in Section M1.05.0 of the Standard Specifications.

10. Topsoil: Salvaged topsoil or imported loam borrow.

C. Backfill and Fill: Satisfactory soils as indicated on the Drawings.

2.2 AGGREGATES AND RELATED MATERIALS

A. Crushed Stone: Imported crushed stone complying with Section M2.01.0 of the Standard Specifications.

B. Crushed Gravel: Dense graded crushed gravel for surfacing. Crushed gravel shall comply with the requirements for Dense Graded Crushed Stone for Sub-base in Section M2.01.7 of the Standard Specifications.

C. Granular Filter Material: Clean, well-graded granular material complying with the following gradation:

% Passing by Weight	Sieve Size (inches)
100	2 in.
85-100	3/4 in.
15-50	No.4

2.3 ROCK MATERIALS

A. General:

1. Rock shall be hard, durable, free of cracks and fractures, resistant to weather and be free from overburden, spoil, shale, limestone, structural defects, and organic material.

2. Rock shall be free of chemical and physical contamination or deleterious materials prior to being delivered to site.

3. Crushed rock, reclaimed materials, or slag materials shall not be used.

4. The least dimension of any particle shall not be less than one-third its greatest dimension.

5. Rock shall meet the following quality requirements:

   a. Apparent specific gravity: 2.6 (min)

   b. Absorption: 3% (max)

   c. Abrasion: 35% (max/500 revolutions)

   d. Freeze-thaw: 2% loss (max)

B. Riprap: Riprap shall be rock that is angular in shape meeting the specified gradation requirements. Rounded clasts or boulders will not be accepted.

1. Type A: Riprap conforming to the FHWA Class VI gradation requirements modified such that the largest intermediate dimension (b-axis) is 36 inches.
2. Type B: Riprap conforming to the FHWA Class III gradation requirements.
3. Type C: Riprap conforming to the FHWA Class I gradation requirements.
4. Type D: Riprap conforming to the FHWA Class IV gradation requirements.

C. Streambed Material:

1. General:
   a. Streambed Material may be Salvaged Streambed Material, imported, or a mixture of the two meeting the required gradation.
   b. Streambed Material shall consist of naturally occurring, rounded to sub-angular particles.
   c. Salvaged Streambed Material shall be stockpiled on site for review and acceptance by the Engineer prior to incorporation into the Work.
2. Type A: Streambed Material Type A shall be a coarse, well-graded mixture meeting the following gradation requirements:

% Passing	Minimum (inches)	Maximum (inches)
100	14	15
84	11	13
50	9	10
16	1.8	2.0
5	0.3	0.4

3. Type B: Streambed Material Type B shall be a coarse, well-graded mixture meeting the following gradation requirements:

% Passing	Minimum (inches)	Maximum (inches)
100	9	10
84	7	8
50	6	7
16	1.2	1.4
5	0.2	0.3

D. Boulders:

1. Weir Boulders: Imported rounded boulders with a nominal b-axis diameter of 2.5 feet. The minimum b-axis diameter shall be 2 feet, and the maximum b-axis diameter shall be 3 feet. The minimum weight of any weir boulder shall be 2,400 lbs.
2. Habitat Boulders: Imported 3- to 4-foot-diameter (b-axis) rounded boulders.
3. Salvaged Boulders: Boulders salvaged from the demolition of the dam and stone masonry wall.
    a. Salvaged Boulders shall be stockpiled on site for review and acceptance by the Engineer prior to incorporation into the Work.
4. Boulders for Retainage at Cashman Park: Imported 3- to 4-foot-diameter (b-axis), naturally rounded boulders.

2.4 CONTAMINATED SOILS

A. In situ and excavated material from within the contamination limits shown on the Drawings and described in the Combined 401 Water Quality Certification (401 WQC) shall be treated as contaminated and shall be managed according to the 401 WQC and approved Health and Safety Plan, Disposal Plan, and Dredged Material Dewatering Plan.

B. Engineer's LSP shall conduct additional sediment sampling in the SED-19 sample area shown on the drawings. Sampling shall comply with the requirements of the Combined 401 Water Quality Certification and MassDEP protocols. As described under Submittals, the Engineer's LSP shall submit sampling data, including a plan of the sample locations, sampling methods and depths, and laboratory QA/QC data to MassDEP. The results shall be used by the Engineer to refine the limits of the lead and PAHs-impacted sediment in that area.

C. Daily cover and contouring soils to be disposed under limits of new final cap at Haverhill Landfill:

1. Dredge materials and soils generated by the Project that are suitable to be used for contouring below the new final cap of the Haverhill Landfill shall meet the requirements for Unlined Landfills as outlined in MassDEP's "Reuse and Disposal of Contaminated Soils at Massachusetts Landfills, Policy COMM-97-01" and the Corrective Action Design (CAD) Permit for the closure of the Northern Mound issued by MassDEP. The CAD Permit Application is under review by MassDEP and incorporates the receipt of dredged materials that meet the COMM-97-01 Policy requirements for Unlined Landfills.
2. In addition, dredge materials and soils meeting the requirements for disposal under the final cap of the Haverhill Landfill shall also meet the following requirements:
    a. Be granular and composed predominantly of inorganic (mineral) materials to minimize settlement due to decomposition, gas generation, etc.;
    b. Be easy to stockpile, spread, compact to high density, and not readily decompose over time;
    c. Have a typical maximum nominal size of 12 inches;
    d. Have a gradation where 50 percent of the material is 6-inches (nominal) or less in size;

e. Have organic content shall be less than 35 percent (by weight) on a material specific basis;

f. Have less than one percent by volume of municipal solid waste;

g. Have less than five percent by volume of construction and demolition waste including asphalt, brick, and concrete (ABC) materials; and

h. Not contain any fines or residuals generated from the processing of construction and demolition waste.

2.5 ALL OTHER EXCAVATION

A. All other excavation materials shall be considered unclassified and may be highly saturated and muck soils.

B. Soft or saturated soils to be reused or transported off site shall be stockpiled on site for drying in accordance with the Dredged Materials Dewatering Plan. Drying time shall be minimized to the extent practicable.

C. Only dispose of satisfactory soils if they cannot be re-used on site.

D. Soils to be disposed above new final cap at Haverhill Landfill:

1. Soils and dredge materials meeting the criteria for disposal above the cap at the Haverhill Landfill Project shall be used between the drainage layer of the cap and the topsoil layer to flatten the fields.

2. The Acceptance criteria for the results of the testing for metals and PCBs shall be less than one-half of the current RCS-1 standards established in the Massachusetts Contingency Plan (MCP) Regulations (310 CMR 40.0000) promulgated by MassDEP. The results for PAHs shall be less than the current RCS-1 standards for each compound analyzed. Averaging of concentrations is not allowed.

3. Soils and dredge materials shall

a. consist of mineral soil substantially free from organic materials, loam, wood, trash, and other objectionable materials which may be compressible, or which cannot be properly compacted.

b. not contain concentrations of anthropogenic contamination above those outlined in the Submittals section.

c. have physical properties such that it can be readily spread and compacted during filling. Snow, ice, and frozen soil will not be permitted.

d. not contain granite blocks, broken concrete, masonry rubble, asphalt pavement, or any material larger than 2 inches in any dimension.

e. have a plasticity index of less than 15 and shall conform to the following gradation limits:

Sieve Size	Percent Finer By Weight
No. 40	75
No. 200	20

2.6 GEOTEXTILES

A. Filter Fabric: Woven geotextile with the following minimum properties determined in accordance with ASTM D4759 and referenced standard test methods:

1. Grab Tensile Strength: 365 x 220 lbs in accordance with ASTM D4632
2. Tear Strength: 115 x 75 lbs in accordance with ASTM D4533
3. CBR Puncture: 675 lbs in accordance with ASTM D6241
4. Water Flow Rate: 145 gpm per sq. ft. in accordance with ASTM D4491
5. Apparent Opening Size: No. 40 in accordance with ASTM D4751
6. Pre-approved: GEOTEX 111F by SI GeoSolutions

PART 3 - EXECUTION

3.1 GENERAL

A. Sediment management activities authorized by the project's Combined 401 Water Quality Certification shall be conducted under the supervision of the Engineer's Licensed Site Professional. Contractor must inform the Engineer a minimum of 10 days prior to these activities.

B. The Contractor shall gain acceptance of materials from the Engineer prior to transport and delivery to the site.

C. Where applicable, materials shall be installed in accordance with manufacturers' instructions.

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

B. Protect subgrades and foundation soils against freezing temperatures or frost. Provide protective insulating materials as necessary.

C. The subgrade surface for riprap installation shall be cut or filled, graded, and compacted to the lines and grades shown on the Drawings.

1. When fill to subgrade lines is required, it shall consist of salvaged soil or other approved material and shall be compacted to a density equal to that of the adjacent native ground.

2. Remove brush, trees, stumps, debris, large stones, or other deleterious materials.

3. Prepared subgrade shall be finished reasonably smooth and free of mounds, dips, or windrows prior to placement of filter fabric.

3.3 DEWATERING

A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding or damaging Project site and surrounding area.

B. Protect excavations, backfills, fills and subgrades from softening, undermining, washout, and damage by rain or water accumulation.

1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches. Provide positive drainage of backfill and fill.

2. Install a dewatering system to keep subgrades dry and convey ground water away from excavations. Maintain dewatering until structures, pipes and appurtenances will not be damaged by surface or ground water. Maintain until dewatering is no longer required.

C. Obtain discharge permit for water discharging into storm drainage system or waterway. Remove particulate matter from pumped or drained water which discharges or flows into storm drainage system or waterway.

3.4 EXCAVATION, GENERAL

A. Unclassified Excavation: Excavation to subgrade elevations regardless of the character of surface and subsurface conditions encountered, including rock, soil materials, and obstructions.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials or rock, replace with satisfactory soil materials.

3.5 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. Extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.

2. Excavations for Walks and Pavements: Excavate surfaces to indicated cross sections, elevations, and grades.

3.6 APPROVAL OF SUBGRADE

A. Notify Engineer when excavations have reached required subgrade. The Contractor shall permit inspection of subgrade by the Engineer prior to placing fill.

B. If Engineer determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.

1. Additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.

C. Proof roll subgrade with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof roll wet or saturated subgrades.

D. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Engineer.

3.7 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill may be used when approved by Engineer.

1. Fill unauthorized excavations under other construction or utility pipe as directed by Engineer.

3.8 STORAGE OF SOIL MATERIALS

A. Stockpile soil materials in accordance with all local, state, and federal regulations.

B. Stockpile borrow materials and satisfactory excavated soil materials. Stockpile soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Prevent windblown dust. Provide erosion control measures.

1. Stockpile soil materials away from edges of excavations. Do not store within critical root zones of trees.

C. Contractor for Little River Dam Removal and River Restoration shall coordinate with the Contractor for the closure of the Haverhill Landfill to place the dredge materials approved to be received at the Haverhill Landfill in a location within the historically landfilled limits of the Northern Mound at a location where they can be placed into the ongoing operations. The Haverhill Landfill construction is scheduled to be awarded by June 30, 2025.

1. If the dredge materials and soils meeting the requirements for disposal at the Haverhill Landfill are generated by the Project prior to the Haverhill Landfill Contractor mobilizing, the Contractor shall install erosion controls around the perimeter and place the dredge materials and soils into a stockpile at the Haverhill Landfill site. At the end of the placement

of the dredge materials and soils, the Contractor shall hydroseed the stockpile and establish vegetation acceptable to the Engineer for closure of the Haverhill Landfill.

2. Dredge materials and soils meeting the requirements for disposal below the cap of the Haverhill Landfill shall be delivered to the Haverhill Landfill on Old Groveland Road and placed at the location designated within the limits of areas to receive a new final cap, as directed by the Contractor for the closure of the Haverhill Landfill.

3. Dredge materials and soils meeting the requirements for disposal above the cap of the Haverhill Landfill shall be delivered to the designated area on Lot 26 in Haverhill off Yemma Road in Groveland and placed into a stockpile. The Contractor shall install erosion controls around the stockpile, place the soils and dredge materials and hydroseed the placed materials and establish vegetation acceptable to the Engineer for closure of the Haverhill Landfill.

3.9 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:

1. Construction below finish grade.
2. Removing concrete formwork.
3. Removing trash and debris.
4. Removing temporary shoring and bracing, and sheeting.

3.10 FILL, GENERAL

A. Remove vegetation, loam, debris, unsatisfactory soils, obstructions, and deleterious materials from ground surface before placing fill.

B. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 3 horizontal so fill material will bond with native substrate.

C. Place and compact fill material horizontally in lifts to required elevations.

D. Boulder placement is a field set item.

3.11 RIPRAP PLACEMENT

A. General:

1. Install filter fabric according to manufacturer's instructions and the following:
    a. Place filter fabric on smooth, prepared subgrade.
    b. Overlap edges by a minimum of 12 inches or as specified by the manufacturer, with anchor pins spaced every 3 feet along overlap.
2. Place riprap immediately after installing filter fabric.

3. Protect filter fabric from puncture or tearing during riprap placement. If necessary, place a layer of sand over fabric for protection.

4. Install riprap to full thickness in one operation.

5. Place riprap. Do not dump or use other methods that cause segregation of stone sizes.

6. If filter fabric is damaged during riprap placement, repair damaged areas by placing a piece of fabric over damaged area or by completing replacing the fabric. Overlaps for repairs or joining of two pieces of fabric shall be a minimum of 12 inches and pinned.

7. Place smaller particles in voids to form a dense, uniform, well-graded mass. Selective loading at the quarry and some hand placement may be necessary to obtain an even distribution of particle sizes.

8. Sequence construction such that riprap installation is completed with the minimum possible delay. Disturbance of areas where riprap is to be placed shall be undertaken only when final preparation and placement of the riprap can immediately follow.

B. Soil-filled Riprap:

1. Omit filter fabric and substitute with 6-inch thickness of Granular Filter Material.

2. Place full thickness of riprap in one operation.

3. Backfill voids with Salvaged Soil and overfill 6 inches.

3.12 STREAMBED MATERIAL PLACEMENT

A. Place streambed material such that the constructed surface forms a dense, uniform, well-graded surface without segregation of particle sizes.

B. Place streambed material horizontally in lifts not exceeding 8 inches in thickness. Compact each lift by tamping with excavator bucket or vibratory place compactor. Wash fines into voids but water jetting each lift after compaction and prior to placing subsequent lifts.

3.13 MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill lift before compaction to within 2 percent of optimum moisture content.

1. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.

2. Remove and replace, or scarify and air-dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.14 COMPACTION OF BACKFILLS AND FILLS

A. Place backfill and fill materials in lifts not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Compact backfill and fill materials to not less than the following percentages of maximum dry unit weight according to ASTM D1557:

1. Under structures, steps, and pavements, and in earth embankments and dams, scarify and recompact top 12 inches of existing subgrade and each lift of backfill or fill material at 95 percent.
2. Under concrete structures, scarify and recompact top 12 inches of existing subgrade and each lift of backfill or fill material at 95 percent within 3 percent wet of optimum.
3. Under walkways, scarify and recompact top 6 inches below subgrade and compact each lift of backfill or fill material at 95 percent.
4. Under lawn or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each lift of backfill or fill material at 90 percent.

D. Compact backfill and fill materials to the following percentages of maximum dry unit weight according to ASTM D698:

1. Floodplain bench and valley slopes at 85 percent.
2. Streambed material at 90 percent.

3.15 GRADING

A. General: Uniformly grade areas to a smooth surface, free from irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

1. Provide a smooth transition between adjacent existing grades and new grades.
2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Site Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:

1. Lawn or Unpaved Areas: Plus or minus 1 inch, however, not consistently in one direction.
2. Dam Crests: Plus or minus 1/2 inch
3. Top of Weir Elevation and Notch Invert Elevation: Plus 2 inches (no minus)
4. Channel Grading: Plus or minus 2 inches

5. Paths: Plus or minus 1 inch

6. Pavements: Plus or minus 1/2 inch

C. Grading inside Structure Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

3.16 BOULDER PLACEMENT

A. Boulders shall be placed in a workmanlike fashion in accordance with the Drawings as directed by the Engineer.

3.17 FIELD QUALITY CONTROL

A. Grade Control: Establish and maintain required lines and elevations. Review lines and grades with the Engineer prior to starting work and as work progresses.

B. Testing Agency: The Contractor shall engage a qualified independent testing agency to perform field quality-control testing.

C. The Contractor shall perform Standard Proctor testing on each representative material type to be used as structural fill.

D. Testing agency shall test compaction of soils in place according to ASTM D1556, ASTM D2167, ASTM D2922, and ASTM D2937, as applicable. Tests shall be performed at the following locations and frequencies:

1. Under concrete structures: At each compacted backfill layer, at least one test for each 50 linear feet of structure length, but no fewer than two tests.

2. Under other structures, steps, and pavements, and in earth embankments and dams: At each compacted backfill layer, at least one test for every 100 cubic yards of backfill material.

3. Under walkways: At each compacted backfill layer, at least one test for every 100 cubic yards of backfill material.

E. Testing results shall be provided to the Engineer at least weekly or as directed by the Engineer during filling or compaction operations stated in 3.14.

F. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; recompact and retest until specified compaction is obtained.

1. Subsequent earth moving operations may proceed only after test results for previously completed work comply with requirements.

3.18 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

1. Scarify or remove and replace soil material to depth as directed by Engineer; reshape and recompact.

C. Where settling occurs before project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to the greatest extent possible.

3.19 EXCAVATED MATERIAL RE-USE AND DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Surplus materials and waste materials, including unsatisfactory soil and trash and debris encountered during earthwork operations, shall be disposed of off site in accordance with all applicable regulations and the requirements of these Contract Documents.

B. The Contractor shall collect and remove trash and debris of every nature from within the limits of disturbance shown on the Drawings. All materials removed shall be legally disposed of off site.

C. The anticipated order of testing and priority of disposal locations for excavated materials is as follows:

1. For areas of excavation outside of known sediment contamination

a. Re-use satisfactory soils on site. Engineer's LSP to perform required testing to determine disposal location of any excess material in the order of priority listed below. Contractor to dispose of material at facility as directed by the Engineer's LSP:

1) Haverhill Landfill above the cap

2) Haverhill Landfill below the cap

b. See pre-characterization lab data provided in Sediment Sampling Report Attachment.

2. For areas of known sediment contamination, as indicated in the Drawings

a. Within Sed-19, Sed-4, and Transect 7 areas

1) Engineer's LSP to conduct additional testing to refine the limits of the Sed-19 area.

2) Engineer's LSP to perform required testing to confirm material is suitable for disposal at Haverhill Landfill below the cap. Contractor to dispose of material at facility as directed by the Engineer's LSP.

b. Within Transect 2 area

1) Engineer's LSP to perform required testing to confirm material is suitable for disposal at receiving facility approved to receive contaminants in provided Sediment Sampling Report Attachment. Contractor to dispose of material at facility as directed by the Engineer's LSP.

D. Engineer's LSP must perform testing before excavated materials are transported from the site.

END OF SECTION

SECTION 31 23 19 – CONTROL OF WATER

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, MASSDOT Standard Specifications for Highways and Bridges and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This section includes the following:

1. Temporary water control measures including cofferdams and water bypass conveyances (Water Control System) for normal water control and flood water control including design and sequencing, construction, installation, maintenance, and removal of temporary protective facilities and appurtenances required to convey surface water beyond or around project work areas and to dewater/divert groundwater seepage into work areas. Temporary measures and appurtenances may include but are not limited to:
    a. Surface and subsurface dams (including cofferdams);
    b. Flow diversions;
    c. Special linings for erosion protection;
    d. Pipes;
    e. Sumps;
    f. Pumps;
    g. Barriers;
    h. Sedimentation basins;
    i. Energy dissipation pools/pads;
    j. Prefabricated sediment containment devices; and
    k. Watertight seals.
2. Safe conveyance of water and flood flows.
3. Maintenance of minimum stream flow in upstream and downstream reaches.
4. Protection of existing structures and features, constructed improvements, work in progress, and downstream areas during precipitation events and high water.

B. Related Sections

1. Section 01 35 13 – Special Conditions
2. Section 01 57 13 – Temporary Erosion and Sedimentation Control
3. Section 02 41 19 – Selective Demolition
4. Section 31 20 00 – Earthwork

1.3 DEFINITIONS

A. Conveyance Structures: Temporary systems for conveying or by-passing water flows from cofferdammed areas to the downstream river channel without overtopping the temporary upstream and downstream cofferdam system(s), adjacent MBTA and Winter Street bridges, or other developed properties during normal river flows.

B. Cofferdammed Area: Work area(s) within the river channel that are protected from river flows following construction of temporary cofferdam(s).

1.4 SUBMITTALS

A. Water Control and Diversion Plan

1. Plan shall describe methods to be employed to allow work to be performed "in the dry" and to manage both the water level in Little River and outflow from Little River while construction is in progress.
2. Plan shall include at a minimum:
    a. Materials and product data
    b. Schedule of operations and phasing approach
    c. Methods for controlling water

B. Flood Response Plan

1. Plan shall describe how weather forecasts, stream flows, and water levels will be monitored to allow adequate time to respond to rising water levels at the construction site. If high water levels are expected, equipment and materials shall be removed from the work area and personnel evacuated. Sufficient materials and equipment required for flood response shall be maintained in a safe location at, or near, the construction site.
2. List of emergency contact personnel and 24-hour contact number(s).

C. Cofferdam Designs

1. Cofferdams shall be designed to resist anticipated forces without failing and to ensure that seepage around, under, or through the cofferdams is manageable.

D. Product Data: Cutsheets, product literature, specifications sheets or other detailed information indicating product sizing, performance characteristics, loading capacities, anchoring requirements, care and maintenance requirements, and other information relative to materials of construction and methods of operation for all products and materials incorporated into the Water Control System.

E. Submittals For Information

1. Shop Drawings: Plans, sections, and details of Water Control System and accessory items, locations of discharge lines, and means of discharge and disposal of water. Drawings shall be signed and sealed by the qualified professional engineer responsible for their preparation and who is registered in the state of Massachusetts.
2. Hydraulic Computations: Supporting hydraulic computations for Water Control System design, signed and sealed by the qualified professional engineer responsible for their preparation and who is registered in the state of Massachusetts.

3. Photographs or videotape, sufficiently detailed, of existing conditions of adjoining construction and site improvements that might be misconstrued as damage caused by water control operations.

1.5 PERFORMANCE REQUIREMENTS

A. General

1. Design, furnish, install, monitor, and maintain a Water Control System capable of supporting and resisting potential hydrostatic and hydrodynamic pressures, flood flows and groundwater seepage rates. The table below provides a summary of the range of water surface elevation, velocity, and discharge conditions that may be experienced in the Little River within the project area.

Event	Water Surface Elevation (Feet)	Maximum Velocity (Feet/Second)	Peak Discharge (Cubic Feet/Second)
95% Exceedance Probability	10.6	0.3	13
50% Exceedance Probability	11.1	0.8	56
Bankfull (2-Year Flood)	13.2	2.7	378
10-Year Flood	16.6	4.2	1,160
50-Year Flood	20.2	4.5	1,920
100-Year Flood	22.8	4.3	2,330

a. Furnish, install, test, operate, monitor, and maintain Water Control System of sufficient scope, size, and capacity to adequately divert water around active project work areas.

b. Continuously monitor and maintain Water Control System material, equipment and operations to minimize suspension of sediment or other soil materials in the river, minimize erosion of channel beds and riverbanks, and protect adjacent structures, features, and properties to remain undisturbed.

c. Remove Water Control System in a controlled fashion when no longer required for construction.

d. Construct, operate and maintain Water Control System to protect the Work and without damaging existing structures to remain or adjacent properties.

2. Prevent induction danger to persons and other living resources and damage or blockage by debris including trees, branches and other debris.

a. Debris entrained by the cofferdam or conveyances shall be removed and disposed off-site promptly.

3. Evaluate need for larger minimum capacity due to project factors including construction duration and risk of damage to constructed features as work progresses.

4. Include controls to protect living resources adjacent to the site and in the downstream watercourse.

B. Flood Water Control Measures

1. Contractor shall have materials and measures readily available for rapid implementation upon the threat or occurrence of flood water flow in excess of normal water control flows, and shall furnish and deploy such materials and measures where required by increased flood flows. Protect erodible areas from erosion and protect components of the existing structures to remain from damage.

C. Location and Materials on Contract Drawings: The locations and materials for Water Control System cofferdam and water bypass provisions shown on the permit-level design drawings are for reference only.

1. The Contractor shall determine its manner of constructing, maintaining and removing its cofferdams and conveyances meeting performance requirements contained herein.

2. Layout cofferdam(s) to provide adequate clearances in all directions as required for execution of work to be performed within the river channel, including room for pumps and suction/discharge lines, bypass pipes, open channels and siphons, and construction operations.

3. All materials used in the cofferdam system must be clean and free of contaminants, debris and trash or other materials that may pollute the river.

a. No material may be used in the cofferdam or by-pass systems that may be harmful to plant growth or aquatic life.

b. All materials shall be stable when subjected to expected river flows such that they will not migrate within the river channel and not be removable in its entirety following construction of downstream river channel modifications.

c. If a liner is used it shall be a continuous, flexible, liner membrane that provides a complete barrier to river flows when positioned. Liners shall extend adequately into the upstream and transverse river channel sections and be anchored in place to provide a complete, firm seal during the work when exposed to hydrostatic/ hydrodynamic pressures of the overlying standing/flowing water column.

4. Alternative water control methods will be considered, providing proposed methods conform to applicable local, state and federal codes; will not require an extension of contract time; and will not result in increase of construction costs.

a. The Engineer is not obligated to accept alternative methods and may impose additional requirements as condition of acceptance.

D. Contractor may allow limited water flows in the areas of work, provided the magnitude of flows and character of channel bottom does endanger site workers, equipment or materials and does not pollute or otherwise cause an excessive increase in turbidity in the downstream watercourse as compared to concurrent turbidity levels in the upstream watercourse.

a. Contractor shall only allow equipment into the river that is in good condition and does not have oil, grease, fuel or other materials on its surface that may damage or pollute the river.

1) All equipment shall be equipment with spill control materials (e.g., booms, dry absorbent) that can be deployed immediately in the event of a release of such materials.

2) All equipment shall be inspected each day prior to entering the river channel for surface materials; if observed such materials shall be completely cleaned and removed from the equipment prior to entering the river channel.

3) The Engineer may, at their sole discretion, direct the Contractor to remove equipment from the river channel that is leaking fluids or is otherwise polluting the water or channel bottom material. The Contractor shall address such conditions causing pollution to the satisfaction of the Engineer prior to resuming work within the river channel.

b. The Contractor shall monitor turbidity in the downstream watercourse throughout the project duration to evaluate turbidity levels and whether such levels are excessive.

c. If the Engineer determines that Contractor's activities are resulting in an excessive increase of turbidity, the Contractor shall suspend work causing such conditions and adjust operations, equipment, materials, activities or locations as required to reduce turbidity levels to acceptable levels.

d. The Engineer shall be solely responsible for evaluating and determining what constitutes an excessive increase of turbidity levels in the watercourse. Such means may include use of real-time turbidity monitoring equipment to evaluate upstream and downstream levels.

PART 2 - PRODUCTS

A. General: Provide materials that are either new or in serviceable condition and manufactured for the intended use in control of water at the site.

B. Sand: Clean, inorganic, well-graded, granular material with 100 percent passing a 1-inch (2.54 cm) sieve.

C. Sandbags: As indicated on the Drawings.

D. Other materials, structures, and equipment shall be as indicated in the Contractor plans and designs submitted to and accepted by the Engineer.

PART 3 - EXECUTION

3.1 GENERAL

A. The Contractor shall take actions necessary to assure the safety and protection of the construction area and downstream areas during any periods of significant rainfall. This shall include bringing manpower, equipment and materials to the site necessary to resist damage or failure as a result of a significant rainfall. The Contractor may need to man the job site 24 hours a day during such events to assure timely response to problems that may develop.

B. Do not begin work in cofferdammed areas until Water Control System materials and equipment are in place and operating as intended such that water levels in active work areas have been lowered to achieve water depths that do not cause excessive sedimentation or otherwise endanger site workers, equipment, constructed features, or adjacent properties, structures and features.

3.2 PREPARATION

A. Investigate and verify existing conditions at the site.

3.3 PROTECTION

A. Because water level is dependent on the flow in the contributing watershed, water level can be expected to vary. The potential for major flood events is always a possibility. Ensure safety of the site and downstream areas.

1. Monitor dewatering systems continuously and provide additional measures as needed to control resulting increases in water surface elevations and water flows without damage or risk of failure to the Water Control System.

B. During predicted periods of significant rainfall, provide 24-hour, on-site coverage to ensure timely response. Maintain personnel and equipment on site to mitigate potential damage during flood events if overtopping of the Water Control System is anticipated to occur.

C. Have materials and measures readily available for rapid implementation upon the threat or occurrence of flood water flow in excess of normal flow conditions or if overtopping of the Water Control System is anticipated. Protect erodible portions of the site from erosion. Protect existing features and completed work from damage.

3.4 MAINTENANCE

A. Monitor water control system daily. Promptly correct seepage, breakage, or other evidence of movement to ensure that temporary cofferdam(s) and water bypass conveyances remain stable and functioning as intended.

B. Maintain siphons or pumps as necessary to maintain dewatered conditions within cofferdammed areas sufficient for completion of work and placement proposed materials under safe, controlled conditions.

C. Maintain personnel and equipment on site during periods of heavy rainfall, flood watches, flashflood watches and flood warnings to mitigate potential damage during flood events.

D. Provide additional materials, equipment and manpower, as required, to resist damage to or failure of temporary water conveyance measures and existing and proposed features including the constructed channel and adjacent walls and structures.

E. Protect adjacent structures from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by cofferdamming and water bypass operations.

F. Promptly repair damages to adjacent areas or structures caused by Water Control System activities.

3.5 FISH PASSAGE TEST FLOW DIVERSIONS

A. Contractor shall temporarily divert test flows through river channel sections containing nature-like fishway boulder weirs and grade control boulder weirs to allow observation and measurement of flows by the Engineer for the purposes of verifying hydraulic performance and adequate and suitable flow conditions for target aquatic species.

1. Contractor shall coordinate such operations with the Engineer, including scheduling and notification at least fourteen (14) days prior to diversion of test flows.

2. Contractor shall conduct a total of up to two (2) test flow diversions as requested by the Engineer for verification of flows and velocities within each channel section at or as near, as can be practicably generated, minimum, normal, and maximum design operating conditions for the fishway structure.

    a. The purpose of the first diversion test within each phase of construction will be to confirm that interstitial spaces within the weir boulders and streambed material were adequately packed/chinked with fill material to minimize seepage. The purpose of the second diversion test, if determined necessary due to excessive seepage, will be to confirm that corrective modifications executed by the Contractor reduce seepage to a level considered acceptable by the Engineer. Flow through each channel section shall be achieved by removing a portion of the upstream cofferdam to allow flow to pass through the work area.

3. Test flows shall occur during normal working weekday hours, extending over a minimum 12-hour period, to allow observation and measurements of flows by the Engineer. If upstream river flows cannot sustain such test flows at the time of testing, the Contractor shall schedule such test flows on a date acceptable to the Engineer when such flows are anticipated.

4. Contractor shall provide the Engineer information on conveyance flow, elevations, and headwater/tailwater conditions as necessary for calculation of actual flow rate(s) during the test diversions.

5. Contractor shall provide water control and make adjustments to constructed channel features (e.g., modifications to placement of weir boulders, placement of additional streambed material) as directed by the Engineer to achieve acceptable flow conditions. Adjustments determined necessary by the Engineer to provide acceptable hydraulic performance and adequate and suitable flow conditions for target aquatic species shall be made by the Contractor at no additional cost to the Owner.

6. Contractor shall restore the Water Control System following completion of test flows.

3.6 REMOVAL AND REPAIRS

A. Upon completion of all work, completely remove temporary cofferdam(s) and water bypass conveyances in a controlled manner to restore river flows through completed portion(s) of the rock ramp fishway in a controlled manner to prevent damage to constructed features (e.g., scour, shifting/movement of placed rock, dry hydrants, etc.) and existing features to remain.

B. Remove water control systems when permanent construction has progressed sufficiently to accommodate hydrostatic pressures and stabilization measures proposed within the river and along its banks are complete.

    1. Repair or replace adjacent work or existing features damaged or displaced by construction operations at no additional cost.

3.7 ALTERNATIVE METHODS

A. The Contractor may propose alternative methods for control of water, for consideration by the Engineer. The proposed alternative method(s):

1. Shall conform to all applicable local, State and Federal codes and regulations and permits.
2. Shall not require an extension of the Contract time.
3. Shall not result in an increase in Contract costs.
4. Shall not cause excessive turbidity in downstream watercourse.
5. Shall safely convey flood flows around work areas.
6. Shall not damage or otherwise cause damage to the adjacent properties, structures or features, including trees and other natural resources.

B. The Engineer is not obligated to accept alternative methods and may impose additional requirements as a condition of acceptance of any alternative method proposed by the Contractor.

3.8 EMERGENCY NOTIFICATION

A. In the event that significant flood flows endanger the site, adjacent properties, structures or downstream areas, the Contractor shall immediately notify the Engineer and the Haverhill Police Department.

END OF SECTION

SECTION 31 32 00 – BIOENGINEERING SOIL STABILIZATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, MASSDOT Standard Specifications for Highways and Bridges, and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes:

1. Fabric Encapsulated Soil (FES) Lifts
2. Surface Fabric Treatment

B. Related Sections

1. Section 31 20 00 – Earthwork
2. Section 31 38 00 – Large Wood
3. Section 32 90 00 - Plantings
4. Section 32 92 19 - Seeding

1.3 SUBMITTALS

1. Manufacturer's certification that the material meets the specified requirements for:
    a. Non-woven coir fabric
    b. Woven coir fabric
    c. Wood staples
    d. Wood stakes

PART 2 - PRODUCTS

2.1 WOVEN AND NON-WOVEN COIR FABRIC

A. The inner (non-woven) layer of coir fabric used in Fabric Encapsulated Soil Lifts and Surface Fabric Treatment shall be North American Green (NAG) style C125BN 100% biodegradable coconut fiber mat or an equal accepted by the Engineer. Fabric shall be delivered in roll widths as specified below and shall meet the following criteria:

Parameter	Procedure/Test	Criterion
Thickness	ASTM D6525	0.23 in
Mass/Unit Area	ASTM D6475	9.79 oz/sq yd
Tensile Strength (Machine Direction)	ASTM D6818	206.4 lbs/ft
Elongation (Machine Direction)	ASTM D6818	15.3%
Tensile Strength (Transverse Direction)	ASTM D6818	145.2 lbs/ft
Elongation (Transverse Direction)	ASTM D6818	12.9%
Roll Width	Measured	6 ft 8 in
Roll Length	Measured	108 ft

B. The outer (woven) layer used in Fabric Encapsulated Soil Lifts and Surface Fabric Treatment shall consist of 100% biodegradable, woven coconut fiber mat. Fabric shall be high strength 700 weight, continuously woven (i.e., without seams), and with the following average roll properties:

Parameter	Procedure/Test	Criterion
Thickness	ASTM D5199	0.35 in
Dry Tensile Strength (Machine Direction)	ASTM D4595	1,512 lbs/ft
Dry Tensile Strength (Cross Direction)	ASTM D4595	1,032 lbs/ft
Mass per unit area	ASTM D5261	20.6 oz/sq yd (min)
Open Area	Measured	50% (max)
Roll Width	Measured	13.1 feet
Roll Length	Measured	165 feet

C. Each roll of coir fabric shall be packaged individually in a suitable sheet, wrapper, or container to protect the fabric from damage during normal storage and handling.

D. Each roll of coir fabric shall be identified with a tag or label securely affixed to the outside of the roll on one end. The label shall include the manufacturer or supplier, the style number, and the roll and lot numbers.

E. Coir fabrics damaged during transport, storage, or placement shall be replaced at no expense to the Owner.

2.2 WOOD STAKES

A. Wood Stakes shall be used to anchor all coir fabrics. Wood Stakes shall be 100% biodegradable wooden stakes that are solid and free of knots or defects. Wood Stakes shall be 18 inches in length. Wood stakes shall be wedge shaped with a minimum equivalent diameter equal to 1.5 inches at the top and should come to a point at the bottom. They shall be manufactured by cutting a standard grade nominal 2-inch x 4-inch lumber lengthwise along the diagonal to create wedge-shaped stakes, or by some other method resulting in a stake of dimensions accepted by the Engineer.

2.3 WOOD STAPLES

A. Wood Staples shall be used in a supplemental manner after fabrics have been secured with Wood Stakes as required to eliminate slack in fabric installation and ensure the fabrics are securely held in contact with the underlying soil.

B. Wood Staples shall be 12 inches in length, untreated, 100% biodegradable wooden staples that are solid and free of knots or defects.

C. Pre-approved: North American Green EcoSTAKES (12-inch)

2.4 CONSTRUCTION FORMS

A. Construction forms shall be used to facilitate construction of FES lifts.

2.5 SEED

A. Refer to Section 32 92 19 – Seeding.

PART 3 - EXECUTION

3.1 GENERAL

A. The Contractor shall gain acceptance of materials from the Engineer prior to transport and delivery to the site.

B. Where applicable, materials shall be installed in accordance with manufacturers' instructions.

C. Activities covered under this section shall comply with Section 31 20 00 – Earthwork unless otherwise specified.

D. The subgrade surface for bioengineering soil stabilization shall be cut or filled, graded, and compacted to the lines and grades shown on the Drawings.

1. When fill to subgrade lines is required, it shall consist of salvaged soil or other approved material and shall be compacted to a density equal to that of the adjacent native ground.
2. Remove brush, trees, stumps, debris, large stones, or other deleterious materials.
3. Prepared subgrade shall be finished reasonably smooth and free of mounds, dips, or windrows prior to placement of filter fabric.

E. Compact fills for Surface Fabric Treatment and FES Lifts to 85 percent of maximum dry unit weight.

3.2 SURFACE FABRIC TREATMENT

A. Extents of Surface Fabric Treatment shall be confirmed on site with the Engineer prior to installation.

B. Apply seed to prepared subgrade prior to installing fabric.

C. Anchor fabrics at the toe of the bank as shown on the Drawings.

D. Secure fabrics in key trench at the top of the bank as shown on the Drawings. Stake fabric to bottom of key trench, pounding stake flush with grade. Backfill trench with fill material specified on the Drawings and seed. Coordinate the locations of key trenches with the Engineer in the field.

E. Install woven coir fabric on top of non-woven coir fabric as shown on the Drawings. Butt inner fabric ends together. Join outer fabric ends by overlapping

F. Install Wood Stakes through both layers of fabric on 3-foot centers in staggered rows.

G. Install Wood Staples through both layers of fabric on 18-inch centers in staggered rows except where Wood Stakes have already been placed.

H. Ease stakes and staples between the fibers of the fabrics. Do not cut holes for stakes or staples.

I. Damaged fabric shall be repaired or replaced. Tears of 6 inches or smaller may be patched with scrap fabric placed beneath the damaged fabrics and extending 1 foot beyond the tear in all directions. Stake around tear with four Wood Stakes on 12-inch centers. Tears greater than 6 inches in size shall be removed and replaced by the Contractor at no additional cost to the Owner.

J. Inspect installed fabrics for areas of loose fabric or voids between fabric and soil. Secure these areas with additional stakes or staples to ensure fabrics are tight and in contact with the underlying soil. The Engineer will review fabric installation. Corrective action requested by the Engineer shall be performed by the Contractor at no additional cost to the Owner.

3.3 FABRIC ENCAPSULATED SOIL LIFTS

A. Extents of FES lifts shall be confirmed on site with the Engineer prior to installation.

B. FES lifts shall be constructed with on-site supervision by the Engineer.

C. FES lifts may be constructed in either an upstream or downstream direction, but fabrics must overlap in the direction indicated on the Drawings.

D. Shape native ground and place and compact fills as required to prepare subgrade for FES Lift construction.

E. Place a series of forms along the bank. Butt ends of forms tightly together.

F. Unroll woven (outer) fabric along the forms, parallel to the channel. Position the fabric such that it extends for 3 feet on the bank side of the forms, and drape the remaining width of fabric over the tops of the forms and onto the stream side.

G. Unroll the non-woven (inner) fabric along the forms, parallel to the channel and on top of the woven fabric. Position the fabric such that it extends for at least 1 foot on the bank side of the forms, and drape the remaining width of fabric over the tops of the forms and onto the stream side.

H. Fabrics should extend at least three feet beyond the end of the last form to provide overlap in the streamwise direction.

I. Stretch and pull the fabrics to remove wrinkles. Secure the fabrics by staking them into the subgrade. Use one Wooden Stake every three feet placed 6 inches back from the vertical face of the forms.

J. Apply seed to the inner fabric along the bank side vertical face of the forms.

K. Fill the lift (i.e., fill over the fabric within the forms) with a 1- to 1.5-foot thickness of the material specified on the Drawings. Level and compact the fill.

L. Apply seed to the top of the compacted fill. Seed should cover at least three feet back from the forms.

M. Fold the fabrics over the seeded and compacted fill. Stretch fabric tightly to remove wrinkles. Secure fabrics with Wood Stakes placed on 3-foot centers and Wood Staples on 1.5-foot centers except where stakes have already been placed.

N. Remove forms by hand or with hand-held tools. Do not tear fabric when removing forms. Do not use machinery to remove forms. Flatten face of lift as indicated on the Drawings.

O. Repeat lift construction to achieve the lines and grades shown on the Drawings.

P. Seed entire fill area of top lift. Secure fabric in key trench as shown on the Drawings. Backfill trench with fill material specified on the Drawings and seed.

Q. Where FES lifts are constructed around bends, fabrics shall be folded as necessary to tighten and secure them firmly to underlying soil. Folds shall be formed in the direction of flow and staked. Fabric shall not be cut.

R. Ease stakes and staples between the fibers of the fabrics. Do not cut holes for stakes or staples.

S. Damaged fabric shall be repaired or replaced. Tears of 6 inches or smaller may be patched with scrap fabric placed beneath the damaged fabrics and extending 1 foot beyond the tear in all directions. Stake around tear with four Wood Stakes on 12-inch centers. Tears greater than 6 inches in size shall be removed and replaced by the Contractor at no additional cost to the Owner.

T. Inspect FES lifts for areas of loose fabric or voids between fabric and soil. Secure these areas with additional stakes or staples to ensure fabrics are tight and in contact with the underlying soil. The Engineer will review fabric installation. Corrective action requested by the Engineer shall be performed by the Contractor at no additional cost to the Owner.

3.4 FIELD QUALITY CONTROL

A. Grade Control: Establish and maintain required lines and elevations. Review lines and grades with the Engineer prior to starting work and as work progresses.

B. Testing Agency: The Contractor shall engage a qualified independent testing agency to perform field quality-control testing.

C. Compaction density testing will be completed as necessary to demonstrate compliance with these specifications.

D. Should testing or visual inspection by the Engineer indicate that subgrades, fills, or backfills have not achieved the specified degree of compaction, the Contractor shall scarify and moisten or aerate, or remove and replace soil to the required depth; recompact and retest until specified compaction is achieved.

1. Subsequent bioengineering soil stabilization operations may proceed only after test results for previously completed work comply with requirements.

2. Corrective action shall be completed by the Contractor at no additional expense to the Owner.

END OF SECTION

SECTION 31 38 00 – LARGE WOOD

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, MASSDOT Standard Specifications for Highways and Bridges, and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes:

1. Large Wood Bank Treatment, including provision and installation of Logs with Rootwads, Logs, Timber Piles, and connection hardware.

B. Related Sections

1. Section 31 10 00 – Site Clearing
2. Section 31 20 00 – Earthwork
3. Section 31 32 00 – Bioengineering Soil Stabilization
4. Section 32 90 00 - Plantings
5. Section 32 92 19 - Seeding

1.3 DEFINITIONS

A. Bole: The portion of a tree trunk exclusive of the rootwad and any branches

B. Diameter at Breast Heigh (DBH): Standard method of measuring the diameter of a tree trunk. DBH is measured approximately 4.3 feet above ground.

C. Driving piles: Refers to installation by pile drivers, including but not limited to, vibratory hammers and impact hammers.

D. Log: Tree trunk with no branches and no rootward

E. Log with Rootwad: Tree trunk with rootwad attached and no branches.

F. Midpoint: The point halfway along a log (Logs and Timber Piles) or halfway between the rootwad flare and the tapered top of the tree as measured along the bole (Logs with Rootwads)

G. Packed slash volume: Volume of slash when compacted by an excavator bucket into a dump truck or similar on-site transport vehicle.

H. Rootward: The flare of roots at the base of a tree trunk

I. Slash: Branches from trees and/or shrubs

J. Timber Pile: A log driven vertically into the ground and used as an anchor for a Large Wood assembly.

1.4 REFERENCE STANDARDS

A. ASTM F1554: Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength

B. ASTM A194: Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both

C. ASTM F436: Standard Specification for Hardened Steel Washers

D. ASTM A615-09: Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement

1.5 SUBMITTALS

A. Large Wood Inventory

1. The Owner shall submit an inventory list for Owner-supplied Large Wood.
2. The Contractor shall submit an inventory list for Contractor-supplied Large Wood.
3. Inventory lists shall be submitted to the Engineer prior to harvest and/or delivery. Lists shall include the following information for each piece of Large Wood:
    a. Species
    b. Presence or absence of rootwad
    c. Length of log (for Logs and Timber Piles) or length of bole (for Logs with Rootwads)
    d. Diameter at midpoint (for Logs and Timber Piles) or DBH (for Logs with Rootwads)

B. Product Data

1. Manufacturer's data and Certificates of Compliance for:
    a. Threadbar
    b. Washers
    c. Nuts

C. Equipment

1. Proposed equipment for movement and placement of Large Wood.
2. Proposed equipment and methods of pile driving.

1.6 QUALITY ASSURANCE

A. Notify the Engineer 7 days prior to Large Wood installation. Large Wood installation is a field set item. Do not install Large Wood without the presence of the Engineer.

B. Take care when handling Large Wood to avoid damage such as abrasion, splitting, crushing, and shearing of trunks and rootwads.

C. Large Wood that is damaged during handling, transport, or installation and no longer meets the specifications will be rejected and shall be removed, disposed of, and replaced at no additional cost to the Owner.

D. Maintain all pile driving equipment in good repair and operating condition. Pile-driving equipment shall be capable of being operated as recommended by the manufacturer.

E. Pile-driving equipment or methods that result in regular or repeated damage to Timber Piles will be rejected.

PART 2 - PRODUCTS

2.1 LARGE WOOD

A. General

1. Timber Piles shall be one of the following species:
    a. Eastern white oak (*Quercus alba*)
    b. Eastern hard (sugar) maple (*Acer saccharum*)
2. All other Large Wood shall be the following species:
    a. White pine (*Pinus strobus*)
    b. Cedar (*Thuja occidentalis, Juniperus virginiana*)
    c. Oak (*Quercus spp.*)
    d. Maple (*Acer spp.*)
    e. Black locust (*Robinia pseudoacacia)*
    f. Shagbark hickory (*Cary ovata*)
3. Species substitutions must be reviewed and accepted by the Engineer prior to harvest. Non-approved materials will be rejected for use as Large Wood.
4. Materials not designated for incorporation into the Project must be removed and disposed of offsite at no cost to the Owner.
5. Trim branches flush with the trunk on Large Wood items defined as having no branches.

B. Logs and Timber Piles

1. Diameter at midpoint shall be a minimum of 12 inches.
2. Length shall be a minimum of 20 feet.
3. Curvature, defined by the amplitude of the curve, shall be less than 3 feet in any direction.

C. Logs with Rootwads

1. Diameter at midpoint shall be a minimum of 12 inches.
2. Bole length shall be a minimum of 20 feet.
3. Rootwad diameter shall be a minimum of 3 feet and a maximum of 6 feet.
4. Bole curvature, defined by the amplitude of the curve, shall be less than 3 feet in any direction.

D. Slash

1. Slash may be salvaged on site during site clearing for use in the Project.
2. Slash shall consist of tree or shrub branches with diameter at midpoint less than 3 inches.

3. Use only native tree and woody shrub species. Vines, forbs, ice, or other non-woody material shall not be used.

4. Slash shall be placed within void spaces of Large Wood assemblies as shown on the Drawings and in coordination with the Engineer.

5. Slash volume shall be 1 cubic yard packed slash volume per installed Log or Log with Rootwad.

2.2 ANCHORING MATERIALS

A. Threadbar

1. Non-galvanized steel with a tensile yield rating no less than 75,000 pounds per square inch and no more than 80,000 pounds per square inch per ASTM A615.

2. Effective (minimum) bar cross-sectional area shall be no less than 0.79 square inches (#8 size reinforcement bar).

3. Threadbar shall be continuously threaded with a thread pitch of no less than 0.3 inches and shall be capable of accepting matching nuts that can be threaded along the entire length of the bar.

4. Dywidag Systems International (DSI) threadbar or accepted equal

B. Washers

1. Flat plate washers

a. Non-galvanized steel flat plate washers with material strength properties equivalent to those of the threadbar.

b. For threadbar with a cross-sectional area of 0.79 square inches, minimum thickness shall be 3/16 inch and coverage area shall be 9 square inches.

c. Minimum thickness and coverage area shall be increased proportionally if larger diameter threadbar is used.

d. Flat plate washers shall be used where threadbar extends out of Large Wood perpendicular to the surface of the wood so that the washer and nut may be seated flush and tight with the Large Wood.

2. Beveled washers

a. Non-galvanized steel beveled washers with material strength properties equivalent to those of the threadbar.

b. For threadbar with a cross-sectional area of 0.79 square inches, minimum diameter shall be 2.5 inches and minimum angle compensation shall be 9.5 degrees per washer.

c. A maximum of two washers may be used compensate for angles up to 19 degrees.

d. Minimum diameter shall be increased proportionally if larger diameter threadbar is used.

e. Beveled washers shall be used where threadbar extends out of Large Wood at an angle such that a flat washer and nut cannot be seated flush and tight with the Large Wood.

C. Nuts

1. Non-galvanized steel nuts with material strength properties equivalent to those of the threadbar.
2. Nuts shall be capable of developing 100% of the threadbar capacity in tension.
3. Nuts shall be compatible with the threadbar diameter and thread type and be from the same supplier as the threadbar.
4. Contractor shall be prepared to provide nuts with one rounded, domed, or mushroomed side to allow for non-binding tightening of the nut if necessary.

PART 3 - EXECUTION

3.1 GENERAL

A. The general locations and layouts of Large Wood are shown on the Drawings, and final extents and configurations will be determined in the field in coordination with the Engineer.

B. The Contractor shall be responsible for managing Large Wood on site and for transporting Large Wood to the installation locations.

C. Estimated quantities of Large Wood are provided in the Bid Form. Final quantities may be modified in the field by the Engineer.

3.2 PREPARATION

A. Excavate as necessary for placement of Large Wood while minimizing disturbance to native ground and/or finished grade. Shape, trim, and finish subgrade to allow for placement of Large Wood as shown on the Drawings.

3.3 LARGE WOOD INSTALLATION

A. Place Large Wood in accordance with the Drawings and in coordination with the Engineer.

B. The Contract may need to adjust connections at the time of installation based on field conditions and supplied Large Wood materials.

C. Place, tamp, and compact material shown on the Drawings around Large Wood. Prevent Large Wood from shifting during subsequent wood and streambed material placement.

D. Where partial burial of Large Wood is shown on the Drawings,

1. Excavate to subgrade prior to placing Large Wood.
2. Excavated material shall be stockpiled for reuse or disposed of off site as required by the Drawings and Section 31 20 00 – Earthwork.
3. Backfill around Large Wood as each layer is installed.
4. Backfill shall be placed, not dumped, around Large Wood and compacted to maximize filling of voids. Compact with an excavator bucket without breaking the Large Wood or damaging connections.

3.4 ANCHORING

A. Large Wood shall be fastened to Large Wood as shown on the Drawings.

B. Drill connections through the center of Large Wood with holes aligned to accept straight threadbar rod. Drill bits shall be no greater than 0.25 inches in diameter larger than the diameter of the threadbar rod and of sufficient length to drill through at least two log diameters.

C. Place threadbar through drilled holes and fasten with 1 washer and 1 nut on each end. Tighten the nuts until the underlying wood begins to compress. Cut excess threadbar so that the ends extend no farther than 2 inches beyond the nuts. Peen the ends of threadbar to prevent nuts from loosening.

D. A connection shall result in a gap no larger than 1 inch between two Large Wood pieces.

3.5 EQUIPMENT

A. To facilitate efficient movement and placement of Large Wood, the Contractor shall furnish a track excavator with a hydraulic thumb attachment or equivalent as reviewed and accepted by the Engineer.

B. Timber Piles shall be installed with a vibratory or impact hammer-type pile driver capable of driving piles to required depths.

END OF SECTION

SECTION 31 50 00 - EXCAVATION SUPPORT AND PROTECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, MASSDOT Standard Specifications for Highways and Bridges, and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes temporary excavation support and protection systems.

B. Related Sections:

1. Section 03 30 00 – Cast-in-Place Concrete
2. Section 31 20 00 - Earthwork

1.3 SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, performance properties, and dimensions of individual components and profiles, and calculations for excavation support and protection system.

B. Shop Drawings: For excavation support and protection system, prepared by or under the supervision of a qualified professional engineer.

1. Include plans, elevations, sections, and details.
2. Show arrangement, locations, and details of soldier piles, piling, lagging, tiebacks, bracing, and other components of excavation support and protection system according to engineering design.
3. Indicate type and location of waterproofing.
4. Include a written plan for excavation support and protection, including sequence of construction of support and protection coordinated with progress of excavation.

C. Coordinate "Qualification Data" Paragraph below with qualification requirements in Section 014000 "Quality Requirements."

D. Qualification Data: Designs and Calculations: Prepared, sealed and signed by a Civil or Structural Engineer registered in the State of Massachusetts

E. Retain "Contractor Calculations" Paragraph below if Contractor is required to design excavation support and protection system; delete paragraph if Owner's design professional designs the excavation support and protection system, which is less common.

1. Contractor Calculations: For excavation support and protection system. Include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 FIELD CONDITIONS

A. Interruption of Existing Utilities: Do not interrupt any utility serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated:

1. Notify City no fewer than two (2) days in advance of proposed interruption of utility.
2. Do not proceed with interruption of utility without City's written permission.

B. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of a geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by a geotechnical engineer. Owner is not responsible for interpretations or conclusions drawn from the data.

1. Make additional test borings and conduct other exploratory operations necessary for excavation support and protection according to the performance requirements.

C. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Provide, monitor, and maintain excavation support and protection system capable of supporting excavation sidewalls and of resisting earth and hydrostatic pressures and superimposed and construction loads.

1. Contractor Design: Design excavation support and protection system, including comprehensive engineering analysis by a qualified professional engineer.
2. Prevent surface water from entering excavations by grading, dikes, or other means.
3. Install excavation support and protection systems without damaging existing buildings, structures, and site improvements adjacent to excavation.
4. Continuously monitor vibrations, settlements, and movements to ensure stability of excavations and constructed slopes and to ensure that damage to permanent structures is prevented.

2.2 MATERIALS

A. General: Provide materials that are either new or in serviceable condition.

B. Structural Steel: ASTM A 36/A 36M, ASTM A 690/A 690M, or ASTM A 992/A 992M.

C. Steel Sheet Piling: ASTM A 328/A 328M, ASTM A 572/A 572M, or ASTM A 690/A 690M; with continuous interlocks.

1. Corners: Site-fabricated mechanical interlock or Roll-formed corner shape with continuous interlock.

D. Wood Lagging: Lumber, mixed hardwood, nominal rough thickness of the rough cut size specified by the design.

E. Cast-in-Place Concrete: ACI 301, of compressive strength required for application.

F. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.

G. Tiebacks: Steel bars, ASTM A 722/A 722M.

H. Tiebacks: Steel strand, ASTM A 416/A 416M.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that could develop during excavation support and protection system operations.

1. Shore, support, and protect utilities encountered.

B. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

C. Locate excavation support and protection systems clear of permanent construction so that construction and finishing of other work is not impeded.

3.2 SOLDIER PILES AND LAGGING

A. Install steel soldier piles before starting excavation. Extend soldier piles below excavation grade level to depths adequate to prevent lateral movement. Space soldier piles at regular intervals not to exceed allowable flexural strength of wood lagging. Accurately align exposed faces of flanges to

vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment.

B. Install wood lagging within flanges of soldier piles as excavation proceeds. Trim excavation as required to install lagging. Fill voids behind lagging with soil, and compact.

C. Install wales horizontally at locations indicated on Drawings and secure to soldier piles.

3.3 SHEET PILING

A. Before starting excavation, install one-piece sheet piling lengths and tightly interlock vertical edges to form a continuous barrier.

B. Accurately place the piling, using templates and guide frames unless otherwise recommended in writing by the sheet piling manufacturer. Limit vertical offset of adjacent sheet piling to 60 inches. Accurately align exposed faces of sheet piling to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment.

C. Cut tops of sheet piling to uniform elevation at top of excavation.

3.4 TIEBACKS

A. Drill, install, grout, and tension tiebacks.

B. Test load-carrying capacity of each tieback and replace and retest deficient tiebacks.

1. Have test loading observed by a qualified professional engineer responsible for design of excavation support and protection system.

C. Maintain tiebacks in place until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.5 BRACING

A. Bracing: Locate bracing to clear columns, floor framing construction, and other permanent work. If necessary to move brace, install new bracing before removing original brace.

1. Do not place bracing where it will be cast into or included in permanent concrete work unless otherwise approved by Engineer.
2. Install internal bracing if required to prevent spreading or distortion of braced frames.
3. Maintain bracing until structural elements are supported by other bracing or until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.6 FIELD QUALITY CONTROL

A. Survey-Work Benchmarks: Resurvey benchmarks at least bi-weekly during installation of excavation support and protection systems, excavation progress, and for as long as excavation

remains open. Maintain an accurate log of surveyed elevations and positions for comparison with original elevations and positions. Promptly notify Engineer if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

B. Promptly correct detected bulges, breakage, or other evidence of movement to ensure that excavation support and protection system remains stable.

C. Promptly repair damages to adjacent facilities caused by installation or faulty performance of excavation support and protection systems.

3.7 REMOVAL AND REPAIRS

A. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and earth and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils and rock or damaging structures, pavements, facilities, and utilities.

1. Remove excavation support and protection systems to a minimum depth of 48 inches below overlying construction and abandon remainder.
2. Fill voids immediately with approved backfill compacted to density specified in Section 312000 "Earth Moving."
3. Repair or replace, as approved by Engineer, adjacent work damaged or displaced by removing excavation support and protection systems.

B. Leave excavation support and protection systems permanently in place.

END OF SECTION

SECTION 31 63 33 – DRILLED MICROPILES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, MASSDOT Standard Specifications for Highways and Bridges, and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This section includes the following:

1. This work shall consist of constructing micropiles of the type and configuration shown on the Contract Drawings and approved working drawings and as specified herein. The Contractor is responsible for furnishing of all design, materials, products, accessories, tools, equipment, services, transportation, labor and supervision, and manufacturing techniques required for design. The micropile load capacities shall be confirmed by verification and proof load testing as required and must meet the test acceptance criteria specified herein.

B. Related Sections:

1. 03 30 00 – Cast-in-Place Concrete
2. 31 20 00 – Earthwork

C. Existing Conditions:

1. Existing Adjacent Facilities: The Contractor shall assume all responsibility for the premises and loss or damage to the property, adjoining property, public ways and utilities, shoring, bracing, and barricades protecting adjacent property. All costs for protecting, repairing, and replacing adjacent property shall be borne by the Contractor.

1.3 REFERENCE STANDARDS

A. General: Comply with the provisions of the latest version of the publications listed below except as otherwise shown or specified.

B. AASHTO Bridge Design Specifications 9th Edition (AASHTO):

C. American Welding Society (AWS):

1. AWS D1.1: Structural Welding Code – Steel
2. AWS D1.4: Structural Welding Code – Reinforcing Steel

D. American Society for Testing and Materials (ASTM):

1. ASTM D 3689: Standard Test Method for Individual Piles under Static Axial Tensile Load

1.4 SUBMITTALS

1. Working Drawings:

a. A plan view identifying location of all micropiles.

b. An elevation view identifying locations and elevations of all micropiles.

c. Design parameters and applicable codes.

d. General notes for constructing the micropile structure including construction sequencing or special construction requirements.

e. Micropile typical sections including micropile spacing, minimum drillhole diameter, pipe casing and reinforcing bar details, splice types and locations, centralizers and spacers, grout bond zone and casing plunge lengths (if used), corrosion protection details, and connection details to the footing.

f. A typical detail of verification and production proof test micropiles defining the micropile length, minimum drillhole diameter, and load test bonded and unbonded test lengths.

g. Details, dimensions, and schedules for all micropiles, casing and reinforcing steel, including reinforcing bar bending details.

2. Certified mill test reports for steel micropiles with ultimate strength, yield strength, elongation, and material properties composition.

3. Detailed plans for the proposed micropile load testing method. Include drawings, details, and structural design calculations necessary to clearly describe the proposed test method, reaction load system capacity and equipment setup, types and accuracy of apparatus to be used for applying and measuring the test loads and pile top movements.

4. Drilling Logs: The Contractor shall review, approve, and submit the drilling logs prepared by the Owner's Testing Agency for each micropile on a daily basis. Logs shall include identification, micropile diameter, bottom elevation, top elevation, nature and location of obstructions, and grout placement.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A minimum of 5 years' experience and not less than three successfully completed projects with similar soil and groundwater conditions, micropile size, depths, and volume of work contained in the project.

B. Professional Engineer Qualifications: A professional engineer who is registered in the jurisdiction where the project is located and who is experienced in providing engineering services of the kind indicated.

C. Survey Work: Engage a surveyor who is registered in the jurisdiction where the project is located, to perform surveys, layout, and measurements. Conduct layout work for each micropile to lines and levels required before installation. Record actual measurements of installation of micropile foundation support systems.

1. Record and maintain information pertinent to each micropile and cooperate with the Owner's Geotechnical Engineer and Owner's Testing Agency to provide data required for reports.

D. Pre-construction Conference: A minimum two weeks prior to scheduled commencement of micropile installation and associated work, meet at project site with installer of micropiles, installers of related work, the Owner's Structural Engineer, Owner's Representative, Owner's Testing Agency, Owner's Geotechnical Engineer, and other representatives directly concerned with performance of the work. Review foreseeable methods and procedures related to micropile work. Record discussion of conference and decisions reached and furnish copy of record to each party attending.

E. Construction Monitoring: The Contractor shall establish a construction monitoring program that includes a monitoring schedule, reviewing and interpreting data, and reporting to the Owner and Architect as required to ensure safety of the existing adjacent structures, roads, sidewalks, buried utilities, and all other structures.

1.6 PROJECT CONDITIONS

A. Site Information: A geotechnical report has been prepared for this Project and is available for information only. The report is not guaranteed to represent conditions that will be encountered. Opinions expressed in this report are those of the geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by the geotechnical engineer. The Owner will not be responsible for interpretations or conclusions drawn from this data by the Contractor.

1. Additional test borings and other exploratory operations may be made by the Contractor at no additional cost to the Owner.

2. The geotechnical report is referenced elsewhere in the Project Manual.

B. Existing Utility Lines and Foundations: Any existing underground utility lines and foundations shown in the Drawings are shown from the best possible information available and shall be verified prior to any excavation or grading work.

1. Known utilities and foundations have been shown only where their existence has been determined by survey, investigation, or record drawings. The precise location of these lines, as well as careful reconnaissance of all areas for both above- and below-ground utilities as well as protection of same, shall be the sole responsibility of the Contractor.

2. Existing utility lines to be retained and shown on the Civil Drawings, or the location of which are made known to the Contractor prior to excavation operations, shall be protected from damage during excavation drilling, filling, and backfilling, and if damaged, shall be repaired by the Contractor, at his expense, and in a manner as directed by the Architect.

3. New Utility Lines: New utility lines shown on the Civil Drawings, or the location of which are made known to the Contractor prior to concrete pier construction, shall be protected from damage during excavation, drilling, filling, and backfilling, and if damaged, shall be repaired by the Contractor, at his expense, and in a manner as directed by the Architect.

C. The Contractor shall assume all responsibility for the premises and loss or damage to the property, adjoining property, public ways and utilities, shoring, bracing, and barricades and protecting adjacent property. All work shall conform to the requirements of the local jurisdiction. All costs for protecting, repairing, and replacing adjacent property shall be borne by the Contractor.

PART 2 PRODUCTS

2.1 MATERIALS

A. General: Provide materials that are either new or in serviceable condition.

B. Reinforcing Bars: Steel core reinforcement as a minimum shall consist of deformed reinforcing bars in accordance with ASTM A722 Grade 150.

C. Recycled Content: Materials shall contain post-industrial (pre-consumer) recycled content and/or post-

D. consumer recycled content. Contractor shall document the cost and percentage (by weight) of each material broken out by post-industrial (pre-consumer) and post-consumer recycled content.

E. Regional Content: Materials shall contain content that is extracted, harvested, recovered, or manufactured within 500 miles of the project site. Contractor shall document the cost and percentage (by weight) of each material that is regional.

PART 3 EXECUTION

3.1 PREPARATION

A. Coordinate the work and the excavation so the micropile structures are safely constructed. Perform the micropile construction and related excavation in accordance with the Construction Documents and Specifications.

3.2 PILE INSTALLATION

B. Micropile allowable construction tolerances are as follows:

1. Centerline of piling shall not be more than 3 inches from indicated plan location.
2. Pile shall be plumb or battered within 2 percent of total-length plan alignment.
3. Top elevation of pile shall be plus 1 inch or minus 2 inches maximum from vertical elevation indicated.
4. Centerline of reinforcing steel shall not be more than 0.5 inches from indicated location.

C. Abandon and cut off rejected piles as directed by the Architect. Leave rejected piles in place and install new piles in locations as directed by the Architect.

3.3 PERFORMANCE AND PROOF TESTING

A. The contractor shall conduct performance tests and proof tests consisting of tension load testing on micropiles. The tests are to be done on piles installed from the bottom of the excavation.

B. Performance Testing:

1. Performing testing will be used at two locations to verify the design of the micropile load transfer bond zone, and the construction method proposed by the Contractor including drilling, installing, and grouting of the micropiles. The drilling-and-grouting method, casing length and outside diameter, reinforcing bar lengths, and depth of embedment for the performance test micropile shall be identical to those specified for the production micropiles at the given location. The performance test micropile structural steel sections shall be sized to safety resist the maximum test load that is equal to 2.8 times the Design Load indicated on the drawings, where 2.8 is the factor of safety (2.0) times a factor of 1.4, which is to account for intermediate state of effective stress due to dewatering system.
2. The Owner's Representative will observe performance testing at each testing location. Performance test results must be reviewed and approved by the Owner's Representative prior to installing any production micropiles.
3. If a micropile that is performance tested fails to meet any of the acceptance criteria for testing as determined by the Owner's Representative, that micropile will be rejected and Contractor shall modify the design or construction procedures and submit revised working drawings. The Contractor shall install and conduct a performance test for another micropile. Micropile installation operations shall not continue until the Owner's Representative has approved the revised working drawings in writing. No extensions of time or compensation will be made for installing and testing additional micropiles.

C. Proof Testing:

1. All micropiles shall be proof tested before mat slab concrete is cast. The test load shall be equal to 1.54 times the Design Load indicated on the Contract Drawings.

2. If any production micropile that is proof tested fails to meet any of the acceptance criteria for proof testing specified herein, that pile will be rejected. Rejected micropiles shall be replaced at locations approved by the Owner's Representative. The Contractor shall submit to the Owner's Representative for approval a remedy plan for replacing rejected micropiles. The remedy plan shall consist of details for replacement of micropiles including additional micropiles to be installed on the Contract Drawings. No extension of time or compensation will be made for the review of a remedy plan for replacing or installing additional micropiles.

D. Proof and Performance Testing shall be performed under the direction of the Contractor's Pile Test Engineer, who is experienced and competent in pile load testing. Static axial pile load testing shall include all equipment necessary to conduct pile testing, interpret the data, and prepare an engineering report documenting this work.

E. The Pile Test Engineer shall complete the Daily Field Report Form for each day in which pile load test activities occur at the test site. Each day, the Pile Testing Engineer shall supply to the Owner's Representative a completed Daily Field Report Form Describing the day's activities.

F. All equipment necessary to perform the pile load test shall be furnished by the Contractor and shall conform to the requirements of ASTM D 3689.

G. At least 4 working days prior to performance testing, and before mobilizing any testing equipment, the Pile Testing Engineer shall submit to the Owner's Representative two copies of the following:

1. A diagram of the load test frame, including reference beams, location and identification of instrumentation.
2. Load cell calibration(s).
3. Hydraulic jack calibration(s).
4. Displacement gauge and transducer calibrations.
5. Any proposed deviation from the testing methods specified herein.
6. Records of all calibrations that have been conducted within 1 year prior to testing. The records shall be traceable to a NIST standard.

H. Proof and Performance Testing shall be performed in accordance with ASTM D 3689, modified as follows:

1. A load test frame shall be provided that is designed to carry at least twice the maximum test load required for the pile in direction of loading.
2. All pile load tests shall be conducted until the test load is reached.
3. Primary and secondary measurement systems shall be utilized for measuring load and displacement. Displacement gauges shall have sufficient travel to determine pile displacement up to 1.5 times the calculated expected displacement of the test pile. Said displacement gauges shall read to an accuracy of 0.001 in. (primary) and 0.01 in. or 0.001 ft. (secondary. These displacement gauges shall be mounted to reference beams whose supports allow a clear distance of not less than 8 ft. from the test pile. Reference beams shall be made of steel or aluminum, shall not be crossed braced, and be sufficiently stiff. The connection between the displacement gauges and the reference beam shall be sufficiently stiff. Displacement gauges shall bear on glass plates.
4. The testing shall begin with a zero reading taken on all the primary and secondary systems.

5. For performance tension load tests, the load applied and the corresponding durations shall be as shown in Table A. During Initial Loading, at least three readings of the primary and secondary systems shall be taken for each load increment. The first reading shall be taken immediately after the load is attained. The second and the third reading shall be taken 1 and 5 minutes, respectively, after the load is attained. After the five-minute reading is taken, the next load increment shall be applied to the test pile. Once the maximum load for the initial cycle has been reached, the full load shall be held constant for 10 minutes. During the load hold, the reading shall be taken at 1, 2, 3, 4, 5, 6, and 10 minutes. If the total recorded movement between 1 minute and 10 minutes exceeds 0.04 inch, the test load shall be held for an additional 50 minutes. Total movement shall be measured at 15, 20, 25, 30, 45, and 60 minutes. If the load is held for 60 minutes, a creep curve showing the creep movement between 1 minute and 60 minutes shall be plotted as a function of the logarithm of time. After this initial maximum load hold is complete, the pile shall be unloaded by reducing the load as described in Table A. During the unloading, at least two readings of the primary and secondary system taken immediately after the load is attained; the second reading shall be taken 1 minute after the load is attained. After this one-minute reading is taken, the load may be decreased to the next load. At the end of the initial cycle, the load shall be a zero, and an initial and 1-minute reading shall be taken. Upon reloading, all loads that have been previously attained shall be held for 1 minute and at least one initial and 1-minute reading shall be taken. At 1.0F load increments, readings of the primary and secondary systems shall be taken when the load is attained, and at 1, 2, 3, 4, 5, 6, 10, 15, 20, 25, and 30 minutes, until the head of the pile is not more than 0.01 inches in 30 minutes.

Table A

Performance Tension Load Test Schedule	
Load	Duration
0	1 minute
0.10F	5 minutes
0.20F	5 minutes
0.30F	5 minutes
0.40F	5 minutes
0.50F	10 minutes for Creep Test
0.60F	5 minutes
0.70F	5 minutes
0.80F	5 minutes
0.90F	5 minutes
1.00F	10 minutes or 60 minutes for Creep Test
0.75F	1 minute
0.50F	1 minute
0.25F	1 minute
0	1 minute
0.10F	1 minute
0.20F	1 minute
0.30F	1 minute
0.40F	1 minute
0.50F	1 minute
0.60F	1 minute
0.70F	1 minute
0.80F	1 minute
0.90F	1 minute
1.00F*	10 minutes or 30 minutes for Creep Test
F = Performance Test Load = 1.4 × FS × Design Load, where FS = 2.0 (1.4 is the factor to account for the immediate state of effective stress due dewatering) *After a 30-minute interval, remove the full load from the pile in four approximately equal decrements with 5-minute intervals between each decrement.	

I. For proof tension load tests, the loads applied and the corresponding durations shall be as shown in Table B. During initial loading, at least three readings of the primary and secondary systems shall be taken for each load increment. The first readings shall be taken immediately after the load is attained. The second and the third readings shall be taken 1 and 5 minutes, respectively, after the load is attained. After the five-minute reading is taken, the next load increment shall be applied to the test pile. The final test load (1.00T) shall be held constant for 10 minutes. During the load hold, the reading shall be taken at 1, 2, 3, 4, 5, 6 and 10 minutes. If the total recorded movement between 1 minute and 10 minutes exceeds 0.04 inch, the test load shall be held for an additional 50 minutes. Total movement shall be measured at 15, 20, 25, 30, 45 and 60 minutes. If the load is held for 60 minutes, a creep curve showing the creep movement between 1 minute and 60 minutes shall be plotted as a function of the logarithm of time.

Table B

Proof Tension Load Test Schedule	
Load	Duration
0	1 minute
0.25T	5 minutes
0.50T	5 minutes
0.75T	5 minutes
1.00T*	10 minutes or 60 minutes for Creep Test
T = Proof Test Load = 1.4 × FS × Design Load, where FS = 1.1 (1.4 is the factor to account for the immediate state of effective stress due dewatering) *After a 10- or 60-minute interval, remove the full load from the pile in four approximately equal decrements with 5-minute intervals between each decrement.	

1. "Load applied to the pile by hydraulic jacks acting between supported test beams and a reaction frame anchored to the pile" as specified in Paragraph 4.3 of ASTM D 3689 shall be used for performance test piles.

2. Proof tensile load testing shall be performed against reaction piles or cribbing in accordance with ASTM D 3689. Existing footings, piles, or other structures shall not be used as reaction points for load testing. An adjacent production micropile in a group may be used as reaction pile. If cribbing is used, the contractor's attention is drawn to the presence of poor bearing soils and underground utilities, which may require special measures to protect against settlement and damage.

J. Within three working days after the piles are ready for testing, a preliminary report shall be transmitted to the Owner's Representative. Said Preliminary report shall include: a completed Daily Field Report, indication the Pile Test Engineer's assessment of the pile capacity load test data sheets, and a load displacement plot.

K. Within 10 working days of the completion of a pile load test, the Pile Test Engineer shall provide to the Owner's Representative an engineering report documenting the pile load testing and findings. The report shall follow the outline stated in ASTM D 3689 and including the following:

1. Project identification and location, Project Name, and test site location, including the pile numbering system used by the Structural Representative.

2. Discussion of the installation dates for the test and reaction piles. Drilling equipment and method of drilling, including make and model, drilling records for test and reaction piles. Names of the pile installation personnel and pile test operator, and other key personnel. Discussion of drilling including depth and diameter, use of casing, footing excavation description, grouting procedure, quantities and pressures.

3. Discussion of as-built tip elevation, bottom of footing elevation, ground surface elevation, pile to elevation, for all test and reaction piles. Discussion of pile type, including grade of steel, splicing grouting, dates of drilling and grouting, and dimensions. Condition of test and reaction piles. Discussion of the sub-service condition, including location, date, and description of nearest soil boring, ground-water elevation, and date determined.

4. Discussion of the deviation from the testing method specified herein (said deviation shall be approved by Owner's Representative prior to testing). Description of the load test set-up including (primary and secondary) instrumentation used to measure load and displacement.

5. Attachments shall include the following:

a. Vicinity Map with Test Location labeled.

b. General Plan with test location labeled.

c. Foundation Plan with test locations labeled.

d. Footing details, with test and reaction pile location labeled.

e. Grouting records.

f. Plot of load vs. displacement (kips and inches) with the elastic tension/line (PL/AE).

g. Sketch of load test set-up, including all instrumentation.

h. Load cell calibration(s).

i. Hydraulic jack calibration(s).

j. Displacement gauge or transducer calibration(s).

k. Relevant sheets from the Log-of-Test Borings.

l. Two copies of the Load Testing Report shall be made and transmitted to the Owner's Representative.

L. A performance-tested micropile shall conform to the following acceptance criteria:

1. The micropile shall sustain the test load of 0.5 F, with a total axial movement at the top of the pile, measured relative to the top of the pile prior to the start of load testing, not exceeding 0.6 inches. Furthermore, the micropile shall sustain the test load 0.8 F, with a total axial movement at the top of the pile, measured relative to the top of the pile prior to the start of load testing, not exceeding 1.4 inches.

2. The creep movement of the end of the micropile of the end of the micropile at the maximum test load F, between 1 and 10 minutes, is less than 0.04 inch. If this creep movement exceeds 0.04 inch, the micropile will be accepted if it meets the creep requirements specified in Article 3.3 M below.

3. Failure does not occur at the 1.00xF maximum test load. Failure is defined as load at which attempts to further increase the test load simply results in continued pile movement.

M. A proof-tested micropile shall conform to the following acceptance criteria:

1. The micropile shall sustain the test load of 1.0T, with a total axial movement at the top of the pile, measured relative to the top of the pile prior to the start of load testing, not exceeding 0.825 inches.

2. The creep movement of the end of the micropile at the maximum test load T, between 1 and 10 minutes, is less than 0.04 inch. If this creep movement exceeds 0.04 inch, the micropile will be accepted if it meets the creep requirements specified in Article 3.3 M below.

3. Failure does not occur at the 1.00xT maximum test load. Failure is defined as load at which attempts to further increase the test load simply results in continued pile movement.

N. If the creep curve plotted from the movement data for micropiles indicates a creep rate of 0.08 inch or less for the last log cycle of time between 6 and 60 minutes, the micropile will be accepted.

O. If a performance-tested or proof-tested micropile is not accepted, micropile operation shall not continue until the Contractor has modified the design or construction procedures or both for the remaining micropile to comply with the specified acceptance criteria. The modifications shall be as agreed to by the Owner's Representative.

3.4 FIELD QUALITY CONTROL

A. General: Work under this Section shall be subject to special inspection and testing by the Owner's Testing Agency and the Owner's Geotechnical Engineer.

B. Continuous Inspection: The Owner's Geotechnical Engineer and the Owner's Testing Agency shall provide continuous inspection during all pile installation and testing and will inspect each micropile for the following conditions:

1. Observe drilling operations and maintain complete and accurate records for each micropile.
2. Verify placement locations, plumbness, and confirm micropile diameters, lengths, and embedment into rock (if applicable).
3. Record grout volumes.
4. Verify reinforcing details and depth to which reinforcement was placed.
5. Identify any pile deviations or unusual occurrences during pile installation.

3.5 DISPOSAL OF MATERIALS

A. Remove surplus excavated material and slurry or grout and legally dispose of it off site.

END OF SECTION

SECTION 32 05 23 - CEMENT AND CONCRETE FOR EXTERIOR IMPROVEMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, MASSDOT Standard Specifications for Highways and Bridges, and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This section specifies cast-in-place concrete, including formwork, reinforcement, concrete materials, mix design, placement procedures, and finishes.

B. This section applies to:

1. Sidewalks, curbs, and gutters
2. Miscellaneous concrete items, including equipment pads, equipment pits, light pole bases, flagpole bases, sign pole bases, boom anchor foundation, interpretive sign bases, segmental retaining walls leveling pad, thrust blocks, and manholes

C. Related Sections:

1. Section 10 14 00 - Signage
2. Section 32 13 73 - Concrete Paving Joint Sealants
3. Section 32 32 23 – Segmental Retaining Walls
4. Section 32 39 00 – Manufactured Site Specialties

1.3 REFERENCE STANDARDS

A. ACI CODE-318 - Building Code Requirements for Structural Concrete and Commentary; 2019 (Reapproved 2022).

B. ACI PRC-304 - Guide for Measuring, Mixing, Transporting, and Placing Concrete; 2000 (Reapproved 2009).

C. ACI PRC-306 - Guide to Cold Weather Concreting; 2016.

D. ACI PRC-308 - Guide to External Curing of Concrete; 2016.

E. ACI PRC-347 - Guide to Formwork for Concrete; 2014 (Reapproved 2021).

F. ACI SPEC-117 - Specification for Tolerances for Concrete Construction and Materials; 2010 (Reapproved 2015).

G. ACI SPEC-301 - Specifications for Concrete Construction; 2020.

H. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement; 2022.

I. ASTM A775/A775M - Standard Specification for Epoxy-Coated Steel Reinforcing Bars; 2022.

J. ASTM A1064/A1064M - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete; 2022.

K. ASTM C39/C39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens; 2023.

L. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete; 2024.

M. ASTM C143/C143M - Standard Test Method for Slump of Hydraulic-Cement Concrete; 2020.

N. ASTM C685/C685M - Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing; 2017.

O. ASTM C881/C881M - Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete; 2020a.

P. ASTM C1602/C1602M - Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete; 2022.

Q. ASTM D3963/D3963M - Standard Specification for Fabrication and Jobsite Handling of Epoxy-Coated Steel Reinforcing Bars; 2021.

1.4 SUBMITTALS

A. Product Data: Submit manufacturers' data on manufactured products showing compliance with specified requirements and installation instructions.

1. For curing compounds, provide data on method of removal in the event of incompatibility with floor covering adhesives.

B. Mix Design: Submit proposed concrete mix design.

1. Indicate proposed mix design complies with requirements of ACI SPEC-301, Section 4 - Concrete Mixtures.

2. Indicate proposed mix design complies with requirements of ACI CODE-318, Chapter 5 - Concrete Quality, Mixing and Placing.

C. Test Reports: Submit report for each test or series of tests specified.

D. Manufacturer's Installation Instructions: For concrete accessories, indicate installation procedures and interface required with adjacent construction.

E. Project Record Documents: Accurately record actual locations of embedded utilities and components that will be concealed from view upon completion of concrete work.

F. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.5 QUALITY ASSURANCE

A. Perform work of this section in accordance with ACI SPEC-301 and ACI CODE-318 and comply with pertinent materials, workmanship, and other applicable requirements of Subsection 476 of the MADOT Standard Specifications, as applicable and appropriate.

B. Follow recommendations of ACI PRC-306 when concreting during cold weather.

PART 2 - PRODUCTS

2.1 FORMWORK

A. Formwork Design and Construction: Comply with guidelines of ACI PRC-347 to provide formwork that will produce concrete complying with tolerances of ACI SPEC-117.

B. Form Materials: Contractor's choice of standard products with sufficient strength to withstand hydrostatic head without distortion in excess of permitted tolerances.

1. Form Facing for Exposed Finish Concrete: Contractor's choice of materials that will provide smooth, stain-free final appearance.

2. Earth Cuts: Do not use earth cuts as forms for vertical surfaces. Natural rock formations that maintain a stable vertical edge may be used as side forms.

3. Form Coating: Release agent that will not adversely affect concrete or interfere with application of coatings.

4. Form Ties: Cone snap type that will leave no metal within 1-1/2 inches of concrete surface.

2.2 REINFORCEMENT MATERIALS

A. Reinforcing Steel: ASTM A615/A615M, Grade 60 (60,000 psi).

1. Type: Deformed billet-steel bars.

2. Finish: Epoxy coated in accordance with ASTM A775/A775M, unless otherwise indicated.

B. Steel Welded Wire Reinforcement (WWR): Galvanized, plain type, ASTM A1064/A1064M.

2.3 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of same type, brand, and source throughout Project:

1. Portland Cement: Standard Specifications, Section M4.01.0 and Section M4.02.01.

a. Fly Ash: Standard Specifications Section M4.01.2.

2. Normal-Weight Aggregates: Standard Specifications, Section M4.02.02.

B. Water: ASTM C1602/C1602M; clean, potable, and not detrimental to concrete.

2.4 ADMIXTURES

A. Do not use chemicals that will result in soluble chloride ions in excess of 0.1 percent by weight of cement.

B. Air-Entraining Admixture: Standard Specifications, Section M4.02.05.B.

C. Water-Reducing Admixture: Standard Specifications, Section M4.02.05.A.

D. Retarding Admixture: Standard Specifications, Section M4.02.05.A.

2.5 BONDING AND JOINTING PRODUCTS

A. Epoxy Bonding System:

1. Complying with ASTM C881/C881M and of Type required for specific application.

B. Slab Isolation Joint Filler: Standard Specifications, Section M9.14.0.

C. Slab Isolation Joint Filler: 1/2-inch thick, height equal to slab thickness, with removable top section forming 1/2-inch deep sealant pocket after removal.

D. Slab Construction Joint Devices: Combination keyed joint form and screed, galvanized steel, with rectangular or round knockout holes for conduit or rebar to pass through joint form at 6 inches on center; ribbed steel stakes for setting.

2.6 CURING MATERIALS

A. Absorptive Cover: Standard Specifications, Section M9.06.3.

B. Moisture-Retaining Cover: Standard Specifications, Section M9.06.1.

C. Clear, Waterborne, Membrane-Forming Curing Compound: Standard Specifications, Section M9.06.5.

2.7 CONCRETE MIX DESIGN

A. Prepare design mixtures, proportioned according to the Standard Specifications, Section M4.02.00, for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.

1. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.

2. When automatic machine placement is used, determine design mixtures and obtain laboratory test results that meet or exceed requirements.

B. Proportion mixtures to provide normal-weight concrete with the following properties:

1. Compressive Strength (28 Days): 3000 psi (minimum) unless otherwise specified.

2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.45.

3. Slump Limit: 4 inches, plus or minus 1 inch.

C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as indicated in the Standard Specifications, Section M4.02.00.

D. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use water-reducing admixture in concrete as required for placement and workability.

2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

E. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:

1. Fly Ash: Standard Specifications, Section M4.02.00.

2.8 MIXING

A. On Project Site: Mix in drum type batch mixer, complying with ASTM C685/C685M. Mix each batch not less than 1-1/2 minutes and not more than 5 minutes.

B. Transit Mixers: Comply with ASTM C94/C94M.

C. Adding Water: If concrete arrives on-site with slump less than suitable for placement, do not add water that exceeds the maximum water-cement ratio or exceeds the maximum permissible slump.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify lines, levels, and dimensions before proceeding with work of this section.

3.2 PREPARATION

A. Formwork: Comply with requirements of ACI SPEC-301. Design and fabricate forms to support all applied loads until concrete is cured and for easy removal without damage to concrete.

B. Verify that forms are clean and free of rust before applying release agent.

C. Coordinate placement of embedded items with erection of concrete formwork and placement of form accessories.

D. Where new concrete is to be bonded to previously placed concrete, prepare existing surface by cleaning and applying bonding agent in according to bonding agent manufacturer's instructions.

1. Use epoxy bonding system for bonding to damp surfaces, for structural load-bearing applications, and where curing under humid conditions is required.

E. Where new concrete with integral waterproofing is to be bonded to previously placed concrete, prepare surfaces to be treated in accordance with waterproofing manufacturer's instructions. Saturate cold joint surface with clean water, and remove excess water before application of coat of waterproofing admixture slurry. Apply slurry coat uniformly with semi-stiff bristle brush at rate recommended by waterproofing manufacturer.

F. In locations where new concrete is doweled to existing work, drill holes in existing concrete, insert steel dowels and pack solid with non-shrink grout.

3.3 INSTALLING REINFORCEMENT AND OTHER EMBEDDED ITEMS

A. Fabricate and handle epoxy-coated reinforcing in accordance with ASTM D3963/D3963M.

B. Comply with requirements of ACI SPEC-301. Clean reinforcement of loose rust and mill scale, and accurately position, support, and secure in place to achieve not less than minimum concrete coverage required for protection.

C. Install welded wire reinforcement in maximum possible lengths, and offset end laps in both directions. Splice laps with tie wire.

D. Verify that anchors, seats, plates, reinforcement and other items to be cast into concrete are accurately placed, positioned securely, and will not interfere with concrete placement.

3.4 PLACING CONCRETE

A. Place concrete in accordance with ACI PRC-304.

B. Maintain records of concrete placement. Record date, location, quantity, air temperature, and test samples taken.

C. Ensure reinforcement, inserts, waterstops, embedded parts, and formed construction joint devices will not be disturbed during concrete placement.

D. Place concrete continuously without construction (cold) joints wherever possible; where construction joints are necessary, before next placement prepare joint surface by removing laitance and exposing the sand and sound surface mortar, by sandblasting or high-pressure water jetting.

3.5 SLAB JOINTING

A. Locate joints as indicated on drawings.

B. Anchor joint fillers and devices to prevent movement during concrete placement.

C. Isolation and Expansion Joints: Use preformed joint filler with removable top section for joint sealant, total height equal to thickness of slab, set flush with top of slab.

1. Install wherever necessary to separate slab from other building members, including columns, walls, equipment foundations, footings, stairs, manholes, sumps, and drains.

D. Load Transfer Construction and Contraction Joints: Install load transfer devices as indicated; saw cut joint at surface as indicated for contraction joints.

E. Saw Cut Contraction Joints: Saw cut joints before concrete begins to cool, within 4 to 12 hours after placing; use 3/16 inch thick blade and cut at least 1 inch deep but not less than one quarter (1/4) the depth of the slab.

F. Construction Joints: Where not otherwise indicated, use metal combination screed and key form, with removable top section for joint sealant.

3.6 CONCRETE FINISHING

A. Repair surface defects, including tie holes, immediately after removing formwork.

B. Unexposed Form Finish: Rub down or chip off fins or other raised areas 1/4 inch or more in height.

C. Exposed Form Finish: Rub down or chip off and smooth fins or other raised areas 1/4 inch or more in height. Provide finish as follows:

1. Smooth Rubbed Finish: Wet concrete and rub with carborundum brick or other abrasive, not more than 24 hours after form removal.

3.7 CURING AND PROTECTION

A. Comply with requirements of ACI PRC-308. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.

B. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.

C. Formed Surfaces: Cure by moist curing with forms in place for full curing period.

D. Surfaces Not in Contact with Forms:

1. Initial Curing: Start as soon as free water has disappeared and before surface is dry. Keep continuously moist for not less than three days by water ponding, water-saturated sand, water-fog spray, or saturated burlap.
2. Final Curing: Begin after initial curing but before surface is dry.
    a. Moisture-Retaining Sheet: Lap strips not less than 3 inches and seal with waterproof tape or adhesive; secure at edges.
    b. Curing Compound: Apply in two coats at right angles, using application rate recommended by manufacturer.

3.8 FIELD QUALITY CONTROL

A. Provide free access to concrete operations at project site and cooperate with appointed firm.

B. Submit proposed mix design of each class of concrete to inspection and testing firm for review prior to commencement of concrete operations.

C. Tests of concrete and concrete materials may be performed at any time to ensure compliance with specified requirements.

D. Compressive Strength Tests: ASTM C39/C39M, for each test, mold and cure three concrete test cylinders. Obtain test samples for each day's pour plus one for every 25 cubic yards or less of each class of concrete placed.

E. Take one additional test cylinder during cold weather concreting, cured on job site under same conditions as concrete it represents.

F. Perform one slump test for each set of test cylinders taken, following procedures of ASTM C143/C143M.

3.9 DEFECTIVE CONCRETE

A. Defective Concrete: Concrete not complying with required lines, details, dimensions, tolerances or specified requirements.

B. Repair or replacement of defective concrete will be determined by the Engineer. The cost of additional testing shall be borne by Contractor when defective concrete is identified.

C. Do not patch, fill, touch-up, repair, or replace exposed concrete except upon express direction of Engineer for each individual area.

END OF SECTION

SECTION 32 12 16 – ASPHALT PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, MassDOT Standard Specifications for Highways and Bridges, and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Bituminous concrete paving
2. Bituminous concrete patching
3. Bituminous concrete paving overlay
4. Bituminous concrete curbing
5. Precast concrete wheel stops
6. Cold milling of existing bituminous concrete pavement

B. Related Sections:

1. Section 31 20 00 – Earthwork
2. Section 32 17 23 – Pavement Markings

1.3 DEFINITIONS

A. Bituminous Concrete Base Course: Asphalt-aggregate layer placed over subgrade, aggregate subbase course, or aggregate base course; and beneath bituminous concrete surface course.

B. Bituminous Concrete Surface Course: The asphalt-aggregate top course of a bituminous concrete pavement, sometimes called a wearing course.

1.4 SYSTEM DESCRIPTION

A. Provide bituminous concrete paving according to materials, workmanship, and other applicable requirements of the MassDOT Standard Specifications.

1.5 SUBMITTALS

A. Job-Mix Designs: Certification of each job mix proposed for the Work.

B. Shop Drawings: Indicate pavement markings, lane separations, and defined parking spaces. Indicate, with international graphics symbol, spaces dedicated to people with disabilities.

C. Qualification Data: For bituminous concrete supplier.

D. Material Certificates: For each paving material, signed by manufacturers.

1.6 QUALITY ASSURANCE

A. Supplier Qualifications: A qualified supplier, registered with and approved by MassDOT.

B. Obtain materials from same source throughout.

C. Installer Qualifications: Qualified according to ASTM D3666 for testing indicated.

D. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of MassDOT for asphalt paving work.

1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

E. Pre-installation Conference: Conduct conference at Project Site

1. Review methods and procedures related to hot-mix asphalt including but not limited to, the following:

a. Review proposed sources of paving materials, including capabilities and location of plant that will manufacture hot-mix asphalt.

b. Review condition of subgrade and preparatory work.

c. Review requirements for protecting paving work, including restriction of traffic during installation period and for remainder of construction period.

d. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.

F. Asphalt-Paving Publication: Comply with AI MS-22, "Construction of Hot Mix Asphalt Pavements," unless more stringent requirements are indicated.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver pavement-marking materials to the project site in original packages with seals unbroken and bearing manufacturer's labels containing brand name and type of material, date of manufacture, and directions for storage.

B. Store pavement-marking materials in a clean, dry, protected location within the temperature range required by manufacturer. Protect stored materials from direct sunlight.

C. Transport bituminous concrete mixture in tight body trucks that have been previously cleaned of foreign material.

1. Tightly cover trucks with waterproof canvas or other suitable covers.

D. Deliver mixture within 25 deg F (3.9 deg C) of approved job mix formula temperature.

1.8 PROJECT CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp or if the following conditions are not met:

1. Prime and Tack Coats: Minimum surface temperature of 60 deg F (15.5 deg C).

2. Slurry Coat: Comply with weather limitations of ASTM D 3910.

3. Bituminous Concrete Base Course: Minimum surface temperature of 40 deg F (4 deg C) and rising at time of placement.

4. Bituminous Concrete Surface Course: Minimum surface temperature of 60 deg F (15.5 deg C) at time of placement.

B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 50 deg F (10 deg C) and not exceeding 95 deg F (35 deg C).

PART 2 - PRODUCTS

2.1 MATERIALS

A. Hot Mix Asphalt Material: Standard Specifications, M3.06.0.

B. Aggregate: Standard Specifications, M3.06.02.

C. Tack Coat: ASTM D977 or emulsified asphalt, or ASTM D2397 cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.

D. Joint Sealer: Standard Specification, M3.05.0.

E. Hot Mix Asphalt for Sidewalks and Driveways: Standard Specifications, M3.07.0.

F. Processed Gravel: Refer to Section 31 20 00.

G. Gravel Borrow: Refer to Section 31 20 00.

H. Stabilization Fabric: Non-woven geotextile filter fabric shall meet the following requirements:
1. Filter fabric material shall conform to the following performance characteristics, measured per the test methods referenced:
    a. 4 oz., nonwoven needle punched geotextile composed of 100% polypropylene staple fibers that are inert to biological degradation and resists naturally encountered chemicals, alkalis, and acids.
    b. Grab Tensile Strength: ASTM D 4632: 115 lbs.
    c. Grab Tensile Elongation: ASTM D 4632: 50%
    d. Trapezoidal Tear: ASTM D4533: 50 lbs.
    e. Puncture: ASTM D4833: 65 lbs.
    f. Apparent Opening Size: ASTM D 4751: 0.212 mm, 70 U.S. Sieve
    g. Permittivity: ASTM D 4491: 2.0 sec -1
    h. Flow Rate: ASTM D 4491: 140 gal/min/s.f.

2.2 MIXES

A. Hot-Mix Asphalt Mixture Design: Standard Specifications, M3.06.4.

B. Asphalt Base Course: 3.0 to 6 percent of asphalt cement by weight in mixture in accordance with AI MS-2.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that surface to receive paving is dry and in suitable condition to support paving and imposed loads.

B. Verify gradients and elevations of base are correct.

C. Proof-roll subbase or aggregate base course using heavy, pneumatic-tired rollers to locate areas that are unstable or that require further compaction.

D. Proceed with paving only after unsatisfactory conditions have been corrected.

3.2 PATCHING

A. Removal: Saw cut perimeter of patch and excavate existing pavement section to sound base.

1. Excavate rectangular or trapezoidal patches, extending 12 inches (305 mm) into adjacent sound pavement, unless otherwise indicated.

2. Cut excavation faces vertically and remove excavated material.

3. Recompact existing unbound-aggregate base course to form new subgrade

B. Tack Coat: Apply tack coat on asphalt or concrete surfaces over subgrade surface at uniform rate of.05 gal/sq yd (.23 L/sq m) to.15 gal/sq yd (.68 L/sq m).

C. Patching: Partially fill excavated pavements with hot-mix asphalt base mix and, while still hot, compact.

1. Cover asphalt base course with tack coat.

2. Cover with hot mix surface layer compacted and finished flush with adjacent surfaces.

3.3 REPAIRS

A. Leveling Course: Install and compact leveling course consisting of hot-mix asphalt surface course to level sags and fill depressions deeper than 1 inch (25 mm) in existing pavements.

1. Install leveling wedges in compacted lifts not exceeding 3 inches (75 mm) thick.

B. Crack and Joint Filling: Remove existing joint filler material from cracks or joints to a depth of 1/4 inch (6 mm).

1. Clean cracks and joints in existing hot-mix asphalt pavement.

2. Use emulsified-asphalt slurry to seal cracks and joints less than 1/4 inch (6 mm) wide. Fill flush with surface of existing pavement and remove excess.

3. Use hot-applied joint sealant to seal cracks and joints more than 1/4 inch (6 mm) wide. Fill flush with surface of existing pavement and remove excess.

3.4 SURFACE PREPARATION

A. General: Immediately before placing hot mix asphalt, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.

B. Sweep loose granular particles from surface of unbound-aggregate intermediate course. Do not dislodge or disturb aggregate embedded in compacted surface of intermediate course.

C. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of.05 gal/sq yd (.23 L/sq m).

1. Allow tack coat to cure undisturbed before applying hot mix asphalt paving.

2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.5 HOT MIX ASPHALT PLACING

A. Machine place hot mix asphalt on prepared surface, spread uniformly, and strike off. Place by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.

1. Place hot mix asphalt surface course in single lift.

2. Spread mix at minimum temperature of 250 F degrees (121 C degrees).

3. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes, unless otherwise indicated.

4. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in hot mix asphalt paving mat.

5. In areas inaccessible to pavers, use staked forms to maintain indicated line and grade. Prevent segregation of mix when placing mix by hand.

B. Place paving in consecutive strips not less than 10 feet (3 m) wide unless infill edge strips of a lesser width are required.

1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips.

C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.6 JOINTS

A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions with same texture and smoothness as other sections of hot mix asphalt course.

1. Clean contact surfaces and apply tack coat to joints.

2. Offset longitudinal joints, in successive courses, a minimum of 6 inches (150 mm).

3. Offset transverse joints, in successive courses, a minimum of 24 inches (610 mm).

4. Compact joints as soon as hot mix asphalt will bear roller weight without excessive displacement.

5. Compact material at joints to a density within 2 percent of specified course density.

3.7 COMPACTION

A. General: Begin compaction as soon as placed paving material will bear roller weight without excessive displacement. Compact material with hot, hand tampers or vibratory-plate compactors in areas inaccessible to rollers.

1. Complete compaction before mix temperature cools to 185 F degrees (85 C degrees).

2. To prevent adhesion of the mixture to the rolls, keep rolls moist with water. Excess liquid shall not be permitted.

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot mix asphalt is still hot enough to achieve specified density. Continue rolling until course has been uniformly compacted to the following density.

1. Average Density: 95 percent of reference maximum theoretical density, but not less than 92 percent nor greater than 97 percent.

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot mix asphalt is still warm.

E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while material is still hot; compact thoroughly.

F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh material. Compact by rolling to specified density and surface smoothness.

G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.8 COLD MILLING

A. Utility Structures: Identify, adjust and protect utility structure frames, grates and covers.

B. Clean existing pavement surface of loose and deleterious material immediately before cold milling. Prevent milled pavement particles from entering drainage system. Remove existing bituminous concrete pavement by cold milling to grades and cross sections indicated.

1. Mill to a depth of 1-1/2 inches (38 mm)

2. Mill to a uniform finished surface free of gouges, grooves, and ridges.

3. Control rate of milling to prevent tearing of existing bituminous concrete course.

4. Repair or replace curbs, manholes, and other construction damaged during cold milling.

5. Excavate and trim unbound-aggregate base course, if encountered, and keep material separate from milled bituminous concrete.

6. Transport bituminous concrete to recycling facility.

7. Keep milled pavement surface free of loose material and dust.

8. Clean adjacent roads, parking areas, and grass areas of milled pavement particles.

3.9 WHEEL STOPS

A. Securely attach wheel stops into pavement with not less than two galvanized steel dowels embedded at one-quarter to one-third points. Securely install dowels into pavement and bond to wheel stop. Recess head of dowel beneath top of wheel stop.

3.10 TOLERANCES

A. Flatness: Maximum variation of 1/4 inch (6 mm) measured with 10 foot (3 m) straight edge.

B. Compacted Thickness: Within 1/4 inch (6 mm) of specified or indicated thickness.

C. Variation from True Elevation: Within 1/2 inch (12 mm).

3.11 FIELD QUALITY CONTROL

A. Provide free access to asphalt operations at project site and cooperate with appointed firm.

B. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D3549/S3549M.

C. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement according to ASTM D979/D979M.

1. Reference maximum theoretical density will be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D2041/D2041M, and compacted according to job-mix specifications.

2. In-place density of compacted pavement will be determined by testing core samples according to ASTM D1188 or ASTM D2726/D2726M.

    a. One core sample will be taken for every 1,000 square yards (836 square meters) or less of installed pavement, with no fewer than three test performed.

    b. Field density of in-place compacted pavement may also be determined by nuclear method according to ASTM D2950/D2950M and correlated with ASTM D1188 or ASTM D2726/D2726M.

3. Replace and compact hot-mix asphalt where core tests were taken.

4. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.12 DISPOSAL

A. Except for material indicated to be recycled, remove excavated materials from Project site and legally dispose of them in an approved landfill.

1. Do not allow excavated materials to accumulate on site.

END OF SECTION

SECTION 32 13 73 - CONCRETE PAVING JOINT SEALANTS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, MASSDOT Standard Specifications for Highways and Bridges, and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes:

1. Self-leveling pourable joint sealants.

B. Related Sections

1. Section 32 05 23 - Cement and Concrete for Exterior Improvements
2. Section 31 13 13 - Concrete Paving

1.3 REFERENCE STANDARDS

A. ASTM C661 - Standard Test Method for Indentation Hardness of Elastomeric-Type Sealants by Means of a Durometer; 2015.

B. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2018.

C. ASTM C1193 - Standard Guide for Use of Joint Sealants; 2016.

1.4 SUBMITTALS

A. Product Data for Sealants: Submit manufacturer's technical data sheets for each product to be used, that includes the following.

PART 2 PRODUCTS

2.1 SELF-LEVELING SEALANTS

A. Self-Leveling Polyurethane Sealant for Horizontal Expansion Joints: ASTM C920, Grade P, Uses T; multi-component; explicitly approved by manufacturer for horizontal expansion joints.

1. Movement Capability: Plus and minus 25 percent, minimum.
2. Hardness Range: 30 to 35, Shore A, when tested in accordance with ASTM C661.
3. Color: Match adjacent concrete surface.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that joints are ready to receive work.

B. Verify that backing materials are compatible with sealants.

3.2 PREPARATION

A. Remove loose materials and foreign matter that could impair adhesion of sealant.

B. Clean joints, and prime as necessary, in accordance with manufacturer's instructions.

C. Perform preparation in accordance with manufacturer's instructions and ASTM C1193.

D. Mask elements and surfaces adjacent to joints from damage and disfigurement due to sealant work; be aware that sealant drips and smears may not be completely removable.

3.3 INSTALLATION

A. Perform work in accordance with sealant manufacturer's requirements for preparation of surfaces and material installation instructions.

B. Perform installation in accordance with ASTM C1193.

C. Install sealant free of air pockets, foreign embedded matter, ridges, and sags, and without getting sealant on adjacent surfaces.

D. Do not install sealant when ambient temperature is outside manufacturer's recommended temperature range, or will be outside that range during the entire curing period, unless manufacturer's approval is obtained and instructions are followed.

E. Nonsag Sealants: Tool surface slightly recessed, unless otherwise indicated; remove masking tape immediately after tooling sealant surface.

3.4 POST-OCCUPANCY

A. Post-Occupancy Inspection: Perform visual inspection of entire length of project sealant joints at a time that joints have opened to their greatest width; i.e. at low temperature in thermal cycle. Report failures immediately and repair.

END OF SECTION

SECTION 32 14 00 – UNIT PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, MASSDOT Standard Specifications for Highways and Bridges Construction and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes:

1. Permeable pavers.

B. Related Sections:

1. Section 01 57 13 - Temporary Erosion and Sedimentation Control
2. Section 31 10 00 - Site Clearing
3. Section 31 20 00 - Earthwork

1.3 DEFINITIONS

A. FRP: Fiberglass-reinforced plastic.

1.4 SUBMITTALS

A. Product Data/Certificates: For each type of product indicated.

1. Permeable pavers
2. Filter Fabric/Nonwoven geotextile

B. Shop Drawings:

1. Permeable pavers:
   a. Height, thickness of pavers, thickness of base, and interior dimensions
   b. Layout pattern

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect materials from dirt and damage.

1.6 PROJECT CONDITIONS

A. Site Information: Research public utility records and verify existing utility locations prior to construction.

PART 2 - PRODUCTS

2.1 PERMEABLE PAVERS

A. Description: Shall consist of permeable pavers installed in locations and to the dimensions specified on the Contract Drawings.

1. Permeable Pavers: Shall consist of Eco-Priora Permeable Concrete Pavers as manufactured by Unilock or approved equal. Pavers shall meet the minimum material and physical properties set forth in ASTM C 936, Standard Specification for Interlocking Concrete Paving Units. Efflorescence is not a cause for rejection.

   a. Average compressive strength 8000 psi (55MPa) with no individual unit under 7,200 psi (50 MPa).

   b. Average absorption of 5% with no unit greater than 7% when tested according to ASTM C 140.

   c. Resistance to 50 freeze-thaw cycles, when tested according to ASTM C1645, with no breakage greater than 1.0% loss in dry weight of any individual unit. Conduct this test method not more than 12 months prior to delivery of units.

2. Color: Granite blend.

3. Laying Pattern: Running Bond.

4. Finish: Standard.

5. Size: Manufacture the sizes indicated with a maximum tolerance of plus or minus 1/16 in all directions. Locations as indicated on Project Drawings.

   a. 120 mm (5 in) x 240 mm (10 in) x 80 mm (3-1/8 in) thick

   b. 240 mm (10 in) x 240 mm (10 in) x 80 mm (3-1/8 in) thick

   Note: Imperial dimensions are nominal equivalents to the metric dimensions.

6. Permeable Joint Opening Aggregate: 1/8 inch to 3/16 inch Granite chips conforming to ASTM C 33 and following gradation requirements:

U.S. Standard Sieve Size	% Passing By Weight
1/4 Inch	97 - 100
No. 4	70 - 83
No. 8	37 - 50
No. 16	0 - 12

7. Bedding Layer: Clean, crushed aggregate conforming to ASTM C 33 and gradation requirements of ASTM D 448 No. 8 as follows:

U.S. Standard Sieve Size	% Passing By Weight
1/2 Inch	100
3/8 Inch	85 - 100
No. 4	10 - 30
No. 8	0 - 10
No. 16	0 - 5

8. Permeable Base Layer: Clean, washed stone aggregate conforming to ASTM C 33 and gradation requirements of ASTM D 448 No. 57 as follows:

U.S. Standard Sieve Size	% Passing By Weight
1-1/2 Inch	100
1 Inch	95 - 100
1/2 Inch	25 - 60
No. 4	0 - 10
No. 8	0 - 5

9. Reservoir Course: Clean, crushed stone aggregate conforming to ASTM C 33 and gradation requirements of ASTM D 448 No. 2 as follows:

U.S. Standard Sieve Size	% Passing By Weight
3 Inch	100
2- 1/2 Inch	90 - 100
2 Inch	35 - 70
1-1/2 Inch	0 - 15
3/4	0 - 5

10. Non-Woven Geotextile/Filter Fabric: Non-woven filter fabric shall meet the following requirements:

    a. Filter fabric material shall conform to the following performance characteristics, measured per the test methods referenced:

        1) 4 oz., nonwoven needle punched geotextile composed of 100% polypropylene staple fibers that are inert to biological degradation and resists naturally encountered chemicals, alkalis, and acids.

        2) Grab Tensile Strength: ASTM D 4632: 115 lbs.

        3) Grab Tensile Elongation: ASTM D 4632: 50%

        4) Trapezoidal Tear: ASTM D4533: 50 lbs.

        5) Puncture: ASTM D4833: 65 lbs.

        6) Apparent Opening Size: ASTM D 4751: 0.212 mm, 70 U.S. Sieve

        7) Permittivity: ASTM D 4491: 2.0 sec -1

        8) Flow Rate: ASTM D 4491: 140 gal/min/s.f.

PART 3 - EXECUTION

3.1 PERMEABLE PAVERS

A. Compact subgrade uniformly to at least 95 percent Modified Proctor per ASTM D 1557.

B. Install non-woven filter fabric along the sides of the excavation.

C. Install the reservoir course in uniform lifts not exceeding 6 inches loose thickness and compact with at least two passes in the vibratory mode then at least two in the static mode with a minimum 10-ton vibratory roller until there is no visible movement. Do not crush aggregate with the roller. Do not exceed the specified surface grade of the reservoir course material by more than 3/4± inches.

D. Install the permeable base layer atop the reservoir course layer in uniform lifts not exceeding 6 inches and compact to at least 95 percent as per ASTM D 4254 with at least two passes in the vibratory mode then at least two in the static mode with a minimum 10-ton vibratory roller until there is no visible movement. Do not crush aggregate with the compaction device. Do not exceed the specified surface grade of the compacted permeable base layer more than 1/2± inches. Grade and compact the upper surface of the permeable base layer material sufficiently to prevent infiltration of the bedding layer to be installed above it. Aggregate material both during construction and throughout its service life.

E. Install the bedding layer atop the permeable base layer. Provide and spread the bedding layer aggregate evenly over the permeable base layer and screed to a nominal thickness of 1-1/2 inches. Protect the screeded bedding layer from being disturbed.

F. Screed only the area which can be covered by pavers in one day. Do not use bedding layer aggregate material to fill depressions in the permeable base layer surface. Keep moisture content constant and density loose and constant until the permeable pavers are set and compacted.

G. Install permeable pavers in accordance with manufacturer instructions. Replace unit pavers with chips, cracks, voids, discolorations, and other defects that might be visible in finished work prior to installation. Vibrate pavers into leveling course with a low-amplitude plate vibrator capable of a 5000-lbf (22-kN) compaction force at 80 to 90 Hz. Perform at least three passes across paving with vibrator. Vibrate only after edge pavers are installed and there is a completed surface. Protect concrete paver surface from scuffing during compaction by utilizing a urethane pad. Remove any cracked or structurally damaged pavers and replace with new units prior to installing Permeable Joint Opening Aggregate material.

H. Provide, spread and sweep Permeable Joint Opening Aggregate into joints immediately after vibrating pavers until full. Vibrate pavers and add Permeable Joint Opening Aggregate material until joints are completely filled, then remove excess material. This will require at least 4 passes with a plate compactor. Remove excess Permeable Joint Aggregate broom clean from surface when installation is complete.

3.2 FIELD QUALITY CONTROL

A. Permeable Pavers:

1. Verify final elevations for conformance to the Contract Drawings after sweeping the surface clean.

a. Prevent final permeable paver finished grade elevations from deviating more than ±3/8 in. under a 10 ft (3 m) straightedge or indicated slope, for finished surface of paving.

b. Lippage: No greater than 1/32-inch difference in height between permeable pavers and adjacent paved surfaces.

END OF SECTION

SECTION 32 14 43 - POROUS UNIT PAVING

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, MASSDOT Standard Specifications for Highways and Bridges, and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes:

1. Reinforced gravel walkway system

B. Related Sections

1. Section 31 20 00 – Earthwork

1.3 REFERENCE STANDARDS

A. ASTM F 1951-08: Standard Specification for Determination of Accessibility of Surface Systems Under and Around Playground Equipment.

B. ASTM D 638-10: Standard Test Method for Tensile Properties of Plastics

C. ASTM C 33: Standard Specification for Concrete Aggregates

1.4 SUBMITTALS

A. Shop Drawings: Submit design detail showing proper cross-section.

B. Samples: Submit manufacturer's sample of porous unit paving system in 10-inch by 10-inch size or greater.

C. Installation Instructions: Manufacturer's printed installation instructions. Include methods for maintaining installed products.

D. Certificates:

1. Manufacturer-signed certificate stating the product is made in the USA.
2. Submit Material Certificates for base course and gravel fill materials.
3. Product certificates signed by the manufacturer certifying material compliance of polyethylene used to make porous pavement system units.
4. ISO Certificate certifying manufacturer's quality management system is currently registered to ISO 9001:2008 quality standards.

E. Substitutions: Porous unit paving system will be considered as an equivalent to the system specified herein provided they meet all areas of this specification without exception. Manufacturers seeking to supply what they represent as equivalent material must submit records, data, independent test results, samples, certifications, and documentation deemed necessary by

the Engineer to prove equivalency.

F. Manufacturer's Material Certification: Product manufacturers shall provide certification of compliance with all applicable testing procedures and related specifications upon written request. Request for certification shall be submitted by the purchasing agency no later than the date of order placement.

1. Product manufacturers shall also have a minimum of 20 years' experience producing products for porous pavement systems.

G. Manufacturer Quality Certification: ISO Certification certifying manufacturer's quality management system for its porous pavement system is currently registered to ISO 9001:2008 quality standards. Any alternate materials from the system specified herein shall provide a certification that their porous pavement system manufacturing process is part of an ISO program, and a certification will be required specifically stating that their testing facility is certified and in accordance with ISO.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

B. Protect porous paving system units/rolls from damage during delivery and store rolls upright, under tarp, to protect from sunlight, when time for delivery to installation exceeds one week.

C. Store anchor pins and washers in a secure location protected from theft or damage.

D. Handling: Protect materials during handling and installation to prevent damage.

1.6 QUALITY ASSURANCE

A. Manufacturer warrants to its purchasers that all products furnished will be free from defects in material and/or workmanship.

B. This warranty shall be extended for a period of five (5) years following the date of shipment.

PART 2 - PRODUCTS

2.1 UNIT PAVING

A. Acceptable Product: GravelPave2 or accepted equal, meeting specifications outlined herein.

B. Acceptable Manufacturer: Invisible Structures, Inc., which is located at: 3510 Himalaya Rd. Suite 200; Aurora, CO 80011; Tel: 303-233-8383; Web: www.invisiblestructures.com.

C. Composition:

1. Manufactured in the USA.

2. High-density polyethylene (HDPE): 100 percent recycled materials.

3. Geotextile fabric backing injection molded to the grid system.

4. Color: black, terra cotta, gray, or tan. Custom colors may be available – Contact the manufacturer.

5. Color Uniformity: Uniform color throughout all unit rolls.
6. Carbon Black for ultraviolet light stabilization.
7. Anchor pins and washers, provided by manufacturer with Gravelpave2.

D. Performance Properties:

1. Maximum Loading Capability: 15,940 psi (2.29 million psf, 109,906 kPa) when filled with gravel.
2. Wheelchair Access testing for ADA Compliance: Passing ASTM F 1951-08.
3. Tensile strength, pull-apart testing: 458 lbf/in from ASTM D638 Modified.
4. System Permeability (Gravelpave2, sand, base course): 2.63 to 38.55 inches of water per hour.
5. Effective Imperviousness (E.I.): 10%.

E. Dimensions (individual units are assembled and distributed into rolls):

1. Roll area: From 108 sq ft (10 sq m) to 538 sq ft (50 sq m), in 108 sq ft (10 sq m) increments
2. Roll Widths: From 3.3 ft (1 m) to 8.2 ft (2.5 m), in 1.6 ft (0.5 m) increments.
3. Roll Lengths: From 32.8 ft (10m) to 65.6 ft (20 m), in 3.3 ft (1 m) increments.
4. Roll Weights: From 41 lbs (19kg) to 205 lbs (93kg), in 41 lbs (19 kg) increments.
5. Unit Nominal Width by Length: 20 inches by 20 inches (0.5 m by 0.5 m) or 40 inches by 40 inches (1 m by 1 m).
6. Nominal Depth: 1 inch (2.5 cm) – for rolls and individual units.
7. Unit Weight: 19 oz (535 g) or 5 lbs. (2.27 kg).
8. Volume Solid: 8 percent.

2.2 SYSTEM COMPONENTS

A. Base Course: Gravel Borrow conforming to the gradation requirements of Section M1.03.0 Type D of the Standard Specifications

1. Alternative size and/or composition of base course materials should be submitted to Invisible Structures, Inc. (Manufacturer) for approval.

B. Gravel Fill: Clean, washed, fine decorative gravel, must be sharp and angular (not rounded) stone, granite hardness. Maximum size of stone shall be: 3/16" to 3/8" (5 mm to 10 mm) and uniform in size - not graded.

C. Anchors: Typical anchors shall be 8-inch-long nails with "fender" type washers 7 x 30 mm od (5/16" id x 1.25") od, all galvanized metal or similar corrosion resistant coating. Supplied anchors may vary in size and type based on source and availability.

PART 3 - EXECUTION

3.1 GENERAL

A. Examine subgrade and base course installed conditions. Do not start porous paving installation until unsatisfactory conditions are corrected. Check for improperly compacted trenches, debris, and improper gradients. Engineer shall inspect subgrade before installing base course.

B. Start of installation constitutes acceptance of existing conditions and responsibility for satisfactory performance. If existing conditions are found unsatisfactory, contact Engineer for resolution.

C. Maintain environmental conditions within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

D. Do not begin installation of porous pavements until all hard surface paving adjacent to porous pavement areas, including concrete walks and asphalt paving, is completed.

E. Install porous pavement system units when ambient air temperatures is at least 55 degrees F (13 degrees C).

F. In cold weather, do not use frozen materials or materials mixed or coated with ice or frost, and do not build on frozen base or wet, saturated, or muddy subgrade

3.2 GENERAL

A. Subgrade Preparation:

1. Prepare subgrade as specified in Section 32 20 00 - Earthwork. Verify subgrade in accordance with porous paving system manufacturer's instructions.

2. Proper subgrade preparation will enable the porous pavement system rolls/units to connect properly and remain level and stationary after installation.

3. Excavate area allowing for unit thickness, the engineered base depth (where required), and 0.5 inch (1.25 cm) for 0.25 inch (6mm) gravel overfill and slight recession to contain gravel.

4. Provide adequate drainage from excavated area if area has potential to collect water, when working with subgrade that has poor permeability.

5. Ensure subgrade is relatively dry and free from standing water.

6. Uniformly grade subgrade.

7. Level and clear subgrade of large objects, such as rocks and pieces of wood.

G. Base Preparation:

1. Install Base as specified in Section 32 20 00 - Earthwork. Verify engineered base (if required) is installed in accordance with porous paving system manufacturer's instructions.

2. Place engineered base in lifts not to exceed 6 inches (150 mm), compacting each lift separately.

H. Gravel Fill

1. Fill the 25 mm (1") high rings and spaces between the rings. Do not overfill by more than 1/4" (6 mm).

3.3 PROTECTION

A. Prohibit traffic, parking on, or use of the paving system until installation is completed. Damage

caused by Contractor operations during construction shall be repaired and damaged portions of the system replaced by the Contractor at no additional cost to the Owner.

B. Any barricades constructed must still be accessible by emergency and fire equipment during and after installation.

3.4 FIELD QUALITY CONTROL

A. Remove and replace segments of paving units where three or more adjacent rings are broken or damaged, reinstalling as specified, so no evidence of replacement is apparent.

B. Perform cleaning during the installation of work and upon completion of the work. Remove all excess materials, debris, and equipment from site. Repair any damage to adjacent materials and surfaces resulting from installation of this work.

3.5 MAINTENANCE

A. The Contractor shall be responsible for maintenance of the porous pavement system until site work is complete. Refer to manufacturer's maintenance guidelines.

B. Keep area free of and remove organic material such as soil runoff, tree leaves, fruit, and other vegetation debris.

C. Broom or rake gravel smooth to no more than 6mm (0.25") above the rings.

D. Refill areas with gravel aggregate where walls of the rings are more than 3mm (0.125") exposed.

E. When snow removal is required, keep a metal edged plow blade a minimum of 17mm (0.75") above the gravel surface during plowing operations to avoid causing damage to the paving system units, or

1. Use a plow blade with a flexible rubber edge, or
2. Use a plow blade with skids on the lower outside corners set so the plow blade does not come in contact with the units.

END OF SECTION

SECTION 32 16 14 - CURBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, MassDOT Standard Specifications for Highways and Bridges and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Vertical granite roadway curb
2. Granite curb returns

B. Related Sections

1. Section 31 20 00 - Earthwork
2. Section 32 12 16 – Asphalt Paving
3. Section 03 30 00 – Cast-In-Place Concrete

1.3 SUBMITTALS

A. Material Certification. For each product, certifying material meets the Specification requirements.

1.4 QUALITY ASSURANCE

A. Comply with pertinent materials, workmanship, and other applicable requirements of Subsections 500, M4, and M9 of the Standard Specifications, as applicable and appropriate.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Vertical Face and Flush Granite Curb: In accordance with Subsection M9.04.1 (Type VA4) of the Standard Specifications with ¾-inch chamfer as shown on Contract Drawings.

B. Granite Curb Corner: In accordance with Subsection M9.04.6 (Type B) of the Standard Specifications with ¾-inch chamfer as shown on the Contract Drawings.

C. Mortar (between planter wall curbing joints): Shall conform to Subsection M4.02.15 of the Standard Specifications.

D. Concrete Curb Lock: Install unreinforced concrete curb lock, conforming to Subsection M4.02.00, at the base of installed curb in accordance with the Contract Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Excavate, prepare foundation, set curb, and point joints in accordance with the dimensions shown on the Contract Drawings or as directed by the Engineer and as included in Subsection 500 of the Standard Specifications. The gravel subbase upon which the curbing is placed shall be compacted to a firm, even surface. All soft and unsuitable materials below curbing shall be removed and replaced with gravel borrow material. Gravel borrow, if required, shall be placed in layers not exceeding 6 inches in depth before compaction. Each layer shall be compacted to 95 percent of maximum density (AASHTO-180) by means of a vibratory compactor of size and type approved by Engineer.

B. Install curbing as indicated on the Contract Drawings and as recommended by manufacturer. The curbing shall be set such that the front top arris line conforms to the required line and grade.

1. Maintain 6-inch curb reveal between top of curb placed along roadway and top of adjacent roadway surface course.

2. Install curbing as indicated on the Contract Drawings and as recommended by manufacturer. The curbing shall be set such that the front top arris line conforms to the required line and grade.

3. Curbing units shall be placed end-to-end as close as possible. No more than ½-inch opening shall show for the full width of the top and the top 8 inches of the vertical joint.

C. Install unreinforced concrete curb lock at the base of installed curbing in accordance with the Contract Drawings.

D. After the curbing has been set and curb lock has hardened, any remaining excavated areas shall be backfilled with approved material and thoroughly compacted back and front to grade in accordance with Subsection 501.65 of the Standard Specifications. Methods of compaction shall preserve the line and grade of the curbing.

E. The joints between curbstones (both front and back) shall be carefully filled with cement mortar and neatly pointed on the top and front exposed portions. After pointing, the curbstones shall be satisfactorily cleaned of all excess mortar that may have been forced out of the joints.

3.2 INSTALLATION TOLERANCES

A. Curb Alignment: 1/4-inch maximum, as determined by using a 10-foot straight edge along front face of curb.

END OF SECTION

SECTION 32 17 23.13 - PAVEMENT MARKINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and Division 01 specification Sections apply to the work of this Section.

1.2 SUMMARY

A. This Section includes

1. Painted pavement markings.

B. Related Sections

1. Section 32 05 23 – Cement and Concrete for Exterior Improvements.
2. Section 32 12 16 - Asphalt Paving.

1.3 REFERENCE STANDARDS

A. FHWA MUTCD - Manual on Uniform Traffic Control Devices for Streets and Highways.

U.S. Department of Transportation, Federal Highway Administration; Current Edition.

B. Standard Specifications - "The Commonwealth of Massachusetts, Massachusetts Department of Transportation, Standard Specifications for Highways and Bridges" and supplements, excluding provisions for "Method of Measurement" and "Basis of Payment".; 2023 Edition.

1.4 SUBMITTALS

A. Product Data: Manufacturer's data sheets on each product to be used, including:

1. Preparation instructions and recommendations.
2. Storage and handling requirements and recommendations.
3. Installation methods.

B. Certificates: Submit each batch of paint stating compliance with specified requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver paint in containers of at least 5 gallons (18 L).

B. Store products in manufacturer's unopened packaging until ready for installation.

C. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.6 FIELD CONDITIONS

A. Do not install products under environmental conditions outside manufacturer's absolute limits.

PART 2 PRODUCTS

2.1 MATERIALS

A. Thermoplastic Reflectorized Pavement Markings:

1. White: Standard Specifications, Section M7.01.05.

2. Yellow: Standard Specifications, Section M7.01.06.

B. Glass Beads: Standard Specifications, Section M7.01.07.

C. Temporary Marking Tape: Preformed, reflective, pressure sensitive adhesive tape in color(s) required; Contractor is responsible for selection of material of sufficient durability as to perform satisfactorily during period for which its use is required.

PART 3 EXECUTION

3.1 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

3.2 PREPARATION

A. Allow new pavement surfaces to cure for a period of not less than 14 days before application of marking materials.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

C. Clean surfaces thoroughly prior to installation.

1. Remove dust, dirt, and other granular surface deposits by sweeping, blowing with compressed air, rinsing with water, or a combination of these methods.

D. Where oil or grease are present, scrub affected areas with several applications of trisodium phosphate solution or other approved detergent or degreaser, and rinse thoroughly after each application; after cleaning, seal oil-soaked areas with cut shellac to prevent bleeding through the new paint.

E. Establish survey control points to determine locations and dimensions of markings; provide templates to control paint application by type and color at necessary intervals.

F. Temporary Pavement Markings: When required or directed by Engineer, apply temporary markings of the color(s), width(s) and length(s) as indicated or directed.

1. After temporary marking has served its purpose, remove temporary marking by carefully controlled sandblasting, approved grinding equipment, or other approved method so that surface to which the marking was applied will not be damaged.

2. At Contractor's option, temporary marking tape may be used in lieu of temporary painted marking; remove unsatisfactory tape and replace with painted markings at no additional cost to Owner.

3.3 INSTALLATION

A. Begin pavement marking as soon as practicable after surface has been cleaned and dried.

B. Do not apply paint if temperature of surface to be painted or the atmosphere is less than 50 degrees F (10 degrees C) or more than 95 degrees F (35 degrees C).

C. Apply in accordance with manufacturer's instructions using an experienced technician that is thoroughly familiar with equipment, materials, and marking layouts.

D. Comply with FHWA MUTCD manual (http://mutcd.fhwa.dot.gov) for details not shown.

E. Apply markings in locations determined by measurement from survey control points; preserve control points until after markings have been accepted.

F. Apply uniformly painted markings of color(s), lengths, and widths as indicated on drawings true, sharp edges and ends.

1. Apply paint in one coat only.

2. Wet Film Thickness: 0.015 inch (0.4 mm), minimum.

3. Width Tolerance: Plus or minus 1/8 inch (3 mm).

G. Roadway Traffic Lanes: Use suitable mobile mechanical equipment that provides constant agitation of paint and travels at controlled speeds.

1. Conduct operations in such a manner that necessary traffic can move without hindrance.

2. Place warning signs at the beginning of the wet line, and at points well in advance of the marking equipment for alerting approaching traffic from both directions. Place small flags or other similarly effective small objects near freshly applied markings at frequent intervals to reduce crossing by traffic.

3. If paint does not dry within expected time, discontinue paint operations until cause of slow drying is determined and corrected.

4. Skip Markings: Synchronize one or more paint "guns" to automatically begin and cut off paint flow; make length of intervals as indicated.

5. Use hand application by pneumatic spray for application of paint in areas where a mobile paint applicator cannot be used.

H. Parking Lots: Apply parking space lines, entrance and exit arrows, painted curbs, and other markings indicated on drawings.

1. Mark the International Handicapped Symbol at indicated parking spaces.

2. Hand application by pneumatic spray is acceptable.

I. Symbols: Use a suitable template that will provide a pavement marking with true, sharp edges and ends, of the design and size indicated.

3.4 DRYING, PROTECTION, AND REPLACEMENT

A. Protect newly painted markings so that paint is not picked up by tires, smeared, or tracked.

B. Provide barricades, warning signs, and flags as necessary to prevent traffic crossing newly painted markings.

C. Allow paint to dry at least the minimum time specified by the applicable paint standard and not less than that recommended by the manufacturer.

D. Remove and replace markings that are applied at less than minimum material rates; deviate from true alignment; exceed length and width tolerances; or show light spots, smears, or other deficiencies or irregularities.

E. Remove markings in manner to avoid damage to the surface to which the marking was applied, using carefully controlled sand blasting, approved grinding equipment, or other approved method.

F. Replace removed markings at no additional cost to Owner.

END OF SECTION

SECTION 32 30 51 – WOOD GUARDRAIL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, MASSDOT Standard Specifications for Highways and Bridges, and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes:

1. Wood guardrail

B. Related Sections:

1. Section 31 20 00 - Earthwork

1.3 SUBMITTALS

A. Product Data: For preservative-treated wood products. Include chemical treatment manufacturer's written instructions for handling, storing, installing, and finishing treated material.

B. Material Certificates:

1. For preservative-treated wood products. Indicate type of preservative used and net amount of preservative retained. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

C. Certificates of Inspection: Issued by lumber grading agency for exposed wood products not marked with grade stamp.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Store materials under cover and protected from weather and contact with damp or wet surfaces. Stack lumber flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Lumber: Shall conform to Voluntary Product Standard PS-70 and be certified according to applicable standard grading and dressing rules and shall bear the official grade and/or trademark of the association under whose rules it is produced.

B. Wood:

1. All wood shall be #2 Southern Yellow Pine (Southern Pine Inspection Bureau Grading), having a stress grade of at least 1,500 psi, or equal. All wood to be new, solid, sound and surface dry with a maximum moisture content of 19%. All wood shall be clearly marked with the official grading information and shall conform to AASHTO M168.
2. Treatment: All wood shall be 0.40 pressure treated with Koppers Wolman CCA Salt Treatment to AWPA C14.
3. Rail and post sizes as indicated on the Drawing.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Set posts in holes dug in thoroughly compacted soil and the bottom of the hole shall be thoroughly rammed so that the posts will have a stable foundation.

B. Remove rock or boulders, if encountered during excavation, in order to provide a hole of sufficient size to set the posts to the normal depth as indicated on the Drawing.

C. Space posts as indicated on the Drawings. Set plumb and normally with the front face at a uniform distance from the edge of the travel way.

D. Backfill post hole excavations with an approved material and thoroughly compact.

E. Mount the rail on the post as indicated on the Drawings. Utilize galvanized bolts to anchor the rail to the posts.

1. Cut rail members accurately so as to provide even bearing over entire surface of joints.
2. No shimming of any kind will be allowed in making joints nor will open joints be accepted.
3. All exposed edges of member shall be chamfered.

F. Wooden guardrail posts with a through check, shake, or end split in the same plane as, or a plane parallel to, the bolt hole and extending from the top of the post to within 3 inches of the bolt hole, will be rejected.

END OF SECTION

SECTION 32 31 13 - CHAIN LINK FENCES AND GATES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, MASSDOT Standard Specifications for Highways and Bridges, and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes:

1. Posts, rails, and frames.
2. Wire fabric.
3. Manual gates with related hardware.
4. Accessories.

B. Related Sections

1. Section 32 05 23 - Cement and Concrete for Exterior Improvements

1.3 REFERENCE STANDARDS

A. ASTM A392 - Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric; 2011a (Reapproved 2017).

B. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength; 2018a.

C. ASTM F567 - Standard Practice for Installation of Chain-Link Fence; 2014a.

D. ASTM F1043 - Standard Specification for Strength and Protective Coatings on Steel Industrial Fence Framework; 2018.

E. ASTM F1083 - Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures; 2018.

F. CLFMI CLF-SFR0111 - Security Fencing Recommendations; 2014.

G. CLFMI WLG 2445 - Wind Load Guide for the Selection of Line Post and Line Post Spacing; 2018.

1.4 SUBMITTALS

A. Product Data: Provide data on fabric, posts, accessories, fittings and hardware.

B. Design Calculations: For high wind load areas, provide calculations for fence fabric and accessory selection as well as line post spacing and foundation details. See CLFMI WLG 2445 for line post and spacing guidance.

C. Shop Drawings: Indicate plan layout, spacing of components, post foundation dimensions, hardware anchorage, and schedule of components. See CLFMI CLF-SFR0111 for planning and design recommendations.

D. Manufacturer's Qualification Statement.

E. Fence Installer Qualification Statement.

1.5 QUALITY ASSURANCE

A. Design Engineer Qualifications: Provide design by or under direct supervision of Professional Engineer experienced in the work of this section and licensed in Massachusetts.

B. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.

C. Fence Installer: Company with demonstrated successful experience installing similar projects and products, with not less than five years of documented experience.

1.6 WARRANTY

A. Provide twenty-year manufacturer warranty.

PART 2 PRODUCTS

2.1 COMPONENTS

A. Contractor is responsible for design of chain link fencing and foundations.

B. Fabric: 2-inch diamond mesh interwoven wire, 6 gauge, 0.1920 inch thick, top selvage knuckle end closed, bottom selvage twisted tight.

C. Tension Wire: 6 gauge, 0.1920-inch-thick steel, single strand.

D. Tie Wire: Aluminum alloy steel wire.

2.2 MATERIALS

A. Posts, Rails, and Frames:

1. ASTM A1011/A1011M, Designation SS; hot-rolled steel strip, cold formed to pipe configuration, longitudinally welded construction, minimum yield strength of 50 ksi; zinc coating complying with ASTM F1043 and ASTM F1083.

B. Wire Fabric:

1. ASTM A392 zinc coated steel chain link fabric.

2.3 MANUAL GATES AND RELATED HARDWARE

A. Hardware for Single Swinging Gates: 180 degree hinges, 2 for gates up to 60 inches high, 3 for taller gates; fork latch with gravity drop and padlock hasp; keeper to hold gate in fully open position.

2.4 ACCESSORIES

A. Caps: Cast steel galvanized; sized to post diameter, set screw retainer.

B. Fittings: Sleeves, bands, clips, rail ends, tension bars, fasteners and fittings; steel.

C. Extension Arms: Cast steel galvanized, to accommodate 3 strands of barbed wire, single arm, vertical.

2.5 FINISHES

A. Components and Fabric: Vinyl coated over coating of 2.0 ounces per square foot galvanizing.

B. Accessories: Same finish as fabric.

C. Color(s): Black.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Verify that areas are clear of obstructions or debris and final grading has been completed.

3.2 INSTALLATION

A. Install framework, fabric, accessories and gates in accordance with ASTM F567.

B. Place fabric on outside of posts and rails.

C. Set intermediate posts plumb, in concrete footings with top of footing 2 inches above finish grade. Slope top of concrete for water runoff.

D. Provide top rail through line post tops and splice with 6-inch-long rail sleeves.

3.3 TOLERANCES

A. Maximum Variation from Plumb: 1/4 inch.

B. Maximum Offset from True Position: 1 inch.

3.4 CLEANING

A. Clean jobsite of excess materials; scatter excess material from post hole excavations uniformly away from posts. Remove excess material if required.

B. Clean fence with mild household detergent and clean water. Rinse well.

END OF SECTION

SECTION 32 31 19 – DECORATIVE METAL FENCES AND GATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, MASSDOT Standard Specifications for Highways and Bridges, and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes the following:

1. Furnishing and installing ornamental steel post fence in accordance with the Drawings and these specifications.

B. Related Sections

1. Section 31 00 00 – Earthwork
2. Section 32 05 23 – Cement and Concrete for Exterior Improvements

1.3 REFERENCES

A. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.

B. ASTM B117 - Practice for Operating Salt-Spray (Fog) Apparatus.

C. ASTM D523 - Test Method for Specular Gloss.

D. ASTM D714 - Test Method for Evaluating Degree of Blistering in Paint.

E. ASTM D822 - Practice for Conducting Tests on Paint and Related Coatings and Materials using Filtered Open-Flame Carbon-Arc Light and Water Exposure Apparatus.

F. ASTM D1654 - Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments.

G. ASTM D2244 - Test Method for Calculation of Color Differences from Instrumentally Measured Color Coordinates.

H. ASTM D2794 - Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).

I. ASTM D3359 - Test Method for Measuring Adhesion by Tape Test.

J. ASTM F2408 – Ornamental Fences Employing Galvanized Steel Tubular Pickets.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

C. Samples: For each fence material and for each color specified.

1. Provide Samples from manufacturer representative of finished project and showing color indicated on the Project Drawings.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Installation performed by licensed contractor with five years of experience in installing fences.

B. Field Measurements: Verify layout information for fences shown on Drawings in relation to property survey, existing structures, and proposed conditions. Verify dimensions by field measurements.

C. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.

1. Include 8-foot length of fence complying with requirements.

2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 COORDINATION

A. Coordinate with adjacent walls and surfaces where fence will be mounted.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle materials and products in strict compliance with manufacturer's instructions and industry standards.

B. Store products indoors in manufacturer's original containers and packaging, with labels clearly identifying product name and manufacturer. Protect from damage.

1.8 WARRANTY

A. Manufacturer's Standard Limited Warranty:

1. Warranty Period: 5 years.

PART 2 - PRODUCTS

2.1 DECORATIVE STEEL FENCES

A. Decorative Steel Fences:

1. Manufacturer: Subject to compliance with requirements, provide products by the following: Ameristar Perimeter Security or approved equal.

2. Product: Aegis II Xtreme – Magestic Style with 3 rails

3. Material: Heavy industrial strength welded steel

4. Height: 3.5 feet and 4 feet, varies by application

B. Posts: Square extruded tubes.

1. Posts: 4 inches square.

C. Post Caps: To be selected from Manufacturers standard steel castings post tops.

D. Post Base Plate: As shown on the Drawings.

E. Rails: 1-3/4 by 3-1/2 inches rails.

F. Pickets: steel tubes, 1 inch square.

1. Picket Spacing: 4.715 inches on center

G. Fasteners: manufacturer's standard internal fastening system.

H. Fabrication: Per manufacturer's recommendation.

I. Finish: All components shall be powder coated black.

2.2 CONCRETE

A. Concrete: Normal-weight, air-entrained, ready-mix concrete with a minimum 28-day compressive strength of 4000 psi, 3-inch slump, and 1-inch maximum aggregate size or dry, packaged, normal-weight concrete mix complying with ASTM C 387/C 387M mixed with potable water according to manufacturer's written instructions.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, construction layout, and other conditions affecting performance of the Work.

B. Do not begin installation before final grading is completed unless otherwise permitted by Engineer.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.3 DECORATIVE FENCE INSTALLATION

A. Install fences according to manufacturer's written instructions and project drawings.

B. Post Setting: Fasten posts to concrete walls and set posts in concrete into firm, undisturbed soil.

1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.

2. Concrete Fill: Place concrete around posts and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.

a. Concealed Concrete: Top 4 inches below grade as indicated on Drawings to allow covering with surface material. Slope top surface of concrete to drain water away from post.

3. Posts Set in Concrete: Extend post to 6 inches from the bottom of concrete.

4. Posts mounted on Concrete: As shown on Drawings.

5. Space posts uniformly as shown on Drawings.

3.4 CLEAN UP

A. The area of the fence line shall be left neat of any debris caused by the installation of the fence.

END OF SECTION

SECTION 32 32 23 - SEGMENTAL RETAINING WALLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, MASSDOT Standard Specifications for Highways and Bridges, and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes:

1. Segmental retaining walls made of modular concrete units with or without soil reinforcement, including:

a. Retaining wall units.

b. Cap units.

c. Shear connectors.

d. Soil reinforcement.

e. Reinforced backfill.

f. Drainage.

B. Related Sections

1. Section 31 20 00 – Earthwork

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Coordinate the installation of soil reinforcement with segmental retaining wall size, location, and installation of service utilities.

1. Provide gravity walls where site conditions do not allow for soil reinforcement.

1.4 SUBMITTALS

A. Segmental Retaining Wall Units:

1. Manufacturer's product data.

2. Test data on unit strength and shear resistance between units.

3. Test data on soil reinforcement connection.

4. Manufacturer's certification that units meet requirements of specification.

5. Storage and handling requirements and recommendations.

6. Installation methods.

B. Soil Reinforcement:

1. Manufacturer's product data.

2. Manufacturer's certificate that product meets requirements of specification.
3. Preparation instructions and recommendations.
4. Storage and handling requirements and recommendations.
5. Installation methods.

C. Shop Drawings: Engineering drawings for installation, including elevations, large-scale details of elevations, typical sections, details, and connections, soil reinforcement, and drainage provisions.

1. Include marked up contract drawings showing exact dimensions for blocks, required coping, and other minor revisions.
2. Design Data: Submit detailed design calculations showing compliance with specified design criteria and material evaluations performed in accordance with specified design standard, signed and sealed by Design Engineer.

D. Unit Sample: Two units typical of size, color, and finish texture specified.

E. Soil Reinforcement to Unit Connector: One connector.

F. Design Engineer's Qualification Statement.

G. Manufacturers' Qualification Statement.

H. Installer's Qualification Statement.

1.5 QUALITY ASSURANCE

A. Design Engineer Qualifications: Provide design by or under direct supervision of Professional Engineer experienced in the work of this section and licensed in Massachusetts.

B. Manufacturer Qualifications -- Concrete Units: Firm specializing in manufacturing products specified in this section and:

1. With not less than 5 years' experience.
2. Having a minimum of 1,000,000 square feet of successfully completed retaining walls.

C. Manufacturer Qualifications -- Soil Reinforcement: Firm specializing in manufacturing products specified in this section and:

1. With not less than 5 years' experience.
2. Having a minimum of 1,000,000 square feet of successfully completed retaining walls.

D. Installer Qualifications: Firm specializing in design and installation of segmental retaining walls and:

1. With not less than 5 years' documented experience.
2. With a minimum of five previously constructed successful projects, similar in size and magnitude, using specified retaining wall system; provide contact names and numbers.
3. Having site supervisor with verifiable qualified experience suitable for this project.

1.6 MOCK-UP

A. Prior to erection of retaining walls, provide mock-up for evaluation of installation workmanship.

B. Erect 5 feet sample wall using materials specified.

C. Locate mock-up where directed by Engineer.

D. Do not start masonry work until mock-up has been approved by Engineer.

E. Retain mock-up during construction as standard for judging completed work. Do not alter or destroy mock-up until work is completed.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store products above ground on wood pallets or blocking, in manufacturer's unopened packaging, until ready for installation.

B. Prevent excessive soil and mud from coming into contact with the face of concrete units.

C. Protect material from damage. Do not use damaged material. Remove damaged material from the site at no cost to the Owner.

D. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Segmental Retaining Walls:

1. Keystone Retaining Wall Systems LLC; Keystone Compac: www.keystonewalls.com/#sle.
2. Redi-Rock International; _____: www.redi-rock.com.
3. Unilock; Rivercrest Wall: www.unilock.com/#sle.
4. Versa-Lok Retaining Wall Systems; www.versa-lok.com.
5. Techo-Block; wwww.techo-bloc.com
6. Or approved equal

2.2 RETAINING WALLS

A. Contractor is responsible for design of the retaining walls.

B. Design Standard: Design retaining walls to be capable of withstanding the effects of gravity loads due to soil pressures resulting from grades indicated, determined in accordance with:

1. NCMA TR-127.
2. Include effects of sloped backfill as indicated on drawings.
3. Include effects of superimposed loads (surcharge) as indicated on drawings.

4. In addition, comply with applicable local, state, and federal codes and regulations.
5. Consider potential failure modes categorized by external, internal, local, compound, and global stability.
6. Seismic Stability: Perform analysis in accordance with ASCE 7.
7. Provide engineering services as required for analysis for all modes of stability.
8. Use of design software for calculations is permitted.
9. Submit complete shop drawings showing all features of the design.

C. Batter Ratio: Between 1 horizontal in 16 vertical and 1 horizontal in 6 vertical.

D. Shear Resistance: Design the wall not to exceed the capacity of materials and soils to resist shear:

1. Shear Resistance Between Units: Determine in accordance with ASTM D6916.
2. Connection Between Units and Soil Reinforcement: Determine in accordance with ASTM D6638. Strength shall exceed the maximum tensile force with a Factor of Safety of 1.5.
3. Coefficient for Direct Shear of Reinforcement on Soil: Determine in accordance with ASTM D5321/D5321M using soil similar in gradation and texture to that to be used for fill in the reinforced zone.

E. Soil Reinforcement:

1. Do not use more than one type of reinforcement attached to units within the same wall.
2. Do not use products made by different manufacturers in the same wall.
3. Minimize the number of different reinforcement and filter products to avoid confusion in placement.
4. Walls Less Than 12 feet High: Use only one type of reinforcement of one grade and strength.
5. Length Back from Wall: Not less than dimensions shown on drawings.
6. Long-Term Design Strength of Reinforcement: LTDS = Tult / (RFd x RFid x RFcr), where:
    a. Tult = Ultimate (tensile) strength per ASTM D4595.
    b. RFd = Reduction Factor for chemical and biological durability; minimum 2.0 if durability testing has not been conducted, otherwise 1.1 for High-density polyethylene. (HDPE), and 1.1 for polyethylene terephthalate (PET).
    c. RFid = Reduction Factor for Installation Damage; minimum 1.1 and 3.0 if testing per ASTM D5818 has not been conducted.
    d. RFcr = Reduction Factor for Creep; consistent with test procedure used for determining the ultimate strength per ASTM D5262.
    e. The product RFd x RFid x RFcr shall be greater than 2.0.

F. Drainage: Design to prevent water accumulation in retained soil, use drainage fill, and provide outlets at intervals along length of wall, as indicated on Drawings.

2.3 MATERIALS

A. Retaining Wall Units: Machine-formed concrete blocks of shapes and sizes suitable for the retaining wall configuration required and complying with ASTM C1372 and the following:

1. Color(s): To be selected by Engineer from manufacturer's full range.
2. Texture: Split face, on exposed surfaces.
3. Face Shape: Straight (flat).
4. Curved Walls: Provide unit shapes that accommodate the required curves without cutting and with gaps between faces of adjacent units of not more than 1/8 inch and a minimum radius of 3 1/2 feet.
5. Acute Corners: Provide special shapes to form corners without cutting; exposed faces finished to match.
6. Height: 6 inches, minimum.
7. Length (Face Width): 12 inches, minimum.
8. Width (Depth from Face): 11 inches, minimum, not including textured finish.
9. Face Wall Thickness: 2 inches, minimum.
10. Batter Dimensional Control: Provide integral positive control to maintain consistent batter dimension.
11. Shear Resistance Mechanism: Manufacturer's standard.
12. Moisture Absorption: 8 percent, maximum.
13. Freeze-Thaw Resistance: Maximum of 1 percent or less weight loss after 100 cycles for each of 5 specimens or maximum of 1.5 percent or less weight loss after 150 cycles for 4 of 5 specimens, when tested in accordance with ASTM C1262/C1262M.
14. Compressive Strength, 28 Day: 3000 pounds per square inch, minimum in accordance with ASTM C140/C140M.
15. Concrete Density: 125 pounds per cubic foot, minimum, oven dry.
16. Dimensional Tolerances: Plus/minus 1/16 inch from specified dimension.
17. Appearance: No visible chips, cracks, or other imperfections when viewed from 10 feet under diffuse lighting.

B. Cap Units: Portland cement concrete machine-formed solid blocks, matching segmental retaining wall units, complying with ASTM C1372, with abutting edges saw cut or formed to provide tight fitting, flush end-to-end joints.

1. Height: 4 inches, minimum.
2. Width: Same as wall units.
3. Depth: To fully cover wall units.
4. Masonry Adhesive: To secure cap units as top course of wall.
    a. Expected Life Span: 30 years.

b. Provide adhesive complying with ASTM C920, Type S, Grade NS, Class 25, and as approved by unit manufacturer.

C. Shear Connectors: Connection method to withstand design stresses and prevent movement of segmental retaining wall units, and to hold soil reinforcement in proper design position during grid pre-tensioning and backfilling.

1. Flexural Strength: 128,000 pounds per square inch, minimum, determined in accordance with ASTM D6638.

2. Short Beam Shear: 6,400 pounds per square inch, minimum, determined in accordance with ASTM D6638.

3. Maintain strength over design temperature range of minus 10 degrees F to plus 100 degrees F.

D. Soil Reinforcement: Polymeric geosynthetic specifically fabricated to interlock with surrounding soil, rock, or earth for use as reinforcement, dimensionally stable and able to retain geometry under manufacture, transport, and installation.

1. Polymeric Material: 100 percent virgin resin with maximum of 5 percent in-plant regrind material; polypropylene, polyethylene, or polyester.

a. Polyethylene and Polypropylene: Stabilized with long term antioxidants.

b. Polyester: Minimum molecular weight of 25,000 and carboxyl end group number less than 30.

2. Permittivity: 0.5 per second, minimum, when tested in accordance with ASTM D4491/D4491M.

3. UV Resistance: 70 percent after 500 hours, when tested in accordance with ASTM D4355/D4355M.

4. Durability: Comply with minimum requirements of AASHTO M 288 Class 1; minimum mass of 8 ounces per square yard.

E. Drainage Filter: Geosynthetic textile.

1. Apparent Opening Size: 70 to 100 U.S. Sieve size, when tested in accordance with ASTM D4751.

2. Permittivity: 0.5 per second, minimum, when tested in accordance with ASTM D4491/D4491M.

3. Durability: Comply with minimum requirements of AASHTO M 288 Class 1; minimum mass of 8 ounces per square yard.

F. Drainage Fill: Clean, freely draining aggregate placed within, between, or immediately behind segmental retaining wall units; do not use pea gravel; use one of the following:

1. Aggregate as approved by Engineer.

2. Aggregate meeting requirements of ASTM D448, Size No. 57.

3. Crushed stone or coarse gravel, 3/8 inch; no more than 5 percent passing No. 200 sieve.

4. Crushed stone or coarse gravel, meeting requirements of ASTM D7928.

G. Reinforced Backfill: Compacted soil placed behind drainage fill within reinforced soil mass; do not use heavy clay or organic soils; comply with one of the following:

1. Use site-excavated or other soil approved by Engineer.
2. Granular soil with less than 35 percent passing No. 200 sieve per ASTM D7928.
3. Inorganic ASTM D2487 soil types GP, GW, SP, or SM, free of debris.
    a. Maximum Size: 3/4 inch, unless approved by Design Engineer, and design strength reduced to account for additional installation damage.
    b. Plasticity of Fines: Less than 10. Liquid Limit: Less than 40, when tested in accordance with ASTM D4318.

H. Drainage Pipe: 4 inch Perforated schedule 40 PVC, complying with ASTM D3034; or corrugated HDPE complying with ASTM F405; with geotextile filter wrap.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify location of existing structures and utilities prior to excavation.

B. Protect adjacent structures from the effects of excavation.

C. Verify that layout dimensions are correct and substrate is in proper condition for installation.

D. Notify Engineer of unsatisfactory conditions.

E. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Sitework:

1. Remove unwanted trees, bushes, and debris as specified in Section 31 10 00.

B. Excavation:

1. Excavate to lines and grades indicated on drawings.
2. Do not disturb embankment or foundation beyond lines. Minimize over-excavation; fill over-excavated areas with compacted reinforced backfill or leveling pad material at Contractor's expense.
3. After excavation, and prior to placement of leveling materials, Geotechnical Engineer will examine bearing soil surface to verify strength meets or exceeds design requirements and assumptions.
4. Replace unsuitable bearing soil as directed by Engineer.
5. Provide means of controlling surface water away from excavation during construction.

C. Leveling Pad:

1. Depth: As approved by Design Engineer.

2. Width: 6 inches minimum extension beyond front and back faces of units.
3. In lieu of pad made solely of aggregate or concrete, pad may be 3 inches, minimum, of thick compacted sand or crushed rock, covered with 2 inches to 3 inches of unreinforced concrete.
4. Location: Top of pad at 1 inch below grade for each 8 inches that wall extends above grade.
5. Compact aggregate to lines and grades on drawings, in lifts 6 inches thick, maximum.
6. Compact aggregate to a minimum of 90 percent modified Proctor density, when determined in accordance with ASTM D1557.
7. Use only hand-operated compaction equipment within 36 inches of back of wall.

D. Verify level grade before proceeding.

E. Install drainage collection pipe with a continuous fall in the direction of flow. Cap open ends as necessary to prevent soil and debris from entering.

3.3 INSTALLATION

A. Install in accordance with drawings, manufacturer instructions, and applicable codes and regulations.

B. Segmental Retaining Wall Units:

1. Place first course of units on leveling pad; check alignment and level. Check for full contact with base and for stability.
2. Place units side by side for full length of wall, aligning back face of straight walls using string line or offset from base line and back face of curved walls using flexible pipe or other method recommended by manufacturer.
3. Do not leave gaps between units.
4. Lay out corners and curves in accordance with manufacturer's instructions. Do not leave gaps to produce wall batter or curvature.
5. Cut blocks with saw; do not split units.
6. Sweep excess material from tops of units before laying succeeding courses.
7. Place a maximum of 2 succeeding courses above level backfill. Check for proper alignment and batter.
8. Where top of wall changes elevation, step units to match grade or turn top course into embankment.
9. Where bottom of wall changes elevation, step base leveling pad and extend lowest course a minimum of two units into slope.
10. Install shear connectors per manufacturer recommendations.

C. Soil Reinforcement: Install each layer on fully compacted fill.

1. Orient soil reinforcement material with highest strength axis perpendicular to wall alignment.

2. Attach to top of wall units and extend horizontally, full length, over compacted backfill slightly sloping downward away from wall.

3. Install in one piece lengths with 100 percent coverage in each layer at each level. Do not splice or leave gaps between panels or ends of pieces.

4. Pull taut and remove slack prior to backfill placement.

D. Drainage Fill: Place drainage fill in, between, and behind units.

1. Compact to lines and grades on drawings, in lifts 6 inches thick, maximum; decrease lift thickness where necessary to achieve required density.

2. Extend drainage fill 12 inches beyond back face of units.

3. Base of drainage fill elevation shall not exceed two courses or 16 inches from base of wall units.

E. Backfill: Place, spread, and compact backfill from behind drainage fill to undisturbed soil while minimizing the development of slack in the soil reinforcement.

1. Use only lightweight hand-operated compaction equipment within 3 feet from back wall face, or one half of wall height, whichever is greater.

2. Place backfill in lifts of maximum 6 inches to 8 inches loose thickness where hand compaction is used and 8 inches to 10 inches where heavy compaction equipment is used.

3. Compact backfill to 95 percent maximum density and upper 2 feet of backfill to 98 percent maximum density, modified Proctor, as determined in accordance with ASTM D1557, or as recommended by Geotechnical Engineer.

4. Moisture content of backfill prior to and during compaction to be within plus or minus 2 percentage points dry of optimum and uniform throughout each layer.

5. Do not operate tracked construction equipment directly upon soil reinforcement. Maintain a minimum fill thickness of 6 inches for operation of tracked vehicles over soil reinforcement. Minimize turning of tracked vehicles while over soil reinforcement.

6. Operate wheeled equipment at speeds less than 10 miles per hour over soil reinforcement.

7. Prevent contamination of the filter fabric, unit fill, blanket drains, chimney drains, and/or drainage composite from poor drainage materials such as fine grained silt and clay.

F. Cap Units: Install and top two courses of units with masonry adhesive.

1. Verify in-place top of wall elevation prior to installation of cap units and adjust accordingly.

2. Clear cap units and top course of segmental retaining wall units of debris and standing water before applying adhesive.

3. Apply masonry adhesive to top surface of top unit and place cap into position over projecting pins. Protect wall face from masonry adhesive.

G. Site Drainage:

1. At end of each day:

a. Grade backfill a minimum of 2 percent away from wall to prevent runoff from adjacent areas from entering wall site and to prevent ponding at the wall.

b. Construct a berm at the crest of the wall to prevent surface water from overtopping.

2. At completion, if other work adjacent to wall is not to be done immediately (paving, landscaping, etc), grade top of backfill and provide temporary drainage to prevent water runoff toward the wall.

3. Surface water control and groundwater seepage shall be the responsibility of the Contractor.

3.4 TOLERANCES

A. Top of Wall:

1. Plan Location: Maximum of plus/minus 1 inch from plan location.

2. Elevation: Maximum of plus/minus 1-1/2 inch from elevations shown on drawings.

B. Face of Wall Flatness: Measured as deviation from a straight edge.

1. In the Vertical Dimension: Plus/minus 1-1/4 inch per 10-foot section.

2. In the Horizontal Dimension of Straight Walls: Plus/minus 1-1/2 inch per 10-foot section.

C. Overall Wall Batter: Within 2 degrees of design, measured from the vertical.

D. Gap Between Adjacent Units: 1/8 inch, maximum.

3.5 CLEANING

A. Clean wall face to remove debris and stains.

B. Leave adjacent paved areas broom clean.

3.6 PROTECTION

A. Prevent damage to wall and earthwork by subsequent construction and uncontrolled runoff until substantial completion; repair damage due to failure to protect wall or earthwork.

B. Do not operate equipment with wheel loads in excess of 150 pounds per square foot live load within 10 feet from the wall face.

C. Do not place temporary soil or fill stockpiles adjacent to wall.

END OF SECTION

SECTION 32 33 00 - SITE FURNISHINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The Drawings and general provisions of the Contract, including General and Supplementary Conditions, MASSDOT Standard Specifications for Highways and Bridges, and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes:
   1. Stone Platform.
   2. Stacked Stone Blocks.
   3. Granite Steps.
   4. Monolithic Granite Stone Benches.
   5. Engraved Granite Monument Stone.
   6. Timber Handrail.

B. Related Sections
   1. Section 32 05 23 – Cement and Concrete for Exterior Improvements
   2. Section 31 20 00 - Earthwork

1.3 SUBMITTALS

A. Product Data: Provide manufacturer's specifications and descriptive literature, installation instructions, and maintenance information.
B. Shop Drawings: Indicate plans for each unit or group of units, elevations with model number, overall dimensions, construction, and anchorage details.

PART 2 - PRODUCTS

2.1 STONE PLATFORM

A. Shape: Rectangular
B. Length: 1.5 feet minimum, 6 feet maximum.
C. Width: 2 feet, allowed tolerance of 6 inches smaller or larger
D. Height: 1 foot, allowed tolerance of 3 inches smaller of larger, provided all stones touching horizontally are the same height.
E. Depth Below Grade: as indicated on Drawings.
F. Material:
   1. Natural native stone blocks.
   2. Blocks shall be hard, durable, free of cracks and fractures, resistant to weather and be free from overburden, spoil, shale, limestone, structural defects, and organic material.

G. Finish: Natural angular, rock face, split face, and/or sawcut are all acceptable. No sharp edges allowed. Verify with Owner prior to installation.

2.2 STACKED STONE BLOCKS

A. Shape: Square and/or Rectangular
B. Length: 1.5 feet minimum, 6 feet maximum.
C. Width: 16 inches minimum, 2 feet maximum.
D. Height: 1 foot minimum, 2.5 feet maximum, above finished grade.
E. Depth Below Grade: as indicated on Drawings.
F. Material:
   1. Natural native stone blocks.
   2. Blocks shall be hard, durable, free of cracks and fractures, resistant to weather and be free from overburden, spoil, shale, limestone, structural defects, and organic material.
G. Finish: Natural angular, rock face, split face, and/or sawcut are all acceptable. No sharp edges allowed. Verify with Owner prior to installation.

2.3 GRANITE STEPS

A. Length: 2 feet minimum, no maximum.
B. Width: refer to Contract Drawing layout and details.
C. Height: Six inches.
D. Material:
   1. Granite shall be standard grade, free of cracks, seams, starts, or other defects which may impair its strength, durability or appearance. Exposed surfaces shall be free from spots, spalls, chips, stains, discoloration, or other defects which would affect its appearance.
   2. Color, texture and finish samples shall be submitted to the Engineer for approval.
   3. Granite shall be supplied in monolithic pieces and shall be light grey, local (New England) granite. Exposed surfaces shall have the following finishes:
E. Finish:
   1. Top surface: Thermal finish with 1" radiused edge at riser
   2. Face, back and sides: Rock or split face
   3. Bottom: sawcut or smooth with minimal variation to allow for stacked placement.
      a. Surfaces concealed in the finished work shall be sawn to approximately true planes. Maximum variation in thickness shall be 3/8 in. Sawn surfaces shall be cleaned of rust stains and iron particles.
      b. All joints shall fit hand tight to the angles as shown on the plans and construction details.
      c. All faces shall be right angles to the plane of the top. Granite shall be cut accurately to required shapes and dimensions as shown on the plans. Arrises shall be cut sharp and true to square, and continuous with adjoining arrises. Where exposed, arrises shall be eased.

2.4 MONOLITHIC GRANITE STONE BENCH

A. Granite shall be standard grade, free of cracks, seams, starts, or other defects which may impair its strength, durability or appearance. Exposed surfaces shall be free from spots, spalls, chips, stains, discoloration, or other defects which would affect its appearance.
B. Color, texture and finish samples shall be submitted to the Engineer for approval.
C. Granite Bench shall be supplied in monolithic pieces and shall be light grey, local (New England) granite. Exposed surfaces shall have the following finishes:
   1. Top surface: Thermal finish
   2. Back and sides: Rock or split face
   3. Bottom: sawcut or smooth with minimal variation to allow for level installation.

D. Surfaces concealed in the finished work shall be sawn to approximately true planes. Maximum variation in thickness shall be 3/8 in. Sawn surfaces shall be cleaned of rust stains and iron particles.
E. All faces shall be right angles to the plane of the top. Granite shall be cut accurately to required shapes and dimensions as shown on the plans. Arrises shall be cut sharp and true to square, and continuous with adjoining arrises. Where exposed, arrises shall be eased.

2.5 ENGRAVED GRANITE MONUMENT STONE

A. Shape: Rectangular
B. Length: 3 feet
C. Width: 2 feet
D. Thickness: 4 inches
E. Letters: Sandblasted or engraved. Text to be provided by owner.
F. Material:
    1. Granite shall be standard grade, free of cracks, seams, starts, or other defects which may impair its strength, durability or appearance. Exposed surfaces shall be free from spots, spalls, chips, stains, discoloration, or other defects which would affect its appearance.
    2. Color, texture and finish samples shall be submitted to the Engineer for approval.
    3. Granite shall be supplied in monolithic pieces and shall be light grey, local (New England) granite. Exposed surfaces shall have the following finishes:
        a. Top surface: Thermal finish
        b. Sides and Bottom: Sawcut

2.6 TIMBER HANDRAIL

A. Width: refer to Contract Drawing layout and details.
B. Materials: refer to Contract Drawing layout and details.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install site furnishings in accordance with Contract Drawings, approved shop drawings, and manufacturer's installation instructions.
B. Verify with Owner's representative that all base and subgrade materials are acceptable, level, plumb, and ready to receive site furnishing items prior to installation.
C. Do not begin installation until unacceptable conditions are corrected.

END OF SECTION

SECTION 32 34 13 – FABRICATED PEDESTRIAN BRIDGE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, MASSDOT Standard Specifications for Highways and Bridges, and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This section includes the following:

1. This work shall consist of designing, furnishing and installing a fully prefabricated steel truss style pedestrian bridge with cast-in-place concrete decking for the span length and width as detailed on the plans and in this specification. The superstructure shall include all bridge bearings, anchor bolts, handrails, bridge railing, and all other necessary materials and equipment to complete the work.

2. The work shall also include equipment, labor, falsework, shoring, bracing, or time required for proper and safe erection of the prefabricated steel truss bridge and such incidental necessary work to provide crane access and setup including grading, lumber, timber, hardware and connectors required to complete the work whether shown on the plans or not.

B. Related Sections:

1. 03 30 00 – Cast-in-Place Concrete

2. 31 63 33 – Drilled Micropiles

C. Existing Conditions:

1. Existing Adjacent Facilities: The Contractor shall assume all responsibility for the premises and loss or damage to the property, adjoining property, public ways and utilities, shoring, bracing, and barricades protecting adjacent property. All costs for protecting, repairing, and replacing adjacent property shall be borne by the Contractor.

1.3 REFERENCE STANDARDS

A. General: Comply with the provisions of the latest version of the publications listed below except as otherwise shown or specified.
B. AASHTO Bridge Design Specifications 9th Edition (AASHTO)
C. AASHTO LRFD Guide Specification for the Design of Pedestrian Bridges
D. American Society for Testing and Materials (ASTM):
   1. ASTM A36
   2. ASTM A242
   3. ASTM A325
   4. ASTM A490
   5. ASTM A500
   6. ASTM A572

7. ASTM A588
8. ASTM A606
9. ASTM A847

E. American Welding Society (AWS):

1. AWS D1.1: Structural Welding Code – Steel
2. AWS D1.4: Structural Welding Code – Reinforcing Steel
3. Society for Protective Coatings Steel Structures Painting Council Surface Preparation Specifications (SSPC)

G. Steel Tube Institute of North America's Hollow Structural Sections "Dimensions and Section Properties."

1.4 SUBMITTALS

A. Submittal Drawings

1. Schematic drawings and diagrams shall be submitted to the Engineer for their review. Submittal drawings shall be unique drawings, prepared to illustrate the specific portion of the work to be done. All relative design information such as member sizes, bridge reactions, and general notes shall be clearly specified on the drawings. Drawings shall have cross referenced details and sheet numbers. All drawings shall be signed and sealed by a Professional Engineer who is licensed in the state of Massachusetts.

B. Structural Calculations

1. Structural calculations for the bridge superstructure shall be submitted by the bridge manufacturer and approved by the Engineer. All calculations shall be signed and sealed by a Professional Engineer who is licensed in the State of Connecticut. The calculations shall include all the design information necessary to determine the structural adequacy of the bridge. The calculations shall at a minimum include the following:
    a. All AASHTO LRFD checks for axial, bending and shear forces in the critical member of each truss member type (i.e. top chord, bottom chord, floor beam, vertical, etc.)
    b. Checks for critical connection failure modes for each truss member type (i.e. vertical, diagonal, floor beam, stc.). Special attention shall be given to all welded tube connections.
    c. All bolted splice connections
    d. Main truss deflection checks.
    e. U-Frame stiffness checks (used to determine K factors for out-of-plane buckling of the top chord) for all half through or "pony" truss bridges.
2. NOTE: The analysis of the design of triangulated truss bridges shall account for moments induced in members due to joint fixity where applicable. Moments due to both truss deflection and joint eccentricity must be considered.

C. Welder certifications in compliance with AWS standard qualification tests.

1.5 QUALITY ASSURANCE

A. Supplier Qualifications: Each bidder is required to identify their intended bridge supplier as part of the bid submittal. The bridge fabricator shall be Certified by the American Institute of Steel Construction to have the personnel, organization, experience, capability and commitment to

produce fabricated structural steel for the category "Major Steel Bridges" as set forth in the AISC Certification Program. Qualified suppliers must have at least five (5) years experience designing and fabricating these type structures and a minimum of five (5) successful bridge projects, of similar construction, complexity and scale, each of which has been in service at least three (3) years. List the location, bridge size, owner, and a contact for reference for each project.

1. The contractor must provide the following documentation, for any proposed supplier who is not pre-approved at least 10 days prior to bid:
    a. Product literature
    b. Representative structural design calculations
    c. Representative drawings
    d. Splicing and erection procedures
    e. Warranty information
    f. Inspection and maintenance procedures
    g. AISC certification
    h. Welder qualifications
2. The engineer will evaluate and verify the accuracy of the submittal prior to bid. If the engineer determines that the qualifying criteria have not been met, the contractor's proposed supplier shall be rejected. The engineer's ruling shall be final.
3. Quality control shall be in accordance with procedures outlined for AISC certification.

B. Installer Qualifications: The installation of the bridge shall be performed only by skilled workers with a satisfactory record of performance on projects of comparable size and quality. All workmanship, fabrication and shop connections shall be in accordance with American Association of State Highway and Transportation Officials Specifications (AASHTO).

C. Welder Qualifications: Qualify procedures and personnel according to the following:

1. ANSI/AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. Filler metal shall be in accordance with applicable sections of AWS A5.28 for the GMAW process.
3. Exposed, bare, unpainted applications of corrosion resistant steels shall be in accordance with applicable sections of AWS D1.1, Section 3.7.3.
4. Properly accredited operators, each of whom shall have a minimum of 6 months experience in welding tubular structures and have demonstrated the ability to make uniform sound welds of the type required.

1.6 PROJECT CONDITIONS

A. Site Information: A geotechnical report has been prepared for this Project and is available for information only. The report is not guaranteed to represent conditions that will be encountered. Opinions expressed in this report are those of the geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by the geotechnical engineer. The Owner will not be responsible for interpretations or conclusions drawn from this data by the Contractor.

1. Additional test borings and other exploratory operations may be made by the Contractor at no additional cost to the Owner.
2. The geotechnical report is referenced elsewhere in the Project Manual.

PART 2 - PRODUCTS

2.1 PREFABRICATED STEEL SUPERSTRUCTURE

A. In addition to requirements indicated on the plans, the prefabricated steel superstructure shall be designed and manufactured to the following requirements:

1. Geometry:
    a. Span Length: Bridge span shall be 130'-0" as measured from each end of the overall bridge structure
    b. Width: Bridge width shall be 8'-0" as measured from the inside face of structural elements at deck level.
2. Bridge Design: Structural design of the bridge structure(s) shall be performed by or under the direct supervision of a Professional Engineer licensed in the State of Massachusetts and performed in accordance with recognized engineering practices and principles and shall include the following:
    a. Design information necessary to determine the structural adequacy of the bridge.
    b. AASHTO LRFD design checks for axial, bending and shear forces in the critical member of each truss member type (for example, top chord, bottom chord, floor beam).
    c. Checks for critical connection failure modes for each truss member type.
    d. Bolted splice connections.
    e. Main truss deflection checks.
    f. Deck design.
    g. Detailed plans, elevations, sections and details.
    h. Splicing and erection procedures.
    i. Warranty information.
    j. Inspection and Maintenance procedures.
    k. AISC Shop Certification.
    l. Welder Certifications. Satisfactorily passing AWS standard qualification tests for all positions with unlimited thickness of base metal.
    m. Welding Procedures: In accordance with ANSI/AWS D1.1 – Structural Welding Code.
3. Design Criteria and Loads: The pedestrian bridge shall be designed in accordance with the LRFD Guide Specifications for the Design of Pedestrian Bridges.

a. In considering design and fabrication issues, this structure shall be assumed to be statically loaded. No dynamic analysis shall be required nor shall fabrication issues typically considered for dynamically loaded structures be considered for this bridge.

b. Load Combinations: Load combinations and load factors as specified in AASHTO LRFD Table 3.4.1-1 and the provisions of the LRFD Guide Specification for the Design of Pedestrian Bridges.

c. Dead Load: The bridge structure shall be designed considering its own dead load (superstructure and specified cast in place concrete decking) only. No additional dead loading need be considered.

d. Uniform Live Load:

i. Pedestrian Live Load: 90 psf of bridge walkway area. Apply load to walkway areas so as to produce maximum stress in member being designed.

ii. Vehicle Load: Design bridge superstructure, floor system and decking for the following vehicle load: AASHTO Design Vehicle: H5 Truck; (10,000 lb.)*

iii. *Dynamic load allowance need not be considered for this loading.

e. Wind Load: Horizontal and Overturning Forces: As required by the AASHTO LRFD Guide Specification for the Design of Pedestrian Bridges and AASHTO LRFD Bridge Design Specifications, 9th Edition.

f. Seismic Loads: Bridge anchor bolt connections shall be designed to withstand seismic restraint forces in accordance with AASHTO LRFD Bridge Design Specifications, 9th Edition. Total restraint force shall be equal to 25% of the dead load reaction at each bearing location.

g. Top Chord Stability: As required by the LRFD Guide Specification for the Design of Pedestrian Bridges and AASHTO LRFD Bridge Design Specifications, 9th Edition.

4. Bridge System Configuration: The bridge shall be configured taking the following into account:

a. The bridge type shall be a Contech Continental Capstone style, or approved equal (as specified in the "Qualified Suppliers" section.

b. The bridge shall be designed utilizing an underhung floor beam (top of floor beam welded to the bottom of the bottom chord) or an H-Section configuration where the floor beams are placed up inside the trusses and attached to the truss verticals.

c. The bridge manufacturer shall determine the distance from the top of the deck to the top and bottom truss members based upon structural and/or shipping requirements, except that any depth restrictions or low chord elevations noted on the plans shall be met.

d. The top of the top chord shall not be less than 42 inches above the deck (measured from the high point of the riding surface) on bike path structures. The overall height of the bridge structure shall be determined based on structural and shipping considerations by the bridge manufacturer.

e. One end of the bridge will be fixed by fully tightening the nuts on the anchor bolts at that end. The opposite end will have finger tight only nuts to allow movement under thermal expansion or contraction.

f. Length: Total bridge length shall be 130'-0" (straight line dimensions) from end to end.

g. Width: Clear width between the railings and all other components shall be 8'-0" as measured from the inside face of structural elements at deck level.

h. Camber: The bridge shall have a vertical camber dimension at midspan equal to 100% of the full dead load deflection plus a maximum of 0.5% of the full length of the bridge.

i. The gap between the prefabricated bridge deck and the timber approach bridge shall be ½-inches maximum.

5. Member Components: All members of the vertical trusses (top and bottom chords, verticals, and diagonals) shall be fabricated from square and/or rectangular structural steel tubing. Other structural members and bracing shall be fabricated from structural steel shapes or square and rectangular structural steel tubing.

   a. Unless the floor and fastenings are specifically designed to provide adequate lateral support to the top flange of open shape stringers (w-shapes or channels), a minimum of one stiffener shall be provided in each stringer at every floor beam location.

6. Elevation Difference: The bridge piers shall be constructed at the same elevation on both ends of the bridge, in accordance with the contract documents.

7. Attachments – Railing System: The railing system shall be configured with a top rail, rub rail, toe plate and vertical safety pickets. The top rail, rub rail and toe plate shall be continuous for the full length of the bridge, and parallel to the top of the deck. The top of the top rail shall be located 4'-0" above the deck surface. The pickets shall be spaced so as to prevent a 4" sphere from passing through the truss rail system.

   a. Pickets shall be placed on the inside of the structure. The top of the vertical pickets shall have a continuous cap angle or some other means of providing a smooth continuous surface.

   b. The rub rail shall be 6 inches in height, the bottom of which shall be located 36 inches above the deck surface. The faces of the top rail, rub rail and toe plate shall be aligned.

   c. The safety rail system shall be designed to withstand a 50 plf load, both transversely and vertically, acting simultaneously. The longitudinal components of the railing shall be also be designed to designed to withstand a concentrated load of 200 pounds acting in any direction, this load is not coincident with the above 50 plf loading requirement. The railing shall also be designed to withstand an infill loading of 200 pounds, applied horizontally at right angles, to a one square foot area at any point in the system.

   d. The maximum deflection in any safety rail element subjected to the design loads shall be ¼".

   e. The entire safety rail system shall be manufactured using weathering steel.

8. Design Limitations: The following design limitations shall be taken into account:

   a. Vertical and Horizontal Deflection: Do not exceed the limits provided in the LRFD Guide Specification for the Design of Pedestrian Bridges.

b. Minimum Thickness of Structural Steel Members: As required in the LRFD Guide Specification for the Design of Pedestrian Bridges.

c. For ASTM A500 and ASTM A847 tubing, the section properties used for design shall be per the Steel Tube Institute of North America's Hollow Structural Sections "Dimensions and Section Properties."

9. Splice Connections: All field connections shall be bolted except where welding is specified on the fabricators plans. Spliced connections for bridge sections shall be bolted, welding splice connections will not be allowed. Bolts shall be 3/4 inch diameter minimum. These splices shall be designed by the fabricator's design engineer. The cost of these splices, including the cost of design, shall be at no extra expense to the owner.

2.2 MATERIALS

A. The prefabricated steel superstructure shall be designed and manufactured using the following materials:

1. Painted Steel:

a. Bridge shall be fabricated using ASTM A500 Grade C cold-formed welded square and rectangular tubing (Fy = 50,000 psi) and/or high strength, low alloy, atmospheric corrosion resistant ASTM A847 cold-formed welded square and rectangular tubing (Fy = 50,000 psi) and/or ASTM A588, ASTM A242, ASTM A572, ASTM A606 (Fy = 50,000 psi) and/or ASTM A36 (Fy = 36,000 psi) plate and structural steel shapes. Splice plates, if required, shall be ASTM A588. All painted bridges shall be painted in a dedicated indoor OSHA approved paint facility that is owned and operated by the bridge fabricator. The fabricator must hold a "Complex Coatings Endorsement" as set forth by AISC.

b. All blast cleaning shall be done in a dedicated OSHA approved indoor facility owned and operated by the bridge fabricator. Blast operations shall use Best Management Practices and exercise environmentally friendly blast media recovery systems.

c. Final paint color shall be determined by the Owner during the submittal process, with samples of any colors available provided at Owner's request.

2. Decking:

a. The bridge shall be furnished with a stay-in-place galvanized steel form deck suitable for pouring a reinforced concrete slab. The form deck shall be designed to carry the dead load of the wet concrete, weight of the form decking, plus a construction load of 20 PSF uniform load or a 150 pound concentrated load on a 1'-0" wide section of deck. When edge supports are used, deflection is limited to 1/180 of the span or ¾", whichever is less. Without edge supports, deflection shall be limited to 1/180 of the span or 3/8", whichever is less.

b. Concrete slab shall have a non-slip (broom) finish.

3. Bridge Bearings:

a. The bridge bearings Utilize teflon on teflon, or stainless steel on teflon slide bearings. The lower bearing surface shall be fully covered by the upper bearing surface at both temperature extremes. Bearings are to be supplied by the manufacturer.

4. Anchor Bolts:

a. The manufacturer shall determine the number, diameter, minimum grade and finish of all anchor bolts. Design bolts to resist all horizontal and uplift forces to be transferred by the superstructure to the supporting foundations. Anchor bolts are to be supplied by the manufacturer.

5. Hardware:

a. The fabrication of the prefabricated pedestrian bridge, including all connections and assemblies, shall be performed as designed and supplied by the manufacturer. Any and all hardware required to assemble and erect the superstructure, as well as secure it to substructure elements, shall be provided by the manufacturer. This shall include anchor devices, bearing/expansion devices and pads, as well as all incidental hardware.

b. All nuts, bolts, washers, steel rods and other miscellaneous hardware shall meet the minimum requirements from Section 900, Subsection 960 of the 2024 MassDOT Standard Specifications as well as Section M8 referenced therein. All nuts, bolts, washers and steel rods shall be weathering steel. High strength nuts, bolts and washers shall be in accordance with ASTM A325 Type 3 or ASTM A490 Type 3.

c. Deck fasteners shall be zinc plated and suitable for use with pressure treated lumber.

PART 3 - EXECUTION

3.1 DELIVERY AND ERECTION

A. The contractor and the fabricator shall coordinate the delivery of the bridge or bridge sections. All work and expenses related to the delivery of the bridge is the responsibility of the contractor. The manufacturer shall provide detailed, written instructions for the proper lifting procedures and splicing procedures (if required). The method and sequence of erection shall be the responsibility of the Contractor.

3.2 MAINTENANCE

A. The bridge manufacturer shall provide written inspection and maintenance procedures to be followed by the bridge owner.

3.3 WARRANTY

A. The prefabricated steel bridge manufacturer shall warrant their steel structure(s) to be free of design, material and workmanship defects for a period of ten years from the date of delivery.

B. Pressure treated lumber used for decking or rails, and overall system including associated attachments: 10 year warranty against defects in design, materials and workmanship as well as against rot, termite damage, or fungal decay for properly maintained bridges.

C. Repair or replacements shall be the exclusive remedy for defects under this warranty.

3.4 FABRICATION

A. The fabrication of the bridge shall conform the following:

1. Drain Holes: When the collection of water inside a structural tube is a possibility, either during construction or during service, the tube shall be provided with a drain hole at its lowest point to let water out.

2. Welds: Special attention shall be given to developing sufficient weld throats on tubular members. Fillet weld details shall be in accordance with AWS D1.1, Section 3.9. Unless determined otherwise by testing, the loss factor "Z" for heel welds shall be in accordance with AWS Table 2.8.

    a. Fillet welds which run onto the radius of a tube shall be built up to obtain the full throat thickness.

    b. The maximum root openings of fillet welds shall not exceed 3/16" in conformance with AWS D1.1, Section 5.22. Weld size or effective throat dimensions shall be increased in accordance with this same section when applicable (i.e. fit-up gaps> 1/16").

    c. For full penetration butt welds of tubular members, fabricate the backing material prior to installation in the tube so as to be continuous around the full tube perimeter, including corners. Backing may be of four types:

        i. A "Box" welded up from four plates.

        ii. Two "Channel" sections, bent to fit the inside radius of the tube, welded together with full penetration welds.

        iii. A smaller tube section which slides inside the spliced tube.

        iv. A solid plate cut to fit the inside radius of the tube.

    d. Corners of the "box" backing, made from four plates shall be welded and ground to match the inside corner radii of the chords. The solid plate option shall require a weep hole either in the chord wall above the "high-side" of the plate or in the plate itself. In all types of backing, the minimum fit-up tolerances for backing must be maintained at the corners of the tubes as well as across the "flats."

3. Finishes: All steel shall be cleaned in accordance with the following:

    a. Blast Cleaning: Bare application of enhanced corrosion resistant steels.

    b. Perform blast cleaning in a dedicated OSHA approved indoor facility owned and operated by the bridge fabricator, using Best Management Practices and exercising environmentally friendly blast media recovery systems.

    c. To aid in a uniformly "weathered" appearance, blast clean all exposed steel surfaces in accordance with Steel Structures Painting Council Surface Preparation Specifications No. 7 Brush-Off Blast Cleaning, SSPC-SP7.

3.5 CONSTRUCTION METHODS

A. Examination: Examine existing conditions, including piers and bearings. Correct unsatisfactory conditions prior to erection of prefabricated bridge.

B. Foundation: The foundation for the bridge shall be complete and stable prior to the installation of the bridge. Provide all materials for construction of the bridge foundations including anchor bolts. Coordinate required anchor bolt size, type, and quantity with pedestrian bridge manufacturer.

Install the anchor bolts in accordance with the manufacturer's details and instructions and at the location and spacing provided by the manufacturer.

C. Bridge Installation: Install in accordance with manufacturer's standard procedures and recommendations.

D. Decking Installation: Install and fasten in accordance with manufacturer's standard procedures. Provide gaps between planks as recommended by manufacturer. Predrill planks prior to installation of bolts or screws.

1. Fasteners

a. Power actuated fasteners are NOT allowed.

b. At Ends of Planks: Use self-tapping screws or hex-head bolts with a steel plank holddown. Provide a minimum of one fastener at end of each plank.

c. Interior Connection Fasteners: Use self-tapping screws or carriage bolts.

2. Planks for Bridges with Widths of 72 to 143 Inches

a. Attach with a minimum of two fasteners at a location approximately near the center of the bridge width.

3. Planks for Bridges Wider than 143 Inches

a. Attach with a minimum of two fasteners located at a minimum of two interior stringer locations approximately at third points of the bridge width.

3.6 CLEANING

A. Remove all excess materials, debris, and equipment from site during installation and upon completion of the Work. Repair any damaged adjacent materials and surfaces.

END OF SECTION

SECTION 32 39 00 – MANUFACTURED SITE SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, MASSDOT Standard Specifications for Highways and Bridges, and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes the following:

1. Boom, anchor, and anchor foundation.

B. Related Sections

1. Section 32 05 23 – Cement and Concrete for Exterior Improvements

1.3 SUBMITTALS

A. Shop drawings and specifications for the boom.

B. Reinforcing shop drawings for the anchor foundation.

C. Shop drawings for the steel pipe, showing all required attachments or modifications for securing of the guy and/or boom.

D. Design calculations and product data for the helical pile, guy wire and any related fittings or attachments.

PART 2 - PRODUCTS

2.1 BOOM, ANCHOR, & ANCHOR FOUNDATION

The boom, anchor, and anchor foundation shall be designed by the Contractor according to the following flow and ground conditions. The boom length shall be determined from the provided water surface elevations and plan contours. The design shall account for potential winter ice formation on the boom.

Event	Water Surface Elevation (Feet)	Maximum Velocity (Feet/Second)	Discharge (Cubic Feet/Second)
95% Exceedance Probability	**10.6**	**0.3**	**13**
50% Exceedance Probability	**11.1**	**0.8**	**56**
Bankfull	**13.2**	**2.7**	**378**
10-Year	**16.6**	**4.2**	**1,160**
50-Year	**20.2**	**4.5**	**1,920**
100-Year	**22.8**	**4.3**	**2,330**

A. Anchor foundation design shall be as indicated on the plans and consist of a 24-inch-diameter steel pipe embedded in a 36-inch-diameter reinforced concrete shaft. Minimum shaft embedment shall be as indicated on the plans, and not consider any organic or deleterious material.

B. Anchor shall be guyed to a helical pile, which shall be designed by the Contractor to withstand, in tension, the calculated maximum boom tension load applied to the anchor. The helical pile shall be oriented in line with the boom tension line, or otherwise designed for an increased load for a differing line of orientation. The pile shall be guyed to a welded bracket attachment at the top of pipe and shall be likewise designed by the Contractor to withstand this loading, along with the guy wire and all other related hardware.

C. Attachments or modifications shall be made to the exposed section of pipe to allow for secure anchorage of the boom, as required by the boom manufacturer. Steel pipe shall be hot dip galvanized after all welded attachments are affixed. All hardware shall be designed for full weather exposure to prevent corrosion.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install boom, anchor, and anchor foundation in accordance with the Contract Drawings, approved shop drawings and specifications, and manufacturer's installation instructions.

B. Concrete shall be installed in accordance with Section 32 05 23 – Cement and Concrete for Exterior Improvements.

END OF SECTION

SECTION 32 92 19 - SEEDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, MASSDOT Standard Specifications for Highways and Bridges, and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes:

1. Seeding, mulching and fertilizer
2. Maintenance

B. Related Sections

1. Section 31 10 00 – Site Clearing
2. Section 31 20 00 - Earthwork
3. Section 32 93 00 - Plantings

1.3 DEFINITIONS

A. Fertilizer: A soil amendment used to produce a soil mixture that adjusts soil nutrients for optimal plant growth.
B. Finish Grade: Elevation of finished surface of planting soil.
C. Seeding Area: Areas to be seeded.
D. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.
E. Weeds: Weeds include, but may not be limited to, dandelion, jimsonweed, quackgrass, horsetail, morning glory, rush grass, mustard, lambsquarter, chickweed, cress, crabgrass, Canadian thistle, nutgrass, poison oak, tansy ragwort, Bermuda grass, Johnson grass, poison ivy, nut sedge, nimblewill, bindweed, bent grass, wild garlic, perennial sorrel, and brome grass.

1.4 SUBMITTALS

A. Certificate: Contractor shall supply a manufacturer's Certificate of Compliance to the specifications with each shipment of each type of seed mix. Certificates shall be attached to the seed containers for inspection and shall contain the guaranteed percentages of purity, weed content, and germination of the seed. No seed may be sown until the seed has been accepted by the Engineer.

B. Additional submittals for Compost
1. List of vendors, including list of compost facilities and feedstock materials
2. Certified results of regular periodic testing by an approved testing facility. Certification shall be per U.S. Composting Council Seal of Testing Assurance (STA) Program.

C. Maintenance Data: Include maintenance instructions, cutting method and maximum grass height; types, application frequency, and recommended coverage of fertilizer.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver grass seed mixture in sealed containers. Seed in damaged packaging will not be accepted. Deliver seed mixture in containers showing percentage of seed mix, year of production, net weight, date of packaging, and location of packaging.

B. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer.

PART 2 - PRODUCTS

2.1 REGULATORY REQUIREMENTS

A. Fertilizer and herbicide composition and application shall comply with federal, state, and local regulations and the project permits.

2.2 SEED MIXTURES

A. Lawn Seed Mixture (Upland/Park Seed Mix):

1. As noted on the Drawings.
2. Seed mix shall comply with the requirements in Table M6.03.0-1 of the Standard Specifications for flat lawn grass areas and Table M6.03.0-2 of the Standard Specifications for sloped lawn grass areas.

B. Conservation Seed Mix:

1. As noted on the Drawings.
2. New England Wetland Plants, Inc.; New England Conservation/Wildlife Mix
3. Or approved equal.

C. Semi-Shade Seed Mix:

1. As noted on the Drawings.
2. New England Wetland Plants, Inc.; New England Semi-Shade Grass and Forbs Mix
3. Or approved equal.

D. Showy Wildflower Seed Mix:

1. As noted on the Drawings.
2. New England Wetland Plants, Inc.; New England Showy Wildflower Mix
3. Or approved equal.

2.3 INORGANIC SOIL AMENDMENTS

A. Lime: ASTM C602, agricultural liming material containing a minimum 80 percent calcium carbonate equivalent and as follows:

1. Provide lime in form of ground dolomitic limestone, with a minimum of 95 percent passing a No. 20 sieve and a minimum of 50 percent passing a No. 100 sieve.

B. Perlite: Horticultural perlite, soil amendment grade.

C. Sand: Clean, washed, natural or manufactured, free of toxic materials.

2.4 ORGANIC SOIL AMENDMENTS

A. Compost: Imported organic soil additives used to meet the requirements of Salvaged Soil. Compost shall comply with the requirements for Compost Type 1 in Section M1.06.0 of the Standard Specifications.

B. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, and material harmful to plant growth.

2.5 SEEDING ACCESSORIES

A. Selective Herbicides: EPA registered and approved, of type recommended by manufacturer for application.

2.6 FERTILIZER

A. Turf Area (Lawn) Commercial Fertilizer: Commercial-grade granular fertilizer, nitrogen free, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in compliance with State of Massachusetts fertilizer laws.

B. Planting Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing agency.

C. Products include:

1. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of 1 percent nitrogen and 18 percent phosphoric acid.

2. Plantone: Organic plant nutrient with potential acidity (CACO2) at 80 pounds per 2,000 pounds as manufactured by Espoma, Millville, New Jersey, or approved equal.

3. Fluid Fertilizer: "Algro" 14-7-4 low chlorine 40 percent organic root food as manufactured and supplied by Plant Food Chemical Company, Cranberry, New Jersey, or approved equal.

4. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.

5. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:

a. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing agency.

2.7 MULCHES

A. Straw Mulch: Air-dry, clean, mildew- and seed-free, threshed straw of wheat, rye, oats, or barley.

B. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.

2.8 FABRICS

A. Biodegradable Erosion Control Fabric: North American Green C125BN or approved equal.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify with the Landscape Architect that prepared soil surface is ready to receive the work of this Section.

3.2 LOAM AND TOPSOIL PLACEMENT

A. Newly Graded Subgrades

1. Do not place if subgrade is frozen, muddy, or excessively wet.
2. Loosen subgrade to a minimum depth of 6 inches. Remove trash, debris, roots, branches, and stones in excess of 1 inch in size.
3. Spread approximately 1/2 the thickness of loam or topsoil over loosened subgrade. Mix thoroughly into top 2 inches of subgrade. Spread remainder of loam or topsoil.

B. Unchanged Subgrades

1. In areas disturbed during construction but were not excavated, prepare surface soil as follows:
   a. Remove existing grass and vegetation. Do not mix into surface soil.
   b. Loosen surface soil to a minimum depth of 6 inches. Apply soil amendments and fertilizers and mix thoroughly into top 4 inches of soil. Till soil to a homogeneous mixture of fine texture.
   c. Remove trash, debris, roots, branches, and stones in excess of 1 inch in size.

3.3 FERTILIZING

A. Apply fertilizer in accordance with manufacturer's instructions.

B. Apply after smooth raking of topsoil and prior to roller compaction.

C. Do not apply fertilizer at same time or with same machine as will be used to apply seed.

D. Mix thoroughly into upper 2 inches of topsoil.

E. Lightly water to aid the dissipation of fertilizer.

3.4 SEEDING

A. Apply seed at the application rates indicated on the Drawings.

B. Apply seed in two intersecting directions. Rake in lightly.

C. Do not seed areas in excess of that which can be mulched on same day.

D. Planting Season: April 1 to June 1, August 1 to September 10.

E. Do not sow immediately following rain, when ground is too dry, or during windy periods.

F. Immediately following seeding, apply mulch to a thickness of 1/8 inches. Maintain clear of shrubs and trees.

G. Apply water with a fine spray immediately after each area has been mulched. Saturate to 4 inches of soil.

H. Following germination, immediately re-seed areas without germinated seeds that are larger than 4 by 4 inches.

3.5 PROTECTION

A. Cover seeded slopes where grade is 4 inches per foot or greater with 100% biodegradable erosion control fabric. Roll fabric onto slopes without stretching or pulling.

3.6 WARRANTY

A. The warranty period shall extend for 2 years from the date of Substantial Completion.

B. Seeding Success Criteria: Seeding will be considered satisfactory if it meets the following criteria:

1. A minimum of 80 percent intended vegetative cover,
2. Not more than 10% of the seeded area with bare spots larger than 1 square foot, and
3. Intended vegetation in healthy condition.

C. Areas not meeting seed success criteria on July 1 following the installation date shall be reseeded at no additional cost to the Owner.

3.7 MAINTENANCE

A. Provide maintenance at no extra cost to Owner; Owner will not pay for water.

B. Provide maintenance of seeded areas through one full growing season following the date of Substantial Completion.

1. Mow grass at regular intervals to maintain at a maximum height of 2-1/2 inches. Do not cut more than 1/3 of grass blade at any one mowing.
2. Neatly trim edges and hand clip where necessary.
3. Immediately remove clippings after mowing and trimming.
4. Water to prevent grass and soil from drying out.
5. Roll surface to remove minor depressions or irregularities.

6. Control growth of weeds. Apply herbicides in accordance with manufacturer's instructions. Remedy damage resulting from improper use of herbicides.
7. Immediately reseed areas that show bare spots.
8. Protect seeded areas with warning signs during maintenance period.

C. Monitor and treat seeded areas for invasive plant species in accordance with Contractor's approved Invasive Species Control Plan. Plan implementation shall begin immediately upon initiation of construction and shall continue for five (5) years.

END OF SECTION

SECTION 32 93 00 - PLANTINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, MASSDOT Standard Specifications for Highways and Bridges, and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes:

1. New trees, shrubs, and plants.
2. Maintenance

B. Related Sections

1. Section 31 10 00 – Site Clearing
2. Section 31 20 00 - Earthwork
3. Section 32 92 19 - Seeding

1.3 DEFINITIONS

A. Backfill: The earth used to replace or the act of replacing earth in an excavation.

B. Balled and Burlapped Stock: Plants dug with firm, natural balls of earth in which they were grown, with ball size not less than sizes indicated; wrapped with burlap, tied, rigidly supported, and drum laced with twine with the root flare visible at the surface of the ball as recommended by ANSI Z60.1.

C. Balled and Potted Stock: Plants dug with firm, natural balls of earth in which they are grown and placed, unbroken, in a container. Ball size is not less than sizes indicated.

D. Container-Grown Stock: Healthy, vigorous, well-rooted exterior plants grown in a container with well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for kind, type, and size of exterior plant required.

E. Fertilizer: A soil amendment used to produce a soil mixture that adjusts soil nutrients for optimal plant growth.

F. Finish Grade: Elevation of finished surface of planting soil.

G. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

H. Pests: Living organisms that occur where they are not desired, or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

I. Planting Area: Areas to be planted.

J. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

K. Plant, Plants, Plant Material: These terms refer to vegetation in general, including trees, shrubs, tubelings, vines, ground covers, ornamental grasses, bulbs, corms, tubers, or herbaceous vegetation.

L. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.

M. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

N. Subsoil: All soil beneath the topsoil layer of the soil profile and typified by the lack of organic matter and soil organisms.

O. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Plant Materials: Include quantities, sizes, quality, and sources for plant materials. Contractor shall provide this information in written certification and verification that plantings have been grown under Zone 6 or hardier conditions.

1. Plant Photographs: Include color photographs in digital format of each required species and size of plant material as it will be furnished to the Project. Take photographs from an angle depicting true size and condition of the typical plant to be furnished. Include a scale rod or other measuring device in each photograph. Identify each photograph with the full scientific name of the plant, plant size, and name of the growing nursery.

C. Submit certificate of compliance with specification for topsoil, fertilizer, and seed.

D. Samples for Verification: For each of the following:

1. Organic Mulch: 1-pint (0.5-liter) volume of organic mulch required; in sealed plastic bag(s) labeled with composition of materials by percentage of weight and source of mulch. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of color, texture, and organic makeup.

E. Product Certificates: For each type of manufactured product, from manufacturer, and complying with the following:

1. Manufacturer's certified analysis of standard products.

2. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.

F. Material Test Reports: For native topsoil and imported topsoil for compliance with planting soil specifications.

G. Care and maintenance procedures.

H. Provide planting schedule that includes not only quantity, but also the quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: The planting shall be done by horticulturally skilled workers, trained and experienced in accepted nursery practices. The Work shall be done under the supervision of a qualified planting supervisor demonstrating a background in landscape operations.

B. Soil-Testing Laboratory Qualifications: An independent or university laboratory recognized by the State Department of Agriculture, such as the University of Massachusetts Amherst (UMass Extension) Soil Testing Laboratory or equivalent, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.

C. Soil Analysis: For native topsoil to be used as a planting soil, furnish soil analysis and a written report by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; sodium absorption ratio; deleterious material; pH; and mineral and plant-nutrient content of the soil.

1. Testing methods and written recommendations shall comply with USDA's Handbook No. 60.

2. The depth, location, and number of samples to be taken shall be per instruction from Engineer for soil to be used for planting purposes.

3. Report suitability of tested soil for plant growth.

a. Based upon the test results, provide recommendations for soil treatments and soil amendments to be incorporated. Provide recommendations in weight per 1,000 sq. ft. or volume per cu. yd. for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.

b. Report presence of problem salts, minerals, or heavy metals, including aluminum, arsenic, barium, cadmium, chromium, cobalt, lead, lithium, and vanadium. If such problem materials are present, provide additional recommendations for corrective action.

D. Measurements: Measure according to ANSI Z60.1. Do not prune to obtain required sizes.

1. Trees and Shrubs: Measure with branches and trunks or canes in their normal position. Take height measurements from or near the top of the root flare for field-grown stock and container grown stock. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip to tip.

E. Plant Material Observation: The Landscape Architect may observe plant material at site before planting for compliance with requirements for genus, species, variety, cultivar, size, and quality. The Landscape Architect retains right to observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and to reject unsatisfactory or defective material at any time during progress of work. The Contractor shall remove rejected trees, shrubs, perennials and vines immediately from the Project site.

1. Notify the Landscape Architect of sources of planting materials seven days in advance of delivery to site.

F. Tubeling Installation Mock-Up: The Contractor shall install a 10 foot by 10 foot swath of tubelings for review and approval by the Landscape Architect prior to commencing the installation of the entire tubeling planting. The Contractor shall coordinate the location of the mock-up planting with the Landscape Architect. The Landscape Architect's recommended updates to the mock-up shall be incorporated into the entirety of the

tubeling planting. The reviewed and approved mock-up may be incorporated into the final planting.

G. Labeling: Label each plant of each variety, size, and caliper with a securely attached, waterproof tag bearing legible designation of common name and full scientific name, including genus and species. Include nomenclature for hybrid, variety, or cultivar, if applicable for the plant as shown on Drawings.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws if applicable.

B. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.

2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.

3. Accompany each delivery of bulk fertilizers, lime, and soil amendments with appropriate certificates.

C. Tubelings shall be kept moist during transport to the site and be promptly protected upon arrival at the site. Protection at the site shall provide continuous shade, must be sheltered from the wind, and must be continuously protected from drying out.

D. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.

E. Handle planting stock by root ball.

F. Deliver plants after preparations for planting have been completed and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist. Protect all plants and products from weather or other damaging or deteriorating conditions.

1. Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.

2. Do not remove container-grown stock from containers before time of planting.

3. Water root systems of plants stored on-site deeply and thoroughly with a fine-mist spray. Water as often as necessary to maintain root systems in a moist, but not overly-wet condition.

G. All areas to be planted shall be inspected by the Contractor before starting work and any defects shall be reported to the Engineer prior to beginning this work. The commencement of work by the Contractor shall indicate acceptance of the areas to be planted.

H. The Contractor shall be solely responsible for judging the full extent of work requirements involved, including, but not limited to the potential need for storing and maintaining temporarily and/or re-handling plants prior to final installation.

I. Plants which have been damaged or have deteriorated in transit or storage are not acceptable.

J. Keep plants moist, fresh, and protected against exposure to sun, wind, and freezing temperatures whether in the receiving yard, in transit, while being handled, or at the job site awaiting planting.

K. Deliver trees and shrubs after preparations for planting have been completed and plant immediately.

L. All trees shall be planted within the same season that they are dug. No heeling in of trees over the winter or planting out of season will be permitted.

M. Those species known to be fall digging hazards shall be dug during the spring season only. Fall planting of these species shall be permitted only with certification from the nursery at the time of digging, and at the discretion of the Engineer.

N. Correlate planting schedule with specified maintenance periods to provide maintenance to date of acceptance.

O. Coordination with Areas to be Seeded: Plant trees and shrubs after finish grades are established and before seeding grassed areas unless otherwise indicated.

1. When planting trees and shrubs after seeding grassed areas, protect and promptly repair, as required, damage caused by planting operations.

PART 2 - PRODUCTS

2.1 REGULATORY REQUIREMENTS

A. Fertilizer and herbicide composition and application shall comply with federal, state, and local regulations and the project permits.

2.2 PLANT MATERIAL

A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant Schedule or Plant Legend shown on Drawings and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.

1. Trees with damaged, crooked, or multiple leaders; tight vertical branches where bark is squeezed between two branches or between branch and trunk ("included bark"); crossing trunks; cut-off limbs more than 3/4 inch (19 mm) in diameter; or with stem girdling roots will be rejected.

2. Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated.

B. Provide plants of sizes, grades, and ball or container sizes complying with ANSI Z60.1 for types and form of plants required. Plants of a larger size may be used if acceptable to Engineer, with a proportionate increase in size of roots or balls.

C. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which shall begin at root flare according to ANSI Z60.1.

D. Perennials and Vines: Provide healthy, field-grown plants from a commercial nursery, of species and variety shown or listed, established and well rooted in pots or similar containers, and complying with ANSI Z60.1.

2.3 IMPORTED TOPSOIL

A. Imported topsoil shall consist of imported loam conforming to Section M.1.05.0 of the MASSDOT Standard Specifications. Imported topsoil shall conform to the following:

1. 10 to 20 percent organic matter as determined by soil testing service, maximum particle size ½", and with maximum 3 percent retained and ¼ inch screen.

    a. Screened.

    b. Free of roots, rocks larger than ½ subsoil, debris, large weeds, invasive plant materials, and foreign matter.

    c. PH 5.5 to 7.0

2. Acceptable textural classes with component percentages as established by the USDA Classification System.

    a. Fine sandy loam.

    b. Sandy loam.

    c. Loam

2.4 PLANTING SOIL

A. Planting Soil: Planting soil shall be native topsoil meeting the below requirements or imported topsoil if the quantity of on-site soil is insufficient.

1. Verify suitability of native topsoil to produce viable planting soil.

2. Clean native topsoil free of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.

3. Mix native topsoil with the following soil amendments and/or fertilizers in the following quantities to produce acceptable planting soil with a PH of between 5.5 and 7.5:

    a. Weight of lime per 1000 sq. ft.: 90 lbs. or as recommended by soil testing agency.

    b. Weight of slow-release fertilizer per 1000 sq. ft.: 5 lbs. or as recommended by soil testing agency for tree and shrub applications.

    c. Ratio of loose compost to topsoil by volume: 1:4.

    d. Ratio of loose peat or manure to topsoil by volume: 1:4.

2.5 INORGANIC SOIL AMENDMENTS

A. Lime: ASTM C602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:

1. Provide lime in the form of ground dolomitic limestone, with a minimum of 95 percent passing a No. 20 sieve and a minimum of 50 percent passing a No. 100 sieve.

B. Perlite: Horticultural perlite, soil amendment grade.

C. Sand: Clean, washed, natural or manufactured, free of toxic materials.

2.6 FERTILIZERS

A. Turf Area (Lawn) Commercial Fertilizer: Commercial-grade granular fertilizer, nitrogen free, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in compliance with State of Massachusetts fertilizer laws.

B. Planting Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing agency.

C. Products include:

1. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of 1 percent nitrogen and 18 percent phosphoric acid.

2. Plantone: Organic plant nutrient with potential acidity (CACO2) at 80 pounds per

   2,000 pounds as manufactured by Espoma, Millville, New Jersey, or approved equal.

3. Fluid Fertilizer: "Algro" 14-7-4 low chlorine 40 percent organic root food as manufactured and supplied by Plant Food Chemical Company, Cranberry, New Jersey, or approved equal.

4. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.

5. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:

   a. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing agency.

2.7 MULCHES

A. Organic Mulch: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of one of the following:

1. Type: Shredded hardwood.

2. Size Range: 3 inches (76 mm) maximum, 1/2 inch (13 mm) minimum.

3. Color: Natural (undyed).

B. Aged pine bark mulch: Free from deleterious materials and an excess of fine particles, shredded pine bark, aged a minimum of 6-months, free of chunks and pieces of wood thicker than ¼ in. consisting of the following:

1. Type: Aged Pine Bark

2. Size Range: 3 inches (76mm) maximum, ½ inch minimum.

3. Color: Natural dark brown (undyed).

2.8 MISCELLANEOUS PRODUCTS

A. Wood Pressure-Preservative Treatment: AWPA C2, with waterborne preservative for soil and freshwater use, acceptable to authorities having jurisdiction, and containing no arsenic; including ammoniacal copper arsenate, ammoniacal copper zinc arsenate, and chromated copper arsenate.

B. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees and shrubs. Deliver in original, sealed, and fully labeled containers and mix according to manufacturer's written instructions.

C. Burlap: Non-synthetic, biodegradable.

D. Mycorrhizal Fungi: Dry, granular inoculant containing at least 5300 spores per lb (of vesicular-arbuscular mycorrhizal fungi and 95 million spores per lb of ectomycorrhizal fungi, 33 percent hydrogel, and a maximum of 5.5 percent inert material.

PART 3 - EXECUTION

3.1 GENERAL

A. Field Measurements: Verify actual grade elevations, service and utility locations, and dimensions of plantings and construction contiguous to the proposed location of new plantings by field measurements before proceeding with planting work.

B. Planting Restrictions: Plant trees and shrubs during one of the following periods. Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.

Deciduous material:	Spring	March 15 to June 1
	Fall	September 15 to December 1
Evergreen material:	Spring	March 15 to May 15
	Fall	August 15 to November 15

C. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions and warranty requirements.

3.2 EXAMINATION

A. Examine areas to receive plants for compliance with requirements and conditions affecting installation and performance.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
2. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.
3. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
4. Uniformly moisten excessively dry soil that is not workable and which is too dusty.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Engineer and replace with new planting soil.

3.3 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

C. Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain Engineer's acceptance of layout before excavating or planting. Make minor adjustments as required.

D. Lay out plants at locations indicated on the Contract Drawings. Stake locations of individual trees and shrubs and outline areas for multiple plantings.

E. Apply antidesiccant, in accordance with manufacturer recommendations, to trees and shrubs using power spray to provide an adequate film over trunks (before wrapping), branches, stems, twigs, and foliage to protect during digging, handling, and transportation.

1. If deciduous trees or shrubs are moved in full leaf, spray with antidesiccant at nursery before moving and again two weeks after planting.

F. Wrap trees and shrubs with burlap fabric over trunks, branches, stems, twigs, and foliage to protect from wind and other damage during digging, handling, and transportation.

3.4 EXCAVATION FOR PLANTING

A. Planting Pits and Trenches: Excavate circular planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are not acceptable. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.

1. Excavate approximately three times as wide as ball diameter for balled and burlapped trees and to a horizontal distance of 8-inches greater than containers of shrubs.

2. Excavate to a depth necessary such that the root flare of tree or shrub is two inches above finish grade after settlement.

3. If area under the plant was initially dug too deep, add planting soil to raise it to the correct level and thoroughly tamp the added soil to prevent settling.

4. Maintain required angles of repose of adjacent materials as shown on the Drawings. Do not excavate subgrades of adjacent paving, structures, hardscapes, or other new or existing improvements.

5. Maintain supervision of excavations during working hours.

6. Keep excavations covered or otherwise protected when unattended by Installer's personnel.

B. Obstructions: Notify Engineer immediately if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.

C. Drainage: Notify Engineer immediately if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits.

3.5 PLANTING

A. Before planting, verify that root flare is visible at top of root ball according to ANSI Z60.1. If root flare is not visible, remove soil in a level manner from the root ball to where the top-most root emerges from the trunk. After soil removal to expose the root flare, verify that root ball still meets size requirements.

B. Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.

C. Set balled and burlapped trees or shrubs plumb and in center of planting pit or trench with root flare 2 inches (50 mm) above adjacent finish grades.

1. Use planting soil for backfill.

2. After placing some backfill around root ball to stabilize plant, carefully cut and remove burlap, rope, and wire baskets from tops of root balls and from sides to one third of the depth of root ball, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.

3. Backfill around root ball in 9-inch layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.

4. Continue backfilling process. Water again after placing and tamping final layer of soil.

D. Set container-grown shrubs plumb and in center of planting pit or trench with root flare 2 inches above adjacent finish grades.

1. Use planting soil for backfill.

2. Carefully remove root ball from container without damaging root ball or plant.

3. Backfill around root ball in 9-inch layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.

4. Continue backfilling process. Water again after placing and tamping final layer of soil.

E. When planting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of the root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of the root ball.

3.6 TREE AND SHRUB PRUNING

A. Remove only dead, dying, or broken branches. Do not prune for shape.

B. Do not apply pruning paint to wounds.

3.7 PLANTING AREA MULCHING

A. Mulch backfilled surfaces of planting areas and other areas indicated.

1. Trees and Shrubs: Apply organic mulch ring of 4-inch average thickness around trees and a 3-inch average thickness around shrubs, to a distance of 8-inches outside of staking around trees and to a distance of 24-inches around trunk or stem of shrubs. Do not place mulch within 3 inches of trunks or stems.

2. Perennials and Vines: Apply organic mulch ring of 2-inch average thickness around plants, to cover entire planting bed. Do not place mulch within 1 inch of growing tip or crown of plant.

3.8 CLEANUP AND PROTECTION

A. During planting, keep adjacent paving and construction clean and work area in an orderly condition.

B. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.

C. After installation and before Substantial Completion, remove nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and Project site.

3.9 DISPOSAL

A. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off site.

3.10 WARRANTY

A. Contractor shall repair or replace plantings and accessories that fail in materials, workmanship, or growth within two years of date of Substantial Completion.

1. Failures include, but are not limited to, the following:

   a. Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner, or incidents that are beyond Contractor's control.

   b. Structural failures including plantings falling or blowing over.

   c. Faulty performance of tree stabilization.

2. Include the following remedial actions as a minimum:

   a. Immediately remove dead plants and replace unless required to plant in the succeeding planting season.

   b. Replace plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.

   c. A limit of one replacement of each plant will be required except for losses or replacements due to failure to comply with requirements.

   d. Provide extended warranty for period equal to original warranty period, for replaced plant material.

3.11 MAINTENANCE

A. The Contractor shall maintain plantings through one full growing season following the date of Substantial Completion.

B. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing tree-stabilization devices, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings. Restore or replace damaged tree wrappings.

C. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.

D. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use integrated past management practices whenever possible to minimize the use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.

END OF SECTION

THE COMMONWEALTH OF MASSACHUSETTS
EXECUTIVE OFFICE OF LABOR AND WORKFORCE DEVELOPMENT
DEPARTMENT OF LABOR STANDARDS
Prevailing Wage Rates

MAURA HEALEY
Governor
KIM DRISCOLL
Lt. Governor

As determined by the Director under the provisions of the Massachusetts General Laws, Chapter 149, Sections 26 to 27H

LAUREN JONES
Secretary
MICHAEL FLANAGAN
Director

Awarding Authority:	Haverhill - City Hall	**City/Town:**	HAVERHILL
Contract Number:	IFB015.26		
Description of Work:	Excavation and re-use or disposal of soil; Construction of channel bed and banks; Construction of rock weirs; Installation of bridge and stormwater outfall scour protection; Construction of retaining walls.		
Job Location:	175 Hilldale Ave, Haverhill, MA		

Information about Prevailing Wage Schedules for Awarding Authorities and Contractors

- The wage rates will remain in effect for the duration of the project, except in the case of multi-year public construction projects. For construction projects lasting longer than one year, awarding authorities must request an updated wage schedule no later than two weeks before the anniversary of the date the contract was executed by the awarding authority and the general contractor. For multi-year CM AT RISK projects, the awarding authority must request an annual update no later than two weeks before the anniversary date, determined as the earlier of: (a) the execution date of the GMP Amendment, or (b) the execution date of the first amendment to permit procurement of construction services. The updated wage schedule must be provided to all contractors, including general and sub-contractors, working on the construction project.
- This annual update requirement is generally not applicable to 27F “rental of equipment” contracts. For such contracts, the prevailing wage rates issued by DLS shall remain in effect for the duration of the contract term. However, if the prevailing wage rate sheet issued does not contain wage rates for each year covered by the contract term, the Awarding Authority must request updated rate sheets from DLS and provide them to the contractor to ensure the correct rates are being paid throughout the duration of the contract. Additionally, if an Awarding Authority exercises an option to renew or extend the contract term, they must request updated rate sheets form DLS and provide them to the contractor.
- This wage schedule applies only to the specific project referenced at the top of this page and uniquely identified by the “Wage Request Number” on all pages of this schedule.
- An Awarding Authority must request an updated wage schedule if it has not opened bids or selected a contractor within 90 days of the date of issuance of the wage schedule. For CM AT RISK projects (bid pursuant to G.L. c.149A), the earlier of: (a) the execution date of the GMP Amendment, or (b) the bid for the first construction scope of work must be within 90-days of the wage schedule issuance date.
- The wage schedule shall be incorporated in any advertisement or call for bids for the project as required by M.G.L. c. 149, § 27. The wage schedule shall be made a part of the contract awarded for the project. The wage schedule must be posted in a conspicuous place at the work site for the life of the project in accordance with M.G.L. c. 149 § 27. The wages listed on the wage schedule must be paid to employees performing construction work on the project whether they are employed by the prime contractor, a filed sub-bidder, or a sub-contractor.
- Apprentices working on the project are required to be registered with the Massachusetts Division of Apprentice Standards (DAS). Apprentices must keep their apprentice identification card on their persons during all work hours on the project. An apprentice registered with DAS may be paid the lower apprentice wage rate at the applicable step as provided on the prevailing wage schedule. **Any apprentice not registered with DAS regardless of whether they are registered with another federal, state, local, or private agency must be paid the journeyworker's rate.**
- Every contractor or subcontractor working on the construction project must submit weekly payroll reports and a Statement of Compliance directly to the awarding authority by mail or email and keep them on file for three years. Each weekly payroll report must contain: the employee’s name, address, occupational classification, hours worked, and wages paid. Do not submit weekly payroll reports to DLS. For a sample payroll reporting form go to http://www.mass.gov/dols/pw.
- Contractors with questions about the wage rates or classifications included on the wage schedule have an affirmative obligation to inquire with DLS at (617) 626-6953.
- Contractors must obtain the wage schedules from awarding authorities. Failure of a contractor or subcontractor to pay the prevailing wage rates listed on the wage schedule to all employees who perform construction work on the project is a violation of the law and subjects the contractor or subcontractor to civil and criminal penalties.
- Employees not receiving the prevailing wage rate set forth on the wage schedule may file a complaint with the Fair Labor Division of the office of the Attorney General at (617) 727-3465.

Construction

Classification	Effective Date	Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
(2 AXLE) DRIVER - EQUIPMENT TEAMSTERS JOINT COUNCIL NO. 10 TEAMSTERS JOINT COUNCIL NO. 10 ZONE B	1/1/2026	$40.95	$16.17	$21.78	$0.00	$0.00	$78.90
	6/1/2026	$41.95	$16.17	$21.78	$0.00	$0.00	$79.90
	12/1/2026	$41.95	$16.17	$23.52	$0.00	$0.00	$81.64
	1/1/2027	$41.95	$16.77	$23.52	$0.00	$0.00	$82.24
(3 AXLE) DRIVER - EQUIPMENT TEAMSTERS JOINT COUNCIL NO. 10 TEAMSTERS JOINT COUNCIL NO. 10 ZONE B	1/1/2026	$41.02	$16.17	$21.78	$0.00	$0.00	$78.97
	6/1/2026	$42.02	$16.17	$21.78	$0.00	$0.00	$79.97
	12/1/2026	$42.02	$16.17	$23.52	$0.00	$0.00	$81.71
	1/1/2027	$42.02	$16.77	$23.52	$0.00	$0.00	$82.31
(4 & 5 AXLE) DRIVER - EQUIPMENT TEAMSTERS JOINT COUNCIL NO. 10 TEAMSTERS JOINT COUNCIL NO. 10 ZONE B	1/1/2026	$41.14	$16.17	$21.78	$0.00	$0.00	$79.09
	6/1/2026	$42.14	$16.17	$21.78	$0.00	$0.00	$80.09
	12/1/2026	$42.14	$16.17	$23.52	$0.00	$0.00	$81.83
	1/1/2027	$42.14	$16.77	$23.52	$0.00	$0.00	$82.43
ADS/SUBMERSIBLE PILOT PILE DRIVER LOCAL 56 PILE DRIVER LOCAL 56 (ZONE 1) For apprentice rates see "Apprentice- PILE DRIVER"	1/1/2024	$117.16	$10.08	$11.62	$12.67	$0.00	$151.53
AIR TRACK OPERATOR LABORERS LABORERS - ZONE 2 For apprentice rates see "Apprentice- LABORER"	12/1/2025	$41.22	$10.65	$9.75	$9.11	$0.00	$70.73
	6/1/2026	$42.66	$10.65	$9.75	$9.11	$0.00	$72.17
	12/1/2026	$44.10	$10.65	$9.75	$9.11	$0.00	$73.61
	6/1/2027	$45.55	$10.65	$9.75	$9.11	$0.00	$75.06
	12/1/2027	$47.00	$10.65	$9.75	$9.11	$0.00	$76.51
	6/1/2028	$48.50	$10.65	$9.75	$9.11	$0.00	$78.01
	12/1/2028	$50.00	$10.65	$9.75	$9.11	$0.00	$79.51
AIR TRACK OPERATOR (HEAVY & HIGHWAY) LABORERS LABORERS - ZONE 2 (HEAVY & HIGHWAY) For apprentice rates see "Apprentice- LABORER (Heavy and Highway)"	12/1/2025	$41.22	$10.65	$9.75	$9.21	$0.00	$70.83
	6/1/2026	$42.66	$10.65	$9.75	$9.21	$0.00	$72.27
	12/1/2026	$44.10	$10.65	$9.75	$9.21	$0.00	$73.71
ASBESTOS REMOVER - PIPE / MECH. EQUIPT. HEAT & FROST INSULATORS LOCAL 6 HEAT & FROST INSULATORS LOCAL 6 (BOSTON)	12/1/2025	$44.80	$14.50	$4.30	$6.75	$0.00	$70.35
ASPHALT RAKER LABORERS LABORERS - ZONE 2 For apprentice rates see "Apprentice- LABORER"	12/1/2025	$40.72	$10.65	$9.75	$9.11	$0.00	$70.23
	6/1/2026	$42.16	$10.65	$9.75	$9.11	$0.00	$71.67
	12/1/2026	$43.60	$10.65	$9.75	$9.11	$0.00	$73.11
	6/1/2027	$45.05	$10.65	$9.75	$9.11	$0.00	$74.56
	12/1/2027	$46.50	$10.65	$9.75	$9.11	$0.00	$76.01
	6/1/2028	$48.00	$10.65	$9.75	$9.11	$0.00	$77.51
	12/1/2028	$49.50	$10.65	$9.75	$9.11	$0.00	$79.01
ASPHALT RAKER (HEAVY & HIGHWAY) LABORERS LABORERS - ZONE 2 (HEAVY & HIGHWAY)	12/1/2025	$40.72	$10.65	$9.75	$9.21	$0.00	$70.33
	6/1/2026	$42.16	$10.65	$9.75	$9.21	$0.00	$71.77
	12/1/2026	$43.60	$10.65	$9.75	$9.21	$0.00	$73.21

Construction

Classification	Effective Date	Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
For apprentice rates see "Apprentice- LABORER (Heavy and Highway)							
ASPHALT/CONCRETE/CRUSHER PLANT-ON SITE	12/1/2025	$58.68	$16.55	$13.35	$3.25	$0.00	$91.83
OPERATING ENGINEERS LOCAL 4	6/1/2026	$59.98	$16.55	$13.35	$3.25	$0.00	$93.13
OPERATING ENGINEERS LOCAL 4	12/1/2026	$61.43	$16.55	$13.35	$3.25	$0.00	$94.58
For apprentice rates see "Apprentice- OPERATING ENGINEERS"							
BACKHOE/FRONT-END LOADER	12/1/2025	$58.68	$16.55	$13.35	$3.25	$0.00	$91.83
OPERATING ENGINEERS LOCAL 4	6/1/2026	$59.98	$16.55	$13.35	$3.25	$0.00	$93.13
OPERATING ENGINEERS LOCAL 4	12/1/2026	$61.43	$16.55	$13.35	$3.25	$0.00	$94.58
For apprentice rates see "Apprentice- OPERATING ENGINEERS"							
BARCO-TYPE JUMPING TAMPER	12/1/2025	$40.72	$10.65	$9.75	$9.11	$0.00	$70.23
LABORERS	6/1/2026	$42.16	$10.65	$9.75	$9.11	$0.00	$71.67
LABORERS - ZONE 2	12/1/2026	$43.60	$10.65	$9.75	$9.11	$0.00	$73.11
	6/1/2027	$45.05	$10.65	$9.75	$9.11	$0.00	$74.56
	12/1/2027	$46.50	$10.65	$9.75	$9.11	$0.00	$76.01
	6/1/2028	$48.00	$10.65	$9.75	$9.11	$0.00	$77.51
	12/1/2028	$49.50	$10.65	$9.75	$9.11	$0.00	$79.01
For apprentice rates see "Apprentice- LABORER"							
BLOCK PAVER, RAMMER / CURB SETTER	12/1/2025	$41.22	$10.65	$9.75	$9.11	$0.00	$70.73
LABORERS	6/1/2026	$42.66	$10.65	$9.75	$9.11	$0.00	$72.17
LABORERS - ZONE 2	12/1/2026	$44.10	$10.65	$9.75	$9.11	$0.00	$73.61
	6/1/2027	$45.55	$10.65	$9.75	$9.11	$0.00	$75.06
	12/1/2027	$47.00	$10.65	$9.75	$9.11	$0.00	$76.51
	6/1/2028	$48.50	$10.65	$9.75	$9.11	$0.00	$78.01
	12/1/2028	$50.00	$10.65	$9.75	$9.11	$0.00	$79.51
For apprentice rates see "Apprentice- LABORER"							
BLOCK PAVER, RAMMER / CURB SETTER (HEAVY & HIGHWAY)	12/1/2025	$41.22	$10.65	$9.75	$9.21	$0.00	$70.83
LABORERS	6/1/2026	$42.66	$10.65	$9.75	$9.21	$0.00	$72.27
LABORERS - ZONE 2 (HEAVY & HIGHWAY)	12/1/2026	$44.10	$10.65	$9.75	$9.21	$0.00	$73.71
For apprentice rates see "Apprentice- LABORER (Heavy and Highway)							
BOILER MAKER	1/1/2024	$48.12	$7.07	$14.60	$6.00	$0.00	$75.79
BOILERMAKERS LOCAL 29							
BOILERMAKERS LOCAL 29							

Apprentice: BOILER MAKER

Effective Date: 1/1/2024

Step	Percent	Apprentice Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
1	65.00	$31.28	$7.07	$9.32	$3.90	$0.00	$51.57
2	65.00	$31.28	$7.07	$9.32	$3.90	$0.00	$51.57
3	70.00	$33.68	$7.07	$10.03	$4.20	$0.00	$54.98
4	75.00	$36.09	$7.07	$10.74	$4.50	$0.00	$58.40
5	80.00	$38.50	$7.07	$11.45	$4.80	$0.00	$61.82
6	85.00	$40.90	$7.07	$12.18	$5.10	$0.00	$65.25

Construction

Classification	Effective Date	Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
BRICK/STONE/ARTIFICIAL MASONRY (INCL. MASONRY WATERPROOFING) BRICKLAYERS LOCAL 3 BRICKLAYERS LOCAL 3 (LYNN)	2/1/2026	$67.95	$12.84	$15.57	$8.02	$0.00	$104.38
	8/1/2026	$70.15	$12.84	$15.57	$8.02	$0.00	$106.58
	2/1/2027	$71.55	$12.84	$15.57	$8.02	$0.00	$107.98

Apprentice: BOILER MAKER

Effective Date: 1/1/2024

Step	Percent	Apprentice Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
7	90.00	$43.31	$7.07	$12.88	$5.40	$0.00	$68.66
8	95.00	$45.71	$7.07	$13.62	$5.70	$0.00	$72.10

Apprentice to Journeyworker Ratio: 1:4

Apprentice: BRICK/STONE/ARTIFICIAL MASONRY (INCL. MASONRY WATERPROOFING)

Effective Date: 2/1/2026

Step	Percent	Apprentice Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
1	50.00	$33.98	$12.84	$15.57	$8.02	$0.00	$70.41
2	60.00	$40.77	$12.84	$15.57	$8.02	$0.00	$77.20
3	70.00	$47.57	$12.84	$15.57	$8.02	$0.00	$84.00
4	80.00	$54.36	$12.84	$15.57	$8.02	$0.00	$90.79
5	90.00	$61.16	$12.84	$15.57	$8.02	$0.00	$97.59

Apprentice: BRICK/STONE/ARTIFICIAL MASONRY (INCL. MASONRY WATERPROOFING)

Effective Date: 8/1/2026

Step	Percent	Apprentice Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
1	50.00	$35.08	$12.84	$15.57	$8.02	$0.00	$71.51
2	60.00	$42.09	$12.84	$15.57	$8.02	$0.00	$78.52
3	70.00	$49.11	$12.84	$15.57	$8.02	$0.00	$85.54
4	80.00	$56.12	$12.84	$15.57	$8.02	$0.00	$92.55
5	90.00	$63.14	$12.84	$15.57	$8.02	$0.00	$99.57

Apprentice to Journeyworker Ratio: 1:5

Classification	Effective Date	Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
BULLDOZER/GRADER/SCRAPER OPERATING ENGINEERS LOCAL 4 OPERATING ENGINEERS LOCAL 4	12/1/2025	$58.02	$16.55	$13.35	$3.25	$0.00	$91.17
	6/1/2026	$59.30	$16.55	$13.35	$3.25	$0.00	$92.45
	12/1/2026	$60.74	$16.55	$13.35	$3.25	$0.00	$93.89
For apprentice rates see "Apprentice- OPERATING ENGINEERS"							
CAISSON & UNDERPINNING BOTTOM MAN LABORERS LABORERS - FOUNDATION AND MARINE	12/1/2025	$49.10	$10.65	$9.75	$9.80	$0.00	$79.30
	6/1/2026	$50.65	$10.65	$9.75	$9.80	$0.00	$80.85
	12/1/2026	$52.15	$10.65	$9.75	$9.80	$0.00	$82.35
For apprentice rates see "Apprentice- LABORER"							
CAISSON & UNDERPINNING LABORER LABORERS	12/1/2025	$47.95	$10.65	$9.75	$9.80	$0.00	$78.15
	6/1/2026	$49.50	$10.65	$9.75	$9.80	$0.00	$79.70

Construction

Classification	Effective Date	Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
LABORERS - FOUNDATION AND MARINE	12/1/2026	$51.00	$10.65	$9.75	$9.80	$0.00	$81.20
For apprentice rates see "Apprentice- LABORER"							
CAISSON & UNDERPINNING TOP MAN	12/1/2025	$48.28	$10.65	$9.75	$9.80	$0.00	$78.48
LABORERS	6/1/2026	$49.83	$10.65	$9.75	$9.80	$0.00	$80.03
LABORERS - FOUNDATION AND MARINE	12/1/2026	$51.33	$10.65	$9.75	$9.80	$0.00	$81.53
For apprentice rates see "Apprentice- LABORER"							
CARBIDE CORE DRILL OPERATOR	12/1/2025	$40.72	$10.65	$9.75	$9.11	$0.00	$70.23
LABORERS	6/1/2026	$42.16	$10.65	$9.75	$9.11	$0.00	$71.67
LABORERS - ZONE 2	12/1/2026	$43.60	$10.65	$9.75	$9.11	$0.00	$73.11
	6/1/2027	$45.05	$10.65	$9.75	$9.11	$0.00	$74.56
	12/1/2027	$46.50	$10.65	$9.75	$9.11	$0.00	$76.01
	6/1/2028	$48.00	$10.65	$9.75	$9.11	$0.00	$77.51
	12/1/2028	$49.50	$10.65	$9.75	$9.11	$0.00	$79.01
For apprentice rates see "Apprentice- LABORER"							
CARPENTER	3/1/2026	$50.85	$11.08	$11.47	$8.50	$0.00	$81.90
CARPENTERS	9/1/2026	$52.10	$11.08	$11.47	$8.50	$0.00	$83.15
CARPENTERS -ZONE 2 (Eastern Massachusetts)	3/1/2027	$53.35	$11.08	$11.47	$8.50	$0.00	$84.40

Apprentice: CARPENTER

Effective Date: 3/1/2026

Step	Percent	Apprentice Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
1	45.00	$22.88	$11.08	$0.00	$1.73	$0.00	$35.69
2	45.00	$22.88	$11.08	$0.00	$1.73	$0.00	$35.69
3	55.00	$27.97	$11.08	$0.00	$3.40	$0.00	$42.45
4	55.00	$27.97	$11.08	$0.00	$3.40	$0.00	$42.45
5	70.00	$35.60	$11.08	$11.41	$5.10	$0.00	$63.19
6	70.00	$35.60	$11.08	$11.41	$5.10	$0.00	$63.19
7	80.00	$40.68	$11.08	$11.44	$6.80	$0.00	$70.00
8	80.00	$40.68	$11.08	$11.44	$6.80	$0.00	$70.00

Apprentice: CARPENTER

Effective Date: 9/1/2026

Step	Percent	Apprentice Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
1	45.00	$23.45	$11.08	$0.00	$1.73	$0.00	$36.26
2	45.00	$23.45	$11.08	$0.00	$1.73	$0.00	$36.26
3	55.00	$28.66	$11.08	$0.00	$3.40	$0.00	$43.14
4	55.00	$28.66	$11.08	$0.00	$3.40	$0.00	$43.14
5	70.00	$36.47	$11.08	$11.41	$5.10	$0.00	$64.06
6	70.00	$36.47	$11.08	$11.41	$5.10	$0.00	$64.06
7	80.00	$41.68	$11.08	$11.44	$6.80	$0.00	$71.00
8	80.00	$41.68	$11.08	$11.44	$6.80	$0.00	$71.00

Apprentice to Journeyworker Ratio: 1:5

Construction

Classification	Effective Date	Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
CARPENTER WOOD FRAME	10/1/2025	$27.37	$7.38	$4.47	$1.00	$0.00	$40.22
CARPENTERS	10/1/2026	$28.47	$7.38	$4.47	$1.00	$0.00	$41.32
CARPENTERS-ZONE 3 (Wood Frame)							
All Aspects of New Wood Frame Work							

Apprentice: CARPENTER WOOD FRAME

Effective Date: 10/1/2025

Step	Percent	Apprentice Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
1	60.00	$16.42	$7.38	$0.00	$0.00	$0.00	$23.80
2	60.00	$16.42	$7.38	$0.00	$0.00	$0.00	$23.80
3	65.00	$17.79	$7.38	$0.00	$1.00	$0.00	$26.17
4	70.00	$19.16	$7.38	$0.00	$1.00	$0.00	$27.54
5	75.00	$20.53	$7.38	$3.80	$1.00	$0.00	$32.71
6	80.00	$21.90	$7.38	$3.80	$1.00	$0.00	$34.08
7	85.00	$23.26	$7.38	$3.80	$1.00	$0.00	$35.44
8	90.00	$24.63	$7.38	$3.80	$1.00	$0.00	$36.81

Apprentice: CARPENTER WOOD FRAME

Effective Date: 10/1/2026

Step	Percent	Apprentice Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
1	60.00	$17.08	$7.38	$0.00	$0.00	$0.00	$24.46
2	60.00	$17.08	$7.38	$0.00	$0.00	$0.00	$24.46
3	65.00	$18.51	$7.38	$0.00	$1.00	$0.00	$26.89
4	70.00	$19.93	$7.38	$0.00	$1.00	$0.00	$28.31
5	75.00	$21.35	$7.38	$3.80	$1.00	$0.00	$33.53
6	80.00	$22.78	$7.38	$3.80	$1.00	$0.00	$34.96
7	85.00	$24.20	$7.38	$3.80	$1.00	$0.00	$36.38
8	90.00	$25.62	$7.38	$3.80	$1.00	$0.00	$37.80

Apprentice to Journeyworker Ratio: 1:5

CEMENT MASONRY/PLASTERING	1/1/2026	$53.24	$13.35	$16.43	$7.78	$1.80	$92.60
PLASTERERS AND CEMENT MASONS LOCAL 534	7/1/2026	$54.49	$13.35	$16.43	$7.78	$1.80	$93.85
Plasterers and Cement Masons - Zone 1	1/1/2027	$55.94	$13.35	$16.43	$7.78	$1.80	$95.30
	7/1/2027	$57.29	$13.35	$16.43	$7.78	$1.80	$96.65
	1/1/2028	$58.64	$13.35	$16.43	$7.78	$1.80	$98.00

Apprentice: CEMENT MASONRY/PLASTERING

Effective Date: 1/1/2026

Step	Percent	Apprentice Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
1	50.00	$26.62	$13.35	$16.43	$0.00	$0.00	$56.40
2	60.00	$31.94	$13.35	$16.43	$7.78	$1.80	$71.30
3	65.00	$34.61	$13.35	$16.43	$7.78	$1.80	$73.97
4	70.00	$37.27	$13.35	$16.43	$7.78	$1.80	$76.63

Construction

Classification	Effective Date	Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate

Apprentice: CEMENT MASONRY/PLASTERING

Effective Date: 1/1/2026

Step	Percent	Apprentice Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
5	75.00	$39.93	$13.35	$16.43	$7.78	$1.80	$79.29
6	80.00	$42.59	$13.35	$16.43	$7.78	$1.80	$81.95
7	90.00	$47.92	$13.35	$16.43	$0.00	$0.00	$77.70

Apprentice: CEMENT MASONRY/PLASTERING

Effective Date: 7/1/2026

Step	Percent	Apprentice Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
1	50.00	$27.25	$13.35	$16.43	$0.00	$0.00	$57.03
2	60.00	$32.69	$13.35	$16.43	$7.78	$1.80	$72.05
3	65.00	$35.42	$13.35	$16.43	$7.78	$1.80	$74.78
4	70.00	$38.14	$13.35	$16.43	$7.78	$1.80	$77.50
5	75.00	$40.87	$13.35	$16.43	$7.78	$1.80	$80.23
6	80.00	$43.59	$13.35	$16.43	$7.78	$1.80	$82.95
7	90.00	$49.04	$13.35	$0.00	$7.78	$0.00	$70.17

Apprentice to Journeyworker Ratio: 1:5

CHAIN SAW OPERATOR LABORERS LABORERS - ZONE 2	12/1/2025	$40.72	$10.65	$9.75	$9.11	$0.00	$70.23
	6/1/2026	$42.16	$10.65	$9.75	$9.11	$0.00	$71.67
	12/1/2026	$43.60	$10.65	$9.75	$9.11	$0.00	$73.11
	6/1/2027	$45.05	$10.65	$9.75	$9.11	$0.00	$74.56
	12/1/2027	$46.50	$10.65	$9.75	$9.11	$0.00	$76.01
	6/1/2028	$48.00	$10.65	$9.75	$9.11	$0.00	$77.51
	12/1/2028	$49.50	$10.65	$9.75	$9.11	$0.00	$79.01
For apprentice rates see "Apprentice- LABORER"							
CLAM SHELLS/SLURRY BUCKETS/HEADING MACHINES OPERATING ENGINEERS LOCAL 4 OPERATING ENGINEERS LOCAL 4	12/1/2025	$59.88	$16.55	$13.35	$3.25	$0.00	$93.03
	6/1/2026	$61.21	$16.55	$13.35	$3.25	$0.00	$94.36
	12/1/2026	$62.69	$16.55	$13.35	$3.25	$0.00	$95.84
For apprentice rates see "Apprentice- OPERATING ENGINEERS"							
COMPRESSOR OPERATOR OPERATING ENGINEERS LOCAL 4 OPERATING ENGINEERS LOCAL 4	12/1/2025	$37.37	$16.55	$13.35	$3.25	$0.00	$70.52
	6/1/2026	$38.23	$16.55	$13.35	$3.25	$0.00	$71.38
	12/1/2026	$39.18	$16.55	$13.35	$3.25	$0.00	$72.33
For apprentice rates see "Apprentice- OPERATING ENGINEERS"							
DELEADER (BRIDGE) PAINTERS LOCAL 35 PAINTERS LOCAL 35 - ZONE 2	1/1/2026	$59.56	$10.35	$12.00	$12.60	$0.00	$94.51

Construction

Classification	Effective Date	Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate

Apprentice: DELEADER (BRIDGE)

Effective Date: 1/1/2026

Step	Percent	Apprentice Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
1	50.00	$29.78	$10.35	$0.00	$0.00	$0.00	$40.13
2	55.00	$32.76	$10.35	$0.00	$6.93	$0.00	$50.04
3	60.00	$35.74	$10.35	$0.00	$7.56	$0.00	$53.65
4	65.00	$38.71	$10.35	$0.00	$8.19	$0.00	$57.25
5	70.00	$41.69	$10.35	$12.00	$8.82	$0.00	$72.86
6	75.00	$44.67	$10.35	$12.00	$9.45	$0.00	$76.47
7	80.00	$47.65	$10.35	$12.00	$10.08	$0.00	$80.08
8	90.00	$53.60	$10.35	$12.00	$11.34	$0.00	$87.29

Apprentice to Journeyworker Ratio: 1:1

Classification	Effective Date	Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
DEMO: ADZEMAN	12/1/2025	$48.00	$10.65	$9.75	$9.65	$0.00	$78.05
LABORERS	6/1/2026	$49.55	$10.65	$9.75	$9.65	$0.00	$79.60
LABORERS - ZONE 2	12/7/2026	$51.05	$10.65	$9.75	$9.65	$0.00	$81.10
	6/7/2027	$52.65	$10.65	$9.75	$9.65	$0.00	$82.70
	12/6/2027	$54.25	$10.65	$9.75	$9.65	$0.00	$84.30
	6/5/2028	$55.93	$10.65	$9.75	$9.65	$0.00	$85.98
	12/4/2028	$57.60	$10.65	$9.75	$9.65	$0.00	$87.65
For apprentice rates see "Apprentice- LABORER"							
DEMO: BACKHOE/LOADER/HAMMER OPERATOR	12/1/2025	$49.00	$10.65	$9.75	$9.65	$0.00	$79.05
LABORERS	6/1/2026	$50.55	$10.65	$9.75	$9.65	$0.00	$80.60
LABORERS - ZONE 2	12/7/2026	$52.05	$10.65	$9.75	$9.65	$0.00	$82.10
	6/7/2027	$53.65	$10.65	$9.75	$9.65	$0.00	$83.70
	12/6/2027	$55.25	$10.65	$9.75	$9.65	$0.00	$85.30
	6/5/2028	$56.93	$10.65	$9.75	$9.65	$0.00	$86.98
	12/4/2028	$58.60	$10.65	$9.75	$9.65	$0.00	$88.65
For apprentice rates see "Apprentice- LABORER"							
DEMO: BURNERS	12/1/2025	$48.75	$10.65	$9.75	$9.65	$0.00	$78.80
LABORERS	6/1/2026	$50.30	$10.65	$9.75	$9.65	$0.00	$80.35
LABORERS - ZONE 2	12/7/2026	$51.80	$10.65	$9.75	$9.65	$0.00	$81.85
	6/7/2027	$53.40	$10.65	$9.75	$9.65	$0.00	$83.45
	12/6/2027	$55.00	$10.65	$9.75	$9.65	$0.00	$85.05
	6/5/2028	$56.68	$10.65	$9.75	$9.65	$0.00	$86.73
	12/4/2028	$58.35	$10.65	$9.75	$9.65	$0.00	$88.40
For apprentice rates see "Apprentice- LABORER"							
DEMO: CONCRETE CUTTER/SAWYER	12/1/2025	$49.00	$10.65	$9.75	$9.65	$0.00	$79.05
LABORERS	6/1/2026	$50.55	$10.65	$9.75	$9.65	$0.00	$80.60
LABORERS - ZONE 2	12/7/2026	$52.05	$10.65	$9.75	$9.65	$0.00	$82.10
	6/7/2027	$53.65	$10.65	$9.75	$9.65	$0.00	$83.70
	12/6/2027	$55.25	$10.65	$9.75	$9.65	$0.00	$85.30
	6/5/2028	$56.93	$10.65	$9.75	$9.65	$0.00	$86.98
	12/4/2028	$58.60	$10.65	$9.75	$9.65	$0.00	$88.65

Construction

Classification	Effective Date	Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
For apprentice rates see "Apprentice- LABORER"							
DEMO: JACKHAMMER OPERATOR LABORERS LABORERS - ZONE 2	12/1/2025	$48.75	$10.65	$9.75	$9.65	$0.00	$78.80
	6/1/2026	$50.30	$10.65	$9.75	$9.65	$0.00	$80.35
	12/7/2026	$51.80	$10.65	$9.75	$9.65	$0.00	$81.85
	6/7/2027	$53.40	$10.65	$9.75	$9.65	$0.00	$83.45
	12/6/2027	$55.00	$10.65	$9.75	$9.65	$0.00	$85.05
	6/5/2028	$56.68	$10.65	$9.75	$9.65	$0.00	$86.73
	12/4/2028	$58.35	$10.65	$9.75	$9.65	$0.00	$88.40
For apprentice rates see "Apprentice- LABORER"							
DEMO: WRECKING LABORER LABORERS LABORERS - ZONE 2	12/1/2025	$48.00	$10.65	$9.75	$9.65	$0.00	$78.05
	6/1/2026	$49.55	$10.65	$9.75	$9.65	$0.00	$79.60
	12/7/2026	$51.05	$10.65	$9.75	$9.65	$0.00	$81.10
	6/7/2027	$52.65	$10.65	$9.75	$9.65	$0.00	$82.70
	12/6/2027	$54.25	$10.65	$9.75	$9.65	$0.00	$84.30
	6/5/2028	$55.93	$10.65	$9.75	$9.65	$0.00	$85.98
	12/4/2028	$57.60	$10.65	$9.75	$9.65	$0.00	$87.65
For apprentice rates see "Apprentice- LABORER"							
DIRECTIONAL DRILL MACHINE OPERATOR OPERATING ENGINEERS LOCAL 4 OPERATING ENGINEERS LOCAL 4	12/1/2025	$58.02	$16.55	$13.35	$3.25	$0.00	$91.17
	6/1/2026	$59.30	$16.55	$13.35	$3.25	$0.00	$92.45
	12/1/2026	$60.74	$16.55	$13.35	$3.25	$0.00	$93.89
For apprentice rates see "Apprentice- OPERATING ENGINEERS"							
DIVER PILE DRIVER LOCAL 56 PILE DRIVER LOCAL 56 (ZONE 1)	8/1/2024	$78.11	$10.08	$11.62	$10.04	$0.00	$109.85
as of 8-1-24, Apprentices with diving licenses begin at second year. % of Diver wage 70/80/90 2A $69.83, 3A $91.79,4A $102.14 Total Rate							
DIVER TENDER PILE DRIVER LOCAL 56 PILE DRIVER LOCAL 56 (ZONE 1)	8/1/2024	$55.79	$10.08	$11.62	$12.67	$0.00	$90.16
as of 8-1-24, Apprentices with diving licenses begin at second year. % of Piledriver wage 70/80/90 2A $54.20, 3A $73.93,4A $82.05 Total Rate							
DIVER TENDER (EFFLUENT) PILE DRIVER LOCAL 56 PILE DRIVER LOCAL 56 (ZONE 1)	8/1/2024	$83.69	$10.08	$11.62	$12.67	$0.00	$118.06
For apprentice rates see "Apprentice- PILE DRIVER"							
DIVER/SLURRY (EFFLUENT) PILE DRIVER LOCAL 56 PILE DRIVER LOCAL 56 (ZONE 1)	8/1/2024	$117.16	$10.08	$11.62	$12.67	$0.00	$151.53
For apprentice rates see "Apprentice- PILE DRIVER"							
DRAWBRIDGE OPERATOR (Construction) DRAWBRIDGE - SEIU LOCAL 888 DRAWBRIDGE - SEIU LOCAL 888	7/1/2020	$26.77	$6.67	$3.93	$0.00	$0.16	$37.53
ELECTRICIAN ELECTRICIANS LOCAL 103 ELECTRICIANS LOCAL 103	3/1/2026	$66.86	$13.00	$14.64	$9.00	$0.00	$103.50
	9/1/2026	$68.78	$13.00	$14.69	$9.00	$0.00	$105.47
	3/1/2027	$69.97	$13.00	$14.73	$9.00	$0.00	$106.70

Construction

Classification	Effective Date	Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
	9/1/2027	$71.88	$13.00	$14.79	$9.00	$0.00	$108.67
	3/1/2028	$73.08	$13.00	$14.82	$9.00	$0.00	$109.90

Apprentice: ELECTRICIAN

Effective Date: 3/1/2026

Step	Percent	Apprentice Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
1	40.00	$26.74	$13.00	$0.80	$0.00	$0.00	$40.54
2	40.00	$26.74	$13.00	$0.80	$0.00	$0.00	$40.54
3	45.00	$30.09	$13.00	$13.53	$4.05	$0.00	$60.67
4	45.00	$30.09	$13.00	$13.53	$4.05	$0.00	$60.67
5	50.00	$33.43	$13.00	$13.63	$4.50	$0.00	$64.56
6	55.00	$36.77	$13.00	$13.73	$4.95	$0.00	$68.45
7	60.00	$40.12	$13.00	$13.83	$5.40	$0.00	$72.35
8	65.00	$43.46	$13.00	$13.93	$5.85	$0.00	$76.24
9	70.00	$46.80	$13.00	$14.03	$6.30	$0.00	$80.13
10	75.00	$50.15	$13.00	$14.13	$6.75	$0.00	$84.03

Apprentice: ELECTRICIAN

Effective Date: 9/1/2026

Step	Percent	Apprentice Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
1	40.00	$27.51	$13.00	$0.83	$0.00	$0.00	$41.34
2	40.00	$27.51	$13.00	$0.83	$0.00	$0.00	$41.34
3	45.00	$30.95	$13.00	$13.56	$4.05	$0.00	$61.56
4	45.00	$30.95	$13.00	$13.56	$4.05	$0.00	$61.56
5	50.00	$34.39	$13.00	$13.66	$4.50	$0.00	$65.55
6	55.00	$37.83	$13.00	$13.76	$4.95	$0.00	$69.54
7	60.00	$41.27	$13.00	$13.87	$5.40	$0.00	$73.54
8	65.00	$44.71	$13.00	$13.97	$5.85	$0.00	$77.53
9	70.00	$48.15	$13.00	$14.07	$6.30	$0.00	$81.52
10	75.00	$51.59	$13.00	$14.18	$6.75	$0.00	$85.52

Apprentice Notes

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Apprentice to Journeyworker Ratio: 2:3

ELEVATOR CONSTRUCTOR	1/1/2026	$77.26	$16.38	$11.06	$10.70	$0.00	$115.40
ELEVATOR CONSTRUCTORS LOCAL 4							
ELEVATOR CONSTRUCTORS LOCAL 4	1/1/2027	$80.55	$16.48	$11.16	$11.00	$0.00	$119.19

Apprentice: ELEVATOR CONSTRUCTOR

Effective Date: 1/1/2026

Step	Percent	Apprentice Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate

Construction

Classification	Effective Date	Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate

Apprentice: ELEVATOR CONSTRUCTOR

Effective Date: 1/1/2026

Step	Percent	Apprentice Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
1	50.00	$38.63	$0.00	$0.00	$0.00	$0.00	$38.63
2	55.00	$42.49	$16.38	$11.06	$10.70	$0.00	$80.63
3	65.00	$50.22	$16.38	$11.06	$10.70	$0.00	$88.36
4	70.00	$54.08	$16.38	$11.06	$10.70	$0.00	$92.22
5	80.00	$61.81	$16.38	$11.06	$10.70	$0.00	$99.95

Apprentice: ELEVATOR CONSTRUCTOR

Effective Date: 1/1/2027

Step	Percent	Apprentice Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
1	50.00	$40.28	$0.00	$0.00	$0.00	$0.00	$40.28
2	55.00	$44.30	$16.48	$11.16	$11.00	$0.00	$82.94
3	65.00	$52.36	$16.48	$11.16	$11.00	$0.00	$91.00
4	70.00	$56.39	$16.48	$11.16	$11.00	$0.00	$95.03
5	80.00	$64.44	$16.48	$11.16	$11.00	$0.00	$103.08

Apprentice to Journeyworker Ratio: 1:1

ELEVATOR CONSTRUCTOR HELPER ELEVATOR CONSTRUCTORS LOCAL 4 ELEVATOR CONSTRUCTORS LOCAL 4	1/1/2026	$54.08	$16.38	$11.06	$10.07	$0.00	$91.59
	1/1/2027	$56.39	$16.48	$11.16	$11.00	$0.00	$95.03
For apprentice rates see "Apprentice - ELEVATOR CONSTRUCTOR"							
FENCE & GUARD RAIL ERECTOR (HEAVY & HIGHWAY) LABORERS LABORERS - ZONE 2 (HEAVY & HIGHWAY)	12/1/2025	$40.72	$10.65	$9.75	$9.21	$0.00	$70.33
	6/1/2026	$42.16	$10.65	$9.75	$9.21	$0.00	$71.77
	12/1/2026	$43.60	$10.65	$9.75	$9.21	$0.00	$73.21
For apprentice rates see "Apprentice- LABORER (Heavy and Highway)							
FIELD ENG.INST.PERSON-BLDG,SITE,HVY/HWY OPERATING ENGINEERS LOCAL 4 OPERATING ENGINEERS LOCAL 4	11/1/2025	$53.56	$16.05	$13.25	$3.25	$0.00	$86.11
	5/1/2026	$55.00	$16.05	$13.25	$3.25	$0.00	$87.55
	11/1/2026	$56.29	$16.05	$13.25	$3.25	$0.00	$88.84
	5/1/2027	$57.72	$16.05	$13.25	$3.25	$0.00	$90.27
For apprentice rates see "Apprentice- OPERATING ENGINEERS"							
FIELD ENG.PARTY CHIEF-BLDG,SITE,HVY/HWY OPERATING ENGINEERS LOCAL 4 OPERATING ENGINEERS LOCAL 4	11/1/2025	$55.17	$16.05	$13.25	$3.25	$0.00	$87.72
	5/1/2026	$56.62	$16.05	$13.25	$3.25	$0.00	$89.17
	11/1/2026	$57.92	$16.05	$13.25	$3.25	$0.00	$90.47
	5/1/2027	$59.37	$16.05	$13.25	$3.25	$0.00	$91.92
For apprentice rates see "Apprentice- OPERATING ENGINEERS"							
FIELD ENG.ROD PERSON-BLDG,SITE,HVY/HWY OPERATING ENGINEERS LOCAL 4 OPERATING ENGINEERS LOCAL 4	11/1/2025	$26.03	$16.05	$13.25	$3.25	$0.00	$58.58
	5/1/2026	$26.88	$16.05	$13.25	$3.25	$0.00	$59.43
	11/1/2026	$27.64	$16.05	$13.25	$3.25	$0.00	$60.19
	5/1/2027	$28.49	$16.05	$13.25	$3.25	$0.00	$61.04

Construction

Classification	Effective Date	Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
For apprentice rates see "Apprentice- OPERATING ENGINEERS"							
FIRE ALARM INSTALLER	3/1/2026	$66.86	$13.00	$14.64	$9.00	$0.00	$103.50
ELECTRICIANS LOCAL 103	9/1/2026	$68.78	$13.00	$14.69	$9.00	$0.00	$105.47
ELECTRICIANS LOCAL 103	3/1/2027	$69.97	$13.00	$14.73	$9.00	$0.00	$106.70
	9/1/2027	$71.88	$13.00	$14.79	$9.00	$0.00	$108.67
	3/1/2028	$73.08	$13.00	$14.82	$9.00	$0.00	$109.90
For apprentice rates see "Apprentice- ELECTRICIAN"							
FIRE ALARM REPAIR / MAINTENANCE	3/1/2026	$53.49	$13.00	$14.23	$7.20	$0.00	$87.92
/ COMMISSIONING	9/1/2026	$55.02	$13.00	$14.28	$7.20	$0.00	$89.50
ELECTRICIANS LOCAL 103	3/1/2027	$55.98	$13.00	$14.31	$7.20	$0.00	$90.49
ELECTRICIANS LOCAL 103	9/1/2027	$57.50	$13.00	$14.36	$7.20	$0.00	$92.06
	3/1/2028	$58.46	$13.00	$14.38	$7.20	$0.00	$93.04
For apprentice rates see "Apprentice- TELECOMMUNICATIONS TECHNICIAN"							
FIREMAN (ASST. ENGINEER)	12/1/2025	$47.09	$16.55	$13.35	$3.25	$0.00	$80.24
OPERATING ENGINEERS LOCAL 4	6/1/2026	$48.15	$16.55	$13.35	$3.25	$0.00	$81.30
OPERATING ENGINEERS LOCAL 4	12/1/2026	$49.33	$16.55	$13.35	$3.25	$0.00	$82.48
For apprentice rates see "Apprentice- OPERATING ENGINEERS"							
FLAGGER & SIGNALER (HEAVY & HIGHWAY)	12/1/2025	$28.09	$10.65	$9.75	$9.21	$0.00	$57.70
LABORERS	6/1/2026	$29.21	$10.65	$9.75	$9.21	$0.00	$58.82
LABORERS - ZONE 2 (HEAVY & HIGHWAY)	12/1/2026	$29.21	$10.65	$9.75	$9.21	$0.00	$58.82
For apprentice rates see "Apprentice- LABORER (Heavy and Highway)"							
FLOORCOVERER	3/1/2026	$59.24	$10.33	$11.47	$8.80	$0.00	$89.84
FLOORCOVERERS LOCAL 2168	9/1/2026	$60.74	$10.33	$11.47	$8.80	$0.00	$91.34
FLOORCOVERERS LOCAL 2168 ZONE I	3/1/2027	$62.24	$10.33	$11.47	$8.80	$0.00	$92.84

Apprentice: FLOORCOVERER

Effective Date: 3/1/2026

Step	Percent	Apprentice Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
1	45.00	$26.66	$10.33	$0.00	$1.76	$0.00	$38.75
2	45.00	$26.66	$10.33	$0.00	$1.76	$0.00	$38.75
3	55.00	$32.58	$10.33	$0.00	$3.52	$0.00	$46.43
4	55.00	$32.58	$10.33	$0.00	$3.52	$0.00	$46.43
5	70.00	$41.47	$10.33	$11.47	$5.28	$0.00	$68.55
6	70.00	$41.47	$10.33	$11.47	$5.28	$0.00	$68.55
7	80.00	$47.39	$10.33	$11.47	$7.04	$0.00	$76.23
8	80.00	$47.39	$10.33	$11.47	$7.04	$0.00	$76.23

Apprentice: FLOORCOVERER

Effective Date: 9/1/2026

Step	Percent	Apprentice Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate

Construction

Classification	Effective Date	Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate

Apprentice: FLOORCOVERER

Effective Date: 9/1/2026

Step	Percent	Apprentice Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
1	45.00	$27.33	$10.33	$0.00	$1.76	$0.00	$39.42
2	45.00	$27.33	$10.33	$0.00	$1.76	$0.00	$39.42
3	55.00	$33.41	$10.33	$0.00	$3.52	$0.00	$47.26
4	55.00	$33.41	$10.33	$0.00	$3.52	$0.00	$47.26
5	70.00	$42.52	$10.33	$11.47	$5.28	$0.00	$69.60
6	70.00	$42.52	$10.33	$11.47	$5.28	$0.00	$69.60
7	80.00	$48.59	$10.33	$11.47	$7.04	$0.00	$77.43
8	80.00	$48.59	$10.33	$11.47	$7.04	$0.00	$77.43

Apprentice Notes

Steps are 750 hrs.

Apprentice to Journeyworker Ratio: 1:1

FORK LIFT/CHERRY PICKER	12/1/2025	$58.68	$16.55	$13.35	$3.25	$0.00	$91.83
OPERATING ENGINEERS LOCAL 4	6/1/2026	$59.98	$16.55	$13.35	$3.25	$0.00	$93.13
OPERATING ENGINEERS LOCAL 4	12/1/2026	$61.43	$16.55	$13.35	$3.25	$0.00	$94.58
For apprentice rates see "Apprentice- OPERATING ENGINEERS"							
GENERATOR/LIGHTING PLANT/HEATERS	12/1/2025	$37.37	$16.55	$13.35	$3.25	$0.00	$70.52
OPERATING ENGINEERS LOCAL 4	6/1/2026	$38.23	$16.55	$13.35	$3.25	$0.00	$71.38
OPERATING ENGINEERS LOCAL 4	12/1/2026	$39.18	$16.55	$13.35	$3.25	$0.00	$72.33
For apprentice rates see "Apprentice- OPERATING ENGINEERS"							
GLAZIER (GLASS PLANK/AIR BARRIER/INTERIOR SYSTEMS)	1/1/2026	$49.06	$10.35	$12.00	$12.60	$0.00	$84.01
GLAZIERS LOCAL 35							
GLAZIERS LOCAL 35 (ZONE 2)							

Apprentice: GLAZIER (GLASS PLANK/AIR BARRIER/INTERIOR SYSTEMS)

Effective Date: 1/1/2026

Step	Percent	Apprentice Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
1	50.00	$24.53	$10.35	$0.00	$0.00	$0.00	$34.88
2	55.00	$26.98	$10.35	$0.00	$6.88	$0.00	$44.21
3	60.00	$29.44	$10.35	$0.00	$7.50	$0.00	$47.29
4	65.00	$31.89	$10.35	$0.00	$8.13	$0.00	$50.37
5	70.00	$34.34	$10.35	$12.00	$8.75	$0.00	$65.44
6	75.00	$36.80	$10.35	$12.00	$9.38	$0.00	$68.53
7	80.00	$39.25	$10.35	$12.00	$10.00	$0.00	$71.60
8	90.00	$44.15	$10.35	$12.00	$11.25	$0.00	$77.75

Apprentice to Journeyworker Ratio: 1:1

HOISTING ENGINEER/CRANES/GRADALLS	12/1/2025	$58.68	$16.55	$13.35	$3.25	$0.00	$91.83

Construction

Classification	Effective Date	Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
OPERATING ENGINEERS LOCAL 4	6/1/2026	$59.98	$16.55	$13.35	$3.25	$0.00	$93.13
OPERATING ENGINEERS LOCAL 4	12/1/2026	$61.43	$16.55	$13.35	$3.25	$0.00	$94.58

Apprentice: HOISTING ENGINEER/CRANES/GRADALLS

Effective Date: 12/1/2025

Step	Percent	Apprentice Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
1	55.00	$32.88	$0.00	$0.00	$0.00	$0.00	$32.88
2	60.00	$35.87	$16.05	$13.25	$3.25	$0.00	$68.42
3	65.00	$38.86	$16.05	$13.25	$3.25	$0.00	$71.41
4	70.00	$41.85	$16.05	$13.25	$3.25	$0.00	$74.40
5	75.00	$44.84	$16.05	$13.25	$3.25	$0.00	$77.39
6	80.00	$47.82	$16.05	$13.25	$3.25	$0.00	$80.37
7	85.00	$50.81	$16.05	$13.25	$3.25	$0.00	$83.36
8	90.00	$53.80	$16.05	$13.25	$3.25	$0.00	$86.35

Apprentice: HOISTING ENGINEER/CRANES/GRADALLS

Effective Date: 6/1/2026

Step	Percent	Apprentice Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
1	55.00	$32.99	$0.00	$0.00	$0.00	$0.00	$32.99
2	60.00	$35.99	$16.55	$13.35	$3.25	$0.00	$69.14
3	65.00	$38.99	$16.55	$13.35	$3.25	$0.00	$72.14
4	70.00	$41.99	$16.55	$13.35	$3.25	$0.00	$75.14
5	75.00	$44.99	$16.55	$13.35	$3.25	$0.00	$78.14
6	80.00	$47.98	$16.55	$13.35	$3.25	$0.00	$81.13
7	85.00	$50.98	$16.55	$13.35	$3.25	$0.00	$84.13
8	90.00	$53.98	$16.55	$13.35	$3.25	$0.00	$87.13

Apprentice to Journeyworker Ratio: 1:6

HVAC (DUCTWORK) SHEETMETAL WORKERS LOCAL 17 SHEETMETAL WORKERS LOCAL 17 - A	2/1/2026	$62.93	$14.91	$18.74	$9.53	$2.98	$109.09
For apprentice rates see "Apprentice- SHEET METAL WORKER"							
HVAC (ELECTRICAL CONTROLS) ELECTRICIANS LOCAL 103 ELECTRICIANS LOCAL 103	3/1/2026	$66.86	$13.00	$14.64	$9.00	$0.00	$103.50
	9/1/2026	$68.78	$13.00	$14.69	$9.00	$0.00	$105.47
	3/1/2027	$69.97	$13.00	$14.73	$9.00	$0.00	$106.70
	9/1/2027	$71.88	$13.00	$14.79	$9.00	$0.00	$108.67
	3/1/2028	$73.08	$13.00	$14.82	$9.00	$0.00	$109.90
For apprentice rates see "Apprentice- ELECTRICIAN"							
HVAC (TESTING AND BALANCING - AIR) SHEETMETAL WORKERS LOCAL 17 SHEETMETAL WORKERS LOCAL 17 - A	2/1/2026	$62.93	$14.91	$18.74	$9.53	$2.98	$109.09
For apprentice rates see "Apprentice- SHEET METAL WORKER"							
HVAC (TESTING AND BALANCING -WATER)	3/1/2026	$70.58	$13.95	$14.00	$9.55	$0.00	$108.08

Construction

Classification	Effective Date	Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
PIPEFITTERS LOCAL 537 PIPEFITTERS LOCAL 537							
For apprentice rates see "Apprentice- PIPEFITTER" or "PLUMBER/PIPEFITTER"							
HVAC MECHANIC PIPEFITTERS LOCAL 537 PIPEFITTERS LOCAL 537	3/1/2026	$70.58	$13.95	$14.00	$9.55	$0.00	$108.08
For apprentice rates see "Apprentice- PIPEFITTER" or "PLUMBER/PIPEFITTER"							
HYDRAULIC DRILLS LABORERS LABORERS - ZONE 2	12/1/2025	$41.22	$10.65	$9.75	$9.11	$0.00	$70.73
	6/1/2026	$42.66	$10.65	$9.75	$9.11	$0.00	$72.17
	12/1/2026	$44.10	$10.65	$9.75	$9.11	$0.00	$73.61
	6/1/2027	$45.55	$10.65	$9.75	$9.11	$0.00	$75.06
	12/1/2027	$47.00	$10.65	$9.75	$9.11	$0.00	$76.51
	6/1/2028	$48.50	$10.65	$9.75	$9.11	$0.00	$78.01
	12/1/2028	$50.00	$10.65	$9.75	$9.11	$0.00	$79.51
For apprentice rates see "Apprentice- LABORER"							
HYDRAULIC DRILLS (HEAVY & HIGHWAY) LABORERS LABORERS - ZONE 2 (HEAVY & HIGHWAY)	12/1/2025	$41.22	$10.65	$9.75	$9.21	$0.00	$70.83
	6/1/2026	$42.66	$10.65	$9.75	$9.21	$0.00	$72.27
	12/1/2026	$44.10	$10.65	$9.75	$9.21	$0.00	$73.71
For apprentice rates see "Apprentice- LABORER (Heavy and Highway)"							
INSULATOR (PIPES & TANKS) HEAT & FROST INSULATORS LOCAL 6 HEAT & FROST INSULATORS LOCAL 6 (BOSTON)	9/1/2025	$60.34	$14.75	$9.52	$10.09	$0.00	$94.70
	9/1/2026	$63.76	$14.75	$9.52	$10.09	$0.00	$98.12

Apprentice: INSULATOR (PIPES & TANKS)

Effective Date: 9/1/2025

Step	Percent	Apprentice Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
1	50.00	$30.17	$14.75	$9.27	$5.05	$0.00	$59.24
2	60.00	$36.20	$14.75	$9.32	$6.05	$0.00	$66.32
3	70.00	$42.24	$14.75	$9.37	$7.06	$0.00	$73.42
4	80.00	$48.27	$14.75	$9.42	$8.07	$0.00	$80.51

Apprentice: INSULATOR (PIPES & TANKS)

Effective Date: 9/1/2026

Step	Percent	Apprentice Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
1	50.00	$31.88	$14.75	$9.27	$5.05	$0.00	$60.95
2	60.00	$38.26	$14.75	$9.32	$6.05	$0.00	$68.38
3	70.00	$44.63	$14.75	$9.37	$7.06	$0.00	$75.81
4	80.00	$51.01	$14.75	$9.42	$8.07	$0.00	$83.25

Apprentice to Journeyworker Ratio: 1:4

IRONWORKER/WELDER IRONWORKERS LOCAL 7	9/16/2025	$53.46	$9.05	$12.75	$14.50	$0.00	$89.76

Construction

Classification	Effective Date	Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
IRONWORKERS LOCAL 7 (LAWRENCE AREA)							

Apprentice: IRONWORKER/WELDER

Effective Date: 9/16/2025

Step	Percent	Apprentice Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
1	60.00	$32.08	$9.05	$12.75	$4.50	$0.00	$58.38
2	75.00	$40.10	$9.05	$12.75	$4.50	$0.00	$66.40
3	85.00	$45.44	$9.05	$12.75	$4.50	$0.00	$71.74
4	0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
5	0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
6	0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00

Apprentice to Journeyworker Ratio: 1:4

JACKHAMMER & PAVING BREAKER OPERATOR LABORERS LABORERS - ZONE 2	12/1/2025	$40.72	$10.65	$9.75	$9.11	$0.00	$70.23
	6/1/2026	$42.16	$10.65	$9.75	$9.11	$0.00	$71.67
	12/1/2026	$43.60	$10.65	$9.75	$9.11	$0.00	$73.11
	6/1/2027	$45.05	$10.65	$9.75	$9.11	$0.00	$74.56
	12/1/2027	$46.50	$10.65	$9.75	$9.11	$0.00	$76.01
	6/1/2028	$48.00	$10.65	$9.75	$9.11	$0.00	$77.51
	12/1/2028	$49.50	$10.65	$9.75	$9.11	$0.00	$79.01
For apprentice rates see "Apprentice- LABORER"							
LABORER LABORERS LABORERS - ZONE 2	12/1/2025	$40.47	$10.65	$9.75	$9.11	$0.00	$69.98
	6/1/2026	$41.91	$10.65	$9.75	$9.11	$0.00	$71.42
	12/1/2026	$43.35	$10.65	$9.75	$9.11	$0.00	$72.86
	6/1/2027	$44.80	$10.65	$9.75	$9.11	$0.00	$74.31
	12/1/2027	$46.25	$10.65	$9.75	$9.11	$0.00	$75.76
	6/1/2028	$47.75	$10.65	$9.75	$9.11	$0.00	$77.26
	12/1/2028	$49.25	$10.65	$9.75	$9.11	$0.00	$78.76

Apprentice: LABORER

Effective Date: 12/1/2025

Step	Percent	Apprentice Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
1	60.00	$25.03	$10.15	$9.50	$9.11	$0.00	$53.79
2	70.00	$29.20	$10.15	$9.50	$9.11	$0.00	$57.96
3	80.00	$33.38	$10.15	$9.50	$9.11	$0.00	$62.14
4	90.00	$37.55	$10.15	$9.50	$9.11	$0.00	$66.31

Apprentice: LABORER

Effective Date: 6/1/2026

Step	Percent	Apprentice Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
1	60.00	$25.15	$10.65	$9.75	$9.11	$0.00	$54.66

Classification	Effective Date	Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate

Apprentice: LABORER

Effective Date: 6/1/2026

Step	Percent	Apprentice Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
2	70.00	$29.34	$10.65	$9.75	$9.11	$0.00	$58.85
3	80.00	$33.53	$10.65	$9.75	$9.11	$0.00	$63.04
4	90.00	$37.72	$10.65	$9.75	$9.11	$0.00	$67.23

Apprentice to Journeyworker Ratio: 1:5

LABORER (HEAVY & HIGHWAY) LABORERS LABORERS - ZONE 2 (HEAVY & HIGHWAY)	12/1/2025	$40.47	$10.65	$9.75	$9.21	$0.00	$70.08
	6/1/2026	$41.91	$10.65	$9.75	$9.21	$0.00	$71.52
	12/1/2026	$43.35	$10.65	$9.75	$9.21	$0.00	$72.96

Apprentice: LABORER (HEAVY & HIGHWAY)

Effective Date: 12/1/2025

Step	Percent	Apprentice Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
1	60.00	$25.03	$10.15	$9.50	$9.21	$0.00	$53.89
2	70.00	$29.20	$10.15	$9.50	$9.21	$0.00	$58.06
3	80.00	$33.38	$10.15	$9.50	$9.21	$0.00	$62.24
4	90.00	$37.55	$10.15	$9.50	$9.21	$0.00	$66.41

Apprentice: LABORER (HEAVY & HIGHWAY)

Effective Date: 6/1/2026

Step	Percent	Apprentice Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
1	60.00	$25.15	$10.65	$9.75	$9.21	$0.00	$54.76
2	70.00	$29.34	$10.65	$9.75	$9.21	$0.00	$58.95
3	80.00	$33.53	$10.65	$9.75	$9.21	$0.00	$63.14
4	90.00	$37.72	$10.65	$9.75	$9.10	$0.00	$67.22

Apprentice to Journeyworker Ratio: 1:5

LABORER: CARPENTER TENDER LABORERS LABORERS - ZONE 2	12/1/2025	$40.47	$10.65	$9.75	$9.11	$0.00	$69.98
	6/1/2026	$41.91	$10.65	$9.75	$9.11	$0.00	$71.42
	12/1/2026	$43.35	$10.65	$9.75	$9.11	$0.00	$72.86
	6/1/2027	$44.80	$10.65	$9.75	$9.11	$0.00	$74.31
	12/1/2027	$46.25	$10.65	$9.75	$9.11	$0.00	$75.76
	6/1/2028	$47.75	$10.65	$9.75	$9.11	$0.00	$77.26
	12/1/2028	$49.25	$10.65	$9.75	$9.11	$0.00	$78.76

For apprentice rates see "Apprentice- LABORER"

LABORER: CEMENT FINISHER TENDER LABORERS LABORERS - ZONE 2	12/1/2025	$40.47	$10.65	$9.75	$9.11	$0.00	$69.98
	6/1/2026	$41.91	$10.65	$9.75	$9.11	$0.00	$71.42
	12/1/2026	$43.35	$10.65	$9.75	$9.11	$0.00	$72.86
	6/1/2027	$44.80	$10.65	$9.75	$9.11	$0.00	$74.31

Construction

Classification	Effective Date	Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
	12/1/2027	$46.25	$10.65	$9.75	$9.11	$0.00	$75.76
	6/1/2028	$47.75	$10.65	$9.75	$9.11	$0.00	$77.26
	12/1/2028	$49.25	$10.65	$9.75	$9.11	$0.00	$78.76
For apprentice rates see "Apprentice- LABORER"							
LABORER: HAZARDOUS WASTE/ASBESTOS REMOVER LABORERS LABORERS - ZONE 2	12/1/2025	$40.56	$10.65	$9.75	$9.65	$0.00	$70.61
	6/1/2026	$42.00	$10.65	$9.75	$9.65	$0.00	$72.05
	12/7/2026	$43.44	$10.65	$9.75	$9.65	$0.00	$73.49
	6/7/2027	$44.89	$10.65	$9.75	$9.65	$0.00	$74.94
	12/6/2027	$46.34	$10.65	$9.75	$9.65	$0.00	$76.39
	6/5/2028	$47.84	$10.65	$9.75	$9.65	$0.00	$77.89
	12/4/2028	$49.34	$10.65	$9.75	$9.65	$0.00	$79.39
For apprentice rates see "Apprentice- LABORER"							
LABORER: MASON TENDER LABORERS LABORERS - ZONE 2	12/1/2025	$40.72	$10.65	$9.75	$9.11	$0.00	$70.23
	6/1/2026	$42.16	$10.65	$9.75	$9.11	$0.00	$71.67
	12/1/2026	$43.60	$10.65	$9.75	$9.11	$0.00	$73.11
	6/1/2027	$45.05	$10.65	$9.75	$9.11	$0.00	$74.56
	12/1/2027	$46.50	$10.65	$9.75	$9.11	$0.00	$76.01
	6/1/2028	$48.00	$10.65	$9.75	$9.11	$0.00	$77.51
	12/1/2028	$49.50	$10.65	$9.75	$9.11	$0.00	$79.01
For apprentice rates see "Apprentice- LABORER"							
LABORER: MASON TENDER (HEAVY & HIGHWAY) LABORERS LABORERS - ZONE 2 (HEAVY & HIGHWAY)	12/1/2025	$40.72	$10.65	$9.75	$9.21	$0.00	$70.33
	6/1/2026	$42.16	$10.65	$9.75	$9.21	$0.00	$71.77
	12/1/2026	$43.60	$10.65	$9.75	$9.21	$0.00	$73.21
For apprentice rates see "Apprentice- LABORER (Heavy and Highway)"							
LABORER: MULTI-TRADE TENDER LABORERS LABORERS - ZONE 2	12/1/2025	$40.47	$10.65	$9.75	$9.11	$0.00	$69.98
	6/1/2026	$41.91	$10.65	$9.75	$9.11	$0.00	$71.42
	12/1/2026	$43.35	$10.65	$9.75	$9.11	$0.00	$72.86
	6/1/2027	$44.80	$10.65	$9.75	$9.11	$0.00	$74.31
	12/1/2027	$46.25	$10.65	$9.75	$9.11	$0.00	$75.76
	6/1/2028	$47.75	$10.65	$9.75	$9.11	$0.00	$77.26
	12/1/2028	$49.25	$10.65	$9.75	$9.11	$0.00	$78.76
For apprentice rates see "Apprentice- LABORER"							
LABORER: TREE REMOVER LABORERS LABORERS - ZONE 2	12/1/2025	$40.47	$10.65	$9.75	$9.11	$0.00	$69.98
	6/1/2026	$41.91	$10.65	$9.75	$9.11	$0.00	$71.42
	12/1/2026	$43.35	$10.65	$9.75	$9.11	$0.00	$72.86
	6/1/2027	$44.80	$10.65	$9.75	$9.11	$0.00	$74.31
	12/1/2027	$46.25	$10.65	$9.75	$9.11	$0.00	$75.76
	6/1/2028	$47.75	$10.65	$9.75	$9.11	$0.00	$77.26
	12/1/2028	$49.25	$10.65	$9.75	$9.11	$0.00	$78.76
This classification applies to the removal of standing trees, and the trimming and removal of branches and limbs when related to public works construction or site clearance incidental to construction . For apprentice rates see "Apprentice- LABORER"							
LASER BEAM OPERATOR LABORERS LABORERS - ZONE 2	12/1/2025	$40.72	$10.65	$9.75	$9.11	$0.00	$70.23
	6/1/2026	$42.16	$10.65	$9.75	$9.11	$0.00	$71.67
	12/1/2026	$43.60	$10.65	$9.75	$9.11	$0.00	$73.11
	6/1/2027	$45.05	$10.65	$9.75	$9.11	$0.00	$74.56

Construction

Classification	Effective Date	Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
	12/1/2027	$46.50	$10.65	$9.75	$9.11	$0.00	$76.01
	6/1/2028	$48.00	$10.65	$9.75	$9.11	$0.00	$77.51
	12/1/2028	$49.50	$10.65	$9.75	$9.11	$0.00	$79.01
For apprentice rates see "Apprentice- LABORER"							
LASER BEAM OPERATOR (HEAVY & HIGHWAY)	12/1/2025	$40.72	$10.65	$9.75	$9.21	$0.00	$70.33
LABORERS LABORERS - ZONE 2 (HEAVY & HIGHWAY)	6/1/2026	$42.16	$10.65	$9.75	$9.21	$0.00	$71.77
	12/1/2026	$43.60	$10.65	$9.75	$9.21	$0.00	$73.21
For apprentice rates see "Apprentice- LABORER (Heavy and Highway)"							
MARBLE & TILE FINISHERS	2/1/2026	$52.08	$12.84	$15.57	$5.78	$0.00	$86.27
BRICKLAYERS LOCAL 3 BRICKLAYERS LOCAL 3 - MARBLE & TILE	8/1/2026	$53.84	$12.84	$15.57	$5.78	$0.00	$88.03
	2/1/2027	$54.96	$12.84	$15.57	$5.78	$0.00	$89.15

Apprentice: MARBLE & TILE FINISHERS

Effective Date: 2/1/2026

Step	Percent	Apprentice Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
1	50.00	$26.04	$12.84	$15.57	$5.78	$0.00	$60.23
2	60.00	$31.25	$12.84	$15.57	$5.78	$0.00	$65.44
3	70.00	$36.46	$12.84	$15.57	$5.78	$0.00	$70.65
4	80.00	$41.66	$12.84	$15.57	$5.78	$0.00	$75.85
5	90.00	$46.87	$12.84	$15.57	$5.78	$0.00	$81.06

Apprentice: MARBLE & TILE FINISHERS

Effective Date: 8/1/2026

Step	Percent	Apprentice Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
1	50.00	$26.92	$12.84	$15.57	$5.78	$0.00	$61.11
2	60.00	$32.30	$12.84	$15.57	$5.78	$0.00	$66.49
3	70.00	$37.69	$12.84	$15.57	$5.78	$0.00	$71.88
4	80.00	$43.07	$12.84	$15.57	$5.78	$0.00	$77.26
5	90.00	$48.46	$12.84	$15.57	$5.78	$0.00	$82.65

Apprentice to Journeyworker Ratio: 1:5

MARBLE MASONS,TILELAYERS & TERRAZZO MECH	2/1/2026	$67.97	$12.84	$15.57	$7.99	$0.00	$104.37
BRICKLAYERS LOCAL 3 BRICKLAYERS LOCAL 3 - MARBLE & TILE	8/1/2026	$70.17	$12.84	$15.57	$7.99	$0.00	$106.57
	2/1/2027	$71.57	$12.84	$15.57	$7.99	$0.00	$107.97

Apprentice: MARBLE MASONS,TILELAYERS & TERRAZZO MECH

Effective Date: 2/1/2026

Step	Percent	Apprentice Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
1	50.00	$33.99	$12.84	$15.57	$7.99	$0.00	$70.39
2	60.00	$40.78	$12.84	$15.57	$7.99	$0.00	$77.18

Construction

Classification	Effective Date	Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate

Apprentice: MARBLE MASONS,TILELAYERS & TERRAZZO MECH

Effective Date: 2/1/2026

Step	Percent	Apprentice Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
3	70.00	$47.58	$12.84	$15.57	$7.99	$0.00	$83.98
4	80.00	$54.38	$12.84	$15.57	$7.99	$0.00	$90.78
5	90.00	$61.17	$12.84	$15.57	$7.99	$0.00	$97.57

Apprentice: MARBLE MASONS,TILELAYERS & TERRAZZO MECH

Effective Date: 8/1/2026

Step	Percent	Apprentice Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
1	50.00	$35.09	$12.84	$15.57	$7.99	$0.00	$71.49
2	60.00	$42.10	$12.84	$15.57	$7.99	$0.00	$78.50
3	70.00	$49.12	$12.84	$15.57	$7.99	$0.00	$85.52
4	80.00	$56.14	$12.84	$15.57	$7.99	$0.00	$92.54
5	90.00	$63.15	$12.84	$15.57	$7.99	$0.00	$99.55

Apprentice to Journeyworker Ratio: 1:5

MECH. SWEEPER OPERATOR (ON CONST. SITES) OPERATING ENGINEERS LOCAL 4 OPERATING ENGINEERS LOCAL 4	12/1/2025	$58.02	$16.55	$13.35	$3.25	$0.00	$91.17
	6/1/2026	$59.30	$16.55	$13.35	$3.25	$0.00	$92.45
	12/1/2026	$60.74	$16.55	$13.35	$3.25	$0.00	$93.89
For apprentice rates see "Apprentice- OPERATING ENGINEERS"							
MECHANICS MAINTENANCE OPERATING ENGINEERS LOCAL 4 OPERATING ENGINEERS LOCAL 4	12/1/2025	$58.02	$16.55	$13.35	$3.25	$0.00	$91.17
	6/1/2026	$59.30	$16.55	$13.35	$3.25	$0.00	$92.45
	12/1/2026	$60.74	$16.55	$13.35	$3.25	$0.00	$93.89
For apprentice rates see "Apprentice- OPERATING ENGINEERS"							
MILLWRIGHT (Zone 2) MILLWRIGHTS LOCAL 1121 MILLWRIGHTS LOCAL 1121 - Zone 2	1/5/2026	$46.86	$10.58	$11.47	$10.00	$0.00	$78.91

Apprentice: MILLWRIGHT (Zone 2)

Effective Date: 1/5/2026

Step	Percent	Apprentice Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
1	55.00	$25.77	$10.58	$0.00	$5.50	$0.00	$41.85
2	65.00	$30.46	$10.58	$0.00	$6.50	$0.00	$47.54
3	75.00	$35.15	$10.58	$11.47	$7.50	$0.00	$64.70
4	85.00	$39.83	$10.58	$11.47	$8.50	$0.00	$70.38

Apprentice Notes

Step 1&2 Appr. indentured after 1/6/2020 receive no pension,

Apprentice to Journeyworker Ratio: 1:4

Construction

Classification	Effective Date	Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
MORTAR MIXER LABORERS LABORERS - ZONE 2	12/1/2025	$40.72	$10.65	$9.75	$9.11	$0.00	$70.23
	6/1/2026	$42.16	$10.65	$9.75	$9.11	$0.00	$71.67
	12/1/2026	$43.60	$10.65	$9.75	$9.11	$0.00	$73.11
	6/1/2027	$45.05	$10.65	$9.75	$9.11	$0.00	$74.56
	12/1/2027	$46.50	$10.65	$9.75	$9.11	$0.00	$76.01
	6/1/2028	$48.00	$10.65	$9.75	$9.11	$0.00	$77.51
	12/1/2028	$49.50	$10.65	$9.75	$9.11	$0.00	$79.01
For apprentice rates see "Apprentice- LABORER"							
OILER (OTHER THAN TRUCK CRANES,GRADALLS) OPERATING ENGINEERS LOCAL 4 OPERATING ENGINEERS LOCAL 4	12/1/2025	$25.08	$16.55	$13.35	$3.25	$0.00	$58.23
	6/1/2026	$25.67	$16.55	$13.35	$3.25	$0.00	$58.82
	12/1/2026	$26.34	$16.55	$13.35	$3.25	$0.00	$59.49
For apprentice rates see "Apprentice- OPERATING ENGINEERS"							
OILER (TRUCK CRANES, GRADALLS) OPERATING ENGINEERS LOCAL 4 OPERATING ENGINEERS LOCAL 4	12/1/2025	$31.05	$16.55	$13.35	$3.25	$0.00	$64.20
	6/1/2026	$31.77	$16.55	$13.35	$3.25	$0.00	$64.92
	12/1/2026	$32.57	$16.55	$13.35	$3.25	$0.00	$65.72
For apprentice rates see "Apprentice- OPERATING ENGINEERS"							
OTHER POWER DRIVEN EQUIPMENT - CLASS II OPERATING ENGINEERS LOCAL 4 OPERATING ENGINEERS LOCAL 4	12/1/2025	$58.02	$16.55	$13.35	$3.25	$0.00	$91.17
	6/1/2026	$59.30	$16.55	$13.35	$3.25	$0.00	$92.45
	12/1/2026	$60.74	$16.55	$13.35	$3.25	$0.00	$93.89
For apprentice rates see "Apprentice- OPERATING ENGINEERS"							
PAINTER (BRIDGES/TANKS) PAINTERS LOCAL 35 PAINTERS LOCAL 35 - ZONE 2	1/1/2026	$59.56	$10.35	$12.00	$12.50	$0.00	$94.41

Apprentice: PAINTER (BRIDGES/TANKS)

Effective Date: 1/1/2026

Step	Percent	Apprentice Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
1	50.00	$29.78	$10.35	$0.00	$0.00	$0.00	$40.13
2	55.00	$32.76	$10.35	$0.00	$6.93	$0.00	$50.04
3	60.00	$35.74	$10.35	$0.00	$7.56	$0.00	$53.65
4	65.00	$38.71	$10.35	$0.00	$8.19	$0.00	$57.25
5	70.00	$41.69	$10.35	$12.00	$8.82	$0.00	$72.86
6	75.00	$44.67	$10.35	$12.00	$9.45	$0.00	$76.47
7	80.00	$47.65	$10.35	$12.00	$10.08	$0.00	$80.08
8	90.00	$53.60	$10.35	$12.00	$11.34	$0.00	$87.29

Apprentice to Journeyworker Ratio: 1:1

PAINTER (SPRAY OR SANDBLAST, NEW) * * If 30% or more of surfaces to be painted are new construction, NEW paint rate shall be used. PAINTERS LOCAL 35 PAINTERS LOCAL 35 - ZONE 2	1/1/2026	$50.46	$10.35	$12.00	$12.60	$0.00	$85.41

Construction

Classification	Effective Date	Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate

Apprentice: PAINTER (SPRAY OR SANDBLAST, NEW) *

Effective Date: 1/1/2026

Step	Percent	Apprentice Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
1	50.00	$25.23	$10.35	$0.00	$0.00	$0.00	$35.58
2	55.00	$27.75	$10.35	$0.00	$6.93	$0.00	$45.03
3	60.00	$30.28	$10.35	$0.00	$7.56	$0.00	$48.19
4	65.00	$32.80	$10.35	$0.00	$8.19	$0.00	$51.34
5	70.00	$35.32	$10.35	$12.00	$8.82	$0.00	$66.49
6	75.00	$37.85	$10.35	$12.00	$9.45	$0.00	$69.65
7	80.00	$40.37	$10.35	$12.00	$10.08	$0.00	$72.80
8	90.00	$45.41	$10.35	$12.00	$11.34	$0.00	$79.10

Apprentice to Journeyworker Ratio: 1:1

PAINTER (SPRAY OR SANDBLAST, REPAINT) PAINTERS LOCAL 35 PAINTERS LOCAL 35 - ZONE 2	1/1/2026	$48.52	$10.35	$12.00	$12.60	$0.00	$83.47

Apprentice: PAINTER (SPRAY OR SANDBLAST, REPAINT)

Effective Date: 1/1/2026

Step	Percent	Apprentice Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
1	50.00	$24.26	$10.35	$0.00	$0.00	$0.00	$34.61
2	55.00	$26.69	$10.35	$0.00	$6.93	$0.00	$43.97
3	60.00	$29.11	$10.35	$0.00	$7.56	$0.00	$47.02
4	65.00	$31.54	$10.35	$0.00	$8.19	$0.00	$50.08
5	70.00	$33.96	$10.35	$12.00	$8.82	$0.00	$65.13
6	75.00	$36.39	$10.35	$12.00	$9.45	$0.00	$68.19
7	80.00	$38.82	$10.35	$12.00	$10.08	$0.00	$71.25
8	90.00	$43.67	$10.35	$12.00	$11.34	$0.00	$77.36

Apprentice to Journeyworker Ratio: 1:1

PAINTER / TAPER (BRUSH, NEW) * * If 30% or more of surfaces to be painted are new construction, NEW paint rate shall be used. PAINTERS LOCAL 35 PAINTERS LOCAL 35 - ZONE 2	1/1/2026	$49.06	$10.35	$12.00	$12.60	$0.00	$84.01

Apprentice: PAINTER / TAPER (BRUSH, NEW) *

Effective Date: 1/1/2026

Step	Percent	Apprentice Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
1	50.00	$24.53	$10.35	$0.00	$0.00	$0.00	$34.88
2	55.00	$26.98	$10.35	$0.00	$6.93	$0.00	$44.26
3	60.00	$29.44	$10.35	$0.00	$7.56	$0.00	$47.35

Construction

Classification	Effective Date	Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate

Apprentice: PAINTER / TAPER (BRUSH, NEW) *

Effective Date: 1/1/2026

Step	Percent	Apprentice Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
4	65.00	$31.89	$10.35	$0.00	$8.19	$0.00	$50.43
5	70.00	$34.34	$10.35	$12.00	$8.82	$0.00	$65.51
6	75.00	$36.80	$10.35	$12.00	$9.45	$0.00	$68.60
7	80.00	$39.25	$10.35	$12.00	$10.08	$0.00	$71.68
8	90.00	$44.15	$10.35	$12.00	$11.34	$0.00	$77.84

Apprentice to Journeyworker Ratio: 1:1

PAINTER / TAPER (BRUSH, REPAINT) PAINTERS LOCAL 35 PAINTERS LOCAL 35 - ZONE 2	1/1/2026	$47.12	$10.35	$12.00	$12.60	$0.00	$82.07

Apprentice: PAINTER / TAPER (BRUSH, REPAINT)

Effective Date: 1/1/2026

Step	Percent	Apprentice Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
1	50.00	$23.56	$10.35	$0.00	$0.00	$0.00	$33.91
2	55.00	$25.92	$10.35	$0.00	$6.93	$0.00	$43.20
3	60.00	$28.27	$10.35	$0.00	$7.56	$0.00	$46.18
4	65.00	$30.63	$10.35	$0.00	$8.19	$0.00	$49.17
5	70.00	$32.98	$10.35	$12.00	$8.82	$0.00	$64.15
6	75.00	$35.34	$10.35	$12.00	$9.45	$0.00	$67.14
7	80.00	$37.70	$10.35	$12.00	$10.08	$0.00	$70.13
8	90.00	$42.41	$10.35	$12.00	$11.34	$0.00	$76.10

Apprentice to Journeyworker Ratio: 1:1

PAINTER TRAFFIC MARKINGS (HEAVY/HIGHWAY) LABORERS LABORERS - ZONE 2 (HEAVY & HIGHWAY)	12/1/2025	$40.47	$10.65	$9.75	$9.21	$0.00	$70.08
	6/1/2026	$41.91	$10.65	$9.75	$9.21	$0.00	$71.52
	12/1/2026	$43.35	$10.65	$9.75	$9.21	$0.00	$72.96
For apprentice rates see "Apprentice- LABORER (Heavy and Highway)							
PANEL & PICKUP TRUCKS DRIVER TEAMSTERS JOINT COUNCIL NO. 10 TEAMSTERS JOINT COUNCIL NO. 10 ZONE B	1/1/2026	$40.78	$16.17	$21.78	$0.00	$0.00	$78.73
	6/1/2026	$41.78	$16.17	$21.78	$0.00	$0.00	$79.73
	12/1/2026	$41.78	$16.17	$23.52	$0.00	$0.00	$81.47
	1/1/2027	$41.78	$16.77	$23.52	$0.00	$0.00	$82.07
PIER AND DOCK CONSTRUCTOR (UNDERPINNING AND DECK) PILE DRIVER LOCAL 56 PILE DRIVER LOCAL 56 (ZONE 1)	8/1/2024	$55.79	$10.08	$11.62	$12.67	$0.00	$90.16
For apprentice rates see "Apprentice- PILE DRIVER"							
PILE DRIVER PILE DRIVER LOCAL 56 PILE DRIVER LOCAL 56 (ZONE 1)	8/1/2024	$55.79	$10.08	$11.62	$12.67	$0.00	$90.16

Construction

Classification	Effective Date	Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
Apprentice: PILE DRIVER							
Effective Date: 8/1/2024							
Step / Percent / Apprentice Base Wage							
1 / 45.00		$25.11	$10.08	$0.00	$2.53	$0.00	$37.72
2 / 55.00		$30.68	$10.08	$0.00	$5.07	$0.00	$45.83
3 / 70.00		$39.05	$10.08	$11.62	$7.60	$0.00	$68.35
4 / 80.00		$44.63	$10.08	$11.62	$10.14	$0.00	$76.47
Apprentice to Journeyworker Ratio: 1:5							
PIPEFITTER & STEAMFITTER PIPEFITTERS LOCAL 537 PIPEFITTERS LOCAL 537	3/1/2026	$70.58	$13.95	$14.00	$9.55	$0.00	$108.08
Apprentice: PIPEFITTER & STEAMFITTER							
Effective Date: 3/1/2026							
Step / Percent / Apprentice Base Wage							
1 / 40.00		$28.23	$13.95	$0.30	$9.55	$0.00	$52.03
2 / 45.00		$31.76	$13.95	$14.00	$9.55	$0.00	$69.26
3 / 60.00		$42.35	$13.95	$14.00	$9.55	$0.00	$79.85
4 / 70.00		$49.41	$13.95	$14.00	$9.55	$0.00	$86.91
5 / 80.00		$56.46	$13.95	$14.00	$9.55	$0.00	$93.96
Apprentice to Journeyworker Ratio: 1:3							
PIPELAYER LABORERS LABORERS - ZONE 2	12/1/2025	$40.72	$10.65	$9.75	$9.11	$0.00	$70.23
	6/1/2026	$42.16	$10.65	$9.75	$9.11	$0.00	$71.67
	12/1/2026	$43.60	$10.65	$9.75	$9.11	$0.00	$73.11
	6/1/2027	$45.05	$10.65	$9.75	$9.11	$0.00	$74.56
	12/1/2027	$46.50	$10.65	$9.75	$9.11	$0.00	$76.01
	6/1/2028	$48.00	$10.65	$9.75	$9.11	$0.00	$77.51
	12/1/2028	$49.50	$10.65	$9.75	$9.11	$0.00	$79.01
For apprentice rates see "Apprentice- LABORER"							
PIPELAYER (HEAVY & HIGHWAY) LABORERS LABORERS - ZONE 2 (HEAVY & HIGHWAY)	12/1/2025	$40.72	$10.65	$9.75	$9.21	$0.00	$70.33
	6/1/2026	$42.16	$10.65	$9.75	$9.21	$0.00	$71.77
	12/1/2026	$43.60	$10.65	$9.75	$9.21	$0.00	$73.21
For apprentice rates see "Apprentice- LABORER (Heavy and Highway)"							
PLUMBERS & GASFITTERS PLUMBERS & GASFITTERS LOCAL 12 PLUMBERS & GASFITTERS LOCAL 12	3/2/2026	$73.89	$14.32	$12.61	$8.00	$0.00	$108.82
	8/31/2026	$76.04	$14.32	$12.61	$8.00	$0.00	$110.97
	3/1/2027	$78.19	$14.32	$12.61	$8.00	$0.00	$113.12
	8/30/2027	$80.34	$14.32	$12.61	$8.00	$0.00	$115.27
	2/28/2028	$82.54	$14.32	$12.61	$8.00	$0.00	$117.47
	9/4/2028	$84.74	$14.32	$12.61	$8.00	$0.00	$119.67
	3/5/2029	$86.94	$14.32	$12.61	$8.00	$0.00	$121.87

Construction

Classification	Effective Date	Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
	9/3/2029	$89.14	$14.32	$12.61	$8.00	$0.00	$124.07
	3/4/2030	$91.09	$14.32	$12.61	$8.00	$0.00	$126.02

Apprentice: PLUMBERS & GASFITTERS

Effective Date: 3/2/2026

Step	Percent	Apprentice Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
1	35.00	$25.86	$14.32	$4.61	$2.80	$0.00	$47.59
2	40.00	$29.56	$14.32	$5.22	$3.20	$0.00	$52.30
3	55.00	$40.64	$14.32	$7.07	$4.40	$0.00	$66.43
4	65.00	$48.03	$14.32	$8.30	$5.20	$0.00	$75.85
5	75.00	$55.42	$14.32	$9.53	$6.00	$0.00	$85.27

Apprentice: PLUMBERS & GASFITTERS

Effective Date: 8/31/2026

Step	Percent	Apprentice Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
1	35.00	$26.61	$14.32	$4.61	$2.80	$0.00	$48.34
2	40.00	$30.42	$14.32	$5.22	$3.20	$0.00	$53.16
3	55.00	$41.82	$14.32	$7.07	$5.20	$0.00	$68.41
4	65.00	$49.43	$14.32	$8.30	$5.20	$0.00	$77.25
5	75.00	$57.03	$14.32	$9.53	$6.00	$0.00	$86.88

Apprentice to Journeyworker Ratio: 1:2

PNEUMATIC CONTROLS (TEMP.) PIPEFITTERS LOCAL 537 PIPEFITTERS LOCAL 537	3/1/2026	$70.58	$13.95	$14.00	$9.55	$0.00	$108.08
For apprentice rates see "Apprentice- PIPEFITTER" or "PLUMBER/PIPEFITTER"							
PNEUMATIC DRILL/TOOL OPERATOR LABORERS LABORERS - ZONE 2	12/1/2025	$40.72	$10.65	$9.75	$9.11	$0.00	$70.23
	6/1/2026	$42.16	$10.65	$9.75	$9.11	$0.00	$71.67
	12/1/2026	$43.60	$10.65	$9.75	$9.11	$0.00	$73.11
	6/1/2027	$45.05	$10.65	$9.75	$9.11	$0.00	$74.56
	12/1/2027	$46.50	$10.65	$9.75	$9.11	$0.00	$76.01
	6/1/2028	$48.00	$10.65	$9.75	$9.11	$0.00	$77.51
	12/1/2028	$49.50	$10.65	$9.75	$9.11	$0.00	$79.01
For apprentice rates see "Apprentice- LABORER"							
PNEUMATIC DRILL/TOOL OPERATOR (HEAVY & HIGHWAY) LABORERS LABORERS - ZONE 2 (HEAVY & HIGHWAY)	12/1/2025	$40.72	$10.65	$9.75	$9.21	$0.00	$70.33
	6/1/2026	$42.16	$10.65	$9.75	$9.21	$0.00	$71.77
	12/1/2026	$43.60	$10.65	$9.75	$9.21	$0.00	$73.21
For apprentice rates see "Apprentice- LABORER (Heavy and Highway)"							
POWDERMAN & BLASTER LABORERS LABORERS - ZONE 2	12/1/2025	$41.47	$10.65	$9.75	$9.11	$0.00	$70.98
	6/1/2026	$42.91	$10.65	$9.75	$9.11	$0.00	$72.42
	12/1/2026	$44.35	$10.65	$9.75	$9.11	$0.00	$73.86
	6/1/2027	$45.80	$10.65	$9.75	$9.11	$0.00	$75.31
	12/1/2027	$47.25	$10.65	$9.75	$9.11	$0.00	$76.76

Construction

Classification	Effective Date	Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
	6/1/2028	$48.75	$10.65	$9.75	$9.11	$0.00	$78.26
	12/1/2028	$50.25	$10.65	$9.75	$9.11	$0.00	$79.76
For apprentice rates see "Apprentice- LABORER"							
POWDERMAN & BLASTER (HEAVY & HIGHWAY)	12/1/2025	$41.47	$10.65	$9.75	$9.21	$0.00	$71.08
LABORERS	6/1/2026	$42.91	$10.65	$9.75	$9.21	$0.00	$72.52
LABORERS - ZONE 2 (HEAVY & HIGHWAY)	12/1/2026	$44.35	$10.65	$9.75	$9.21	$0.00	$73.96
For apprentice rates see "Apprentice- LABORER (Heavy and Highway)"							
POWER SHOVEL/DERRICK/TRENCHING MACHINE	12/1/2025	$58.68	$16.55	$13.35	$3.25	$0.00	$91.83
OPERATING ENGINEERS LOCAL 4	6/1/2026	$59.98	$16.55	$13.35	$3.25	$0.00	$93.13
OPERATING ENGINEERS LOCAL 4	12/1/2026	$61.43	$16.55	$13.35	$3.25	$0.00	$94.58
For apprentice rates see "Apprentice- OPERATING ENGINEERS"							
PUMP OPERATOR (CONCRETE)	12/1/2025	$58.02	$16.55	$13.35	$3.25	$0.00	$91.17
OPERATING ENGINEERS LOCAL 4	6/1/2026	$59.30	$16.55	$13.35	$3.25	$0.00	$92.45
OPERATING ENGINEERS LOCAL 4	12/1/2026	$60.74	$16.55	$13.35	$3.25	$0.00	$93.89
For apprentice rates see "Apprentice- OPERATING ENGINEERS"							
PUMP OPERATOR (DEWATERING, OTHER)	12/1/2025	$37.37	$16.55	$13.35	$3.25	$0.00	$70.52
OPERATING ENGINEERS LOCAL 4	6/1/2026	$38.23	$16.55	$13.35	$3.25	$0.00	$71.38
OPERATING ENGINEERS LOCAL 4	12/1/2026	$39.18	$16.55	$13.35	$3.25	$0.00	$72.33
For apprentice rates see "Apprentice- OPERATING ENGINEERS"							
READY-MIX CONCRETE DRIVER	1/1/2026	$30.50	$11.97	$6.65	$0.00	$0.00	$49.12
TEAMSTERS 170							
TEAMSTERS 170 - J.G. MacLellan (Lowell)							
RECLAIMERS	12/1/2025	$58.02	$16.55	$13.35	$3.25	$0.00	$91.17
OPERATING ENGINEERS LOCAL 4	6/1/2026	$59.30	$16.55	$13.35	$3.25	$0.00	$92.45
OPERATING ENGINEERS LOCAL 4	12/1/2026	$60.74	$16.55	$13.35	$3.25	$0.00	$93.89
For apprentice rates see "Apprentice- OPERATING ENGINEERS"							
RIDE-ON MOTORIZED BUGGY OPERATOR	12/1/2025	$40.72	$10.65	$9.75	$9.11	$0.00	$70.23
LABORERS	6/1/2026	$42.16	$10.65	$9.75	$9.11	$0.00	$71.67
LABORERS - ZONE 2	12/1/2026	$43.60	$10.65	$9.75	$9.11	$0.00	$73.11
	6/1/2027	$45.05	$10.65	$9.75	$9.11	$0.00	$74.56
	12/1/2027	$46.50	$10.65	$9.75	$9.11	$0.00	$76.01
	6/1/2028	$48.00	$10.65	$9.75	$9.11	$0.00	$77.51
	12/1/2028	$49.50	$10.65	$9.75	$9.11	$0.00	$79.01
For apprentice rates see "Apprentice- LABORER"							
ROLLER/SPREADER/MULCHING MACHINE	12/1/2025	$58.02	$16.55	$13.35	$3.25	$0.00	$91.17
OPERATING ENGINEERS LOCAL 4	6/1/2026	$59.30	$16.55	$13.35	$3.25	$0.00	$92.45
OPERATING ENGINEERS LOCAL 4	12/1/2026	$60.74	$16.55	$13.35	$3.25	$0.00	$93.89
For apprentice rates see "Apprentice- OPERATING ENGINEERS"							
ROOFER (Inc.Roofer Waterproofng &Roofer Damproofg)	2/1/2026	$53.53	$14.53	$12.67	$9.03	$0.00	$89.76
ROOFERS LOCAL 33							
ROOFERS LOCAL 33							

Construction

Classification	Effective Date	Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate

Apprentice: ROOFER (Inc.Roofer Waterproofng &Roofer Damproofg)

Effective Date: 2/1/2026

Step	Percent	Apprentice Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
1	50.00	$26.77	$14.53	$6.52	$9.03	$0.00	$56.85
2	60.00	$32.12	$14.53	$12.67	$9.03	$0.00	$68.35
3	65.00	$34.79	$14.53	$12.67	$9.03	$0.00	$71.02
4	75.00	$40.15	$14.53	$12.67	$9.03	$0.00	$76.38
5	85.00	$45.50	$14.53	$12.67	$9.03	$0.00	$81.73

Apprentice Notes

** 1:5, 2:6-10, the 1:10; Reroofing: 1:4, then 1:1

Apprentice to Journeyworker Ratio: 1:5

ROOFER SLATE / TILE / PRECAST CONCRETE ROOFERS LOCAL 33 ROOFERS LOCAL 33	2/1/2026	$53.78	$14.53	$12.67	$9.03	$0.00	$90.01

For apprentice rates see "Apprentice- ROOFER"

SHEETMETAL WORKER SHEETMETAL WORKERS LOCAL 17 SHEETMETAL WORKERS LOCAL 17 - A	2/1/2026	$62.93	$14.91	$18.74	$9.53	$2.98	$109.09

Apprentice: SHEETMETAL WORKER

Effective Date: 2/1/2026

Step	Percent	Apprentice Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
1	42.00	$26.43	$14.91	$6.19	$0.00	$0.00	$47.53
2	42.00	$26.43	$14.91	$6.19	$0.00	$0.00	$47.53
3	47.00	$29.58	$14.91	$10.93	$1.25	$1.62	$58.29
4	47.00	$29.58	$14.91	$10.93	$1.25	$1.62	$58.29
5	52.00	$32.72	$14.91	$11.66	$1.50	$1.74	$62.53
6	52.00	$32.72	$14.91	$11.66	$1.75	$1.75	$62.79
7	60.00	$37.76	$14.91	$12.84	$2.00	$1.93	$69.44
8	65.00	$40.90	$14.91	$13.58	$2.25	$2.04	$73.68
9	75.00	$47.20	$14.91	$15.06	$2.75	$2.28	$82.20
10	85.00	$53.49	$14.91	$16.53	$2.75	$2.49	$90.17

Apprentice to Journeyworker Ratio: 1:4

SPECIALIZED EARTH MOVING EQUIP < 35 TONS TEAMSTERS JOINT COUNCIL NO. 10 TEAMSTERS JOINT COUNCIL NO. 10 ZONE B	1/1/2026	$41.24	$16.17	$21.78	$0.00	$0.00	$79.19
	6/1/2026	$42.24	$16.17	$21.78	$0.00	$0.00	$80.19
	12/1/2026	$42.24	$16.17	$23.52	$0.00	$0.00	$81.93
	1/1/2027	$42.24	$16.77	$23.52	$0.00	$0.00	$82.53
SPECIALIZED EARTH MOVING EQUIP > 35 TONS TEAMSTERS JOINT COUNCIL NO. 10	1/1/2026	$41.53	$16.17	$21.78	$0.00	$0.00	$79.48
	6/1/2026	$42.53	$16.17	$21.78	$0.00	$0.00	$80.48

Construction

Classification	Effective Date	Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
TEAMSTERS JOINT COUNCIL NO. 10 ZONE B	12/1/2026	$42.53	$16.17	$23.52	$0.00	$0.00	$82.22
	1/1/2027	$42.53	$16.77	$23.52	$0.00	$0.00	$82.82
SPRINKLER FITTER SPRINKLER FITTERS LOCAL 550 SPRINKLER FITTERS LOCAL 550 - (Section B) Zone 2	1/1/2026	$64.85	$13.45	$7.45	$18.25	$0.00	$104.00

Apprentice: SPRINKLER FITTER

Effective Date: 1/1/2026

Step	Percent	Apprentice Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
1	0.00	$22.70	$13.45	$13.84	$0.00	$0.00	$49.99
2	0.00	$25.94	$13.45	$14.75	$0.00	$0.00	$54.14
3	0.00	$29.18	$13.45	$15.67	$0.00	$0.00	$58.30
4	0.00	$32.43	$13.45	$16.57	$0.00	$0.00	$62.45
5	0.00	$35.67	$13.45	$17.49	$0.00	$0.00	$66.61
6	0.00	$38.91	$13.45	$18.40	$0.00	$0.00	$70.76
7	0.00	$42.15	$13.45	$19.32	$0.00	$0.00	$74.92
8	0.00	$45.40	$13.45	$20.22	$0.00	$0.00	$79.07
9	0.00	$48.64	$13.45	$21.15	$0.00	$0.00	$83.24
10	0.00	$51.88	$13.45	$22.05	$0.00	$0.00	$87.38

Apprentice Notes

Apprentice entered prior 9/30/10:

Apprentice to Journeyworker Ratio: 1:3

STEAM BOILER OPERATOR OPERATING ENGINEERS LOCAL 4 OPERATING ENGINEERS LOCAL 4	12/1/2025	$58.02	$16.55	$13.35	$3.25	$0.00	$91.17
	6/1/2026	$59.30	$16.55	$13.35	$3.25	$0.00	$92.45
	12/1/2026	$60.74	$16.55	$13.35	$3.25	$0.00	$93.89
For apprentice rates see "Apprentice- OPERATING ENGINEERS"							
TAMPERS, SELF-PROPELLED OR TRACTOR DRAWN OPERATING ENGINEERS LOCAL 4 OPERATING ENGINEERS LOCAL 4	12/1/2025	$58.02	$16.55	$13.35	$3.25	$0.00	$91.17
	6/1/2026	$59.30	$16.55	$13.35	$3.25	$0.00	$92.45
	12/1/2026	$60.74	$16.55	$13.35	$3.25	$0.00	$93.89
For apprentice rates see "Apprentice- OPERATING ENGINEERS"							
TELECOMMUNICATION TECHNICIAN TELECOMMUNICATION TECHNICIAN ELECTRICIANS LOCAL 103 ELECTRICIANS LOCAL 103	3/1/2026	$53.49	$13.00	$14.23	$7.20	$0.00	$87.92
	9/1/2026	$55.02	$13.00	$14.28	$7.20	$0.00	$89.50
	3/1/2027	$55.98	$13.00	$14.31	$7.20	$0.00	$90.49
	9/1/2027	$57.50	$13.00	$14.36	$7.20	$0.00	$92.06
	3/1/2028	$58.46	$13.00	$14.38	$7.20	$0.00	$93.04
For apprentice rates and ratios see "Apprentice- ELECTRICIAN"							

Apprentice: TELECOMMUNICATION TECHNICIAN

Effective Date: 3/1/2026

Step	Percent	Apprentice Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate

Construction

Classification	Effective Date	Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate

Apprentice: TELECOMMUNICATION TECHNICIAN

Effective Date: 3/1/2026

Step	Percent	Apprentice Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
1	45.00	$24.07	$13.00	$0.72	$0.00	$0.00	$37.79
2	45.00	$24.07	$13.00	$0.72	$0.00	$0.00	$37.79
3	50.00	$26.75	$13.00	$13.43	$3.60	$0.00	$56.78
4	50.00	$26.75	$13.00	$13.43	$3.60	$0.00	$56.78
5	55.00	$29.42	$13.00	$13.51	$3.96	$0.00	$59.89
6	60.00	$32.09	$13.00	$13.59	$4.32	$0.00	$63.00
7	65.00	$34.77	$13.00	$13.67	$4.68	$0.00	$66.12
8	70.00	$37.44	$13.00	$13.75	$5.04	$0.00	$69.23
9	75.00	$40.12	$13.00	$13.83	$5.40	$0.00	$72.35
10	80.00	$42.79	$13.00	$13.91	$5.76	$0.00	$75.46

Apprentice: TELECOMMUNICATION TECHNICIAN

Effective Date: 9/1/2026

Step	Percent	Apprentice Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
1	45.00	$24.76	$13.00	$0.74	$0.00	$0.00	$38.50
2	45.00	$24.76	$13.00	$0.74	$0.00	$0.00	$38.50
3	50.00	$27.51	$13.00	$13.46	$3.60	$0.00	$57.57
4	50.00	$27.51	$13.00	$13.46	$3.60	$0.00	$57.57
5	55.00	$30.26	$13.00	$13.54	$3.96	$0.00	$60.76
6	60.00	$33.01	$13.00	$13.62	$4.32	$0.00	$63.95
7	65.00	$35.76	$13.00	$13.70	$4.68	$0.00	$67.14
8	70.00	$38.51	$13.00	$13.79	$5.04	$0.00	$70.34
9	75.00	$41.27	$13.00	$13.87	$5.40	$0.00	$73.54
10	80.00	$44.02	$13.00	$13.96	$5.76	$0.00	$76.74

Apprentice to Journeyworker Ratio: 1:1

TERRAZZO FINISHERS	2/1/2026	$66.89	$12.84	$15.57	$8.02	$0.00	$103.32
BRICKLAYERS LOCAL 3	8/1/2026	$69.09	$12.84	$15.57	$8.02	$0.00	$105.52
BRICKLAYERS LOCAL 3 - MARBLE & TILE	2/1/2027	$70.49	$12.84	$15.57	$8.02	$0.00	$106.92

Apprentice: TERRAZZO FINISHERS

Effective Date: 2/1/2026

Step	Percent	Apprentice Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
1	50.00	$33.45	$12.84	$15.57	$8.02	$0.00	$69.88
2	60.00	$40.13	$12.84	$15.57	$8.02	$0.00	$76.56
3	70.00	$46.82	$12.84	$15.57	$8.02	$0.00	$83.25
4	80.00	$53.51	$12.84	$15.57	$8.02	$0.00	$89.94
5	90.00	$60.20	$12.84	$15.57	$8.02	$0.00	$96.63

Construction

Classification	Effective Date	Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate

Apprentice: TERRAZZO FINISHERS

Effective Date: 8/1/2026

Step	Percent	Apprentice Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
1	50.00	$34.55	$12.84	$15.57	$8.02	$0.00	$70.98
2	60.00	$41.45	$12.84	$15.57	$8.02	$0.00	$77.88
3	70.00	$48.36	$12.84	$15.57	$8.02	$0.00	$84.79
4	80.00	$55.27	$12.84	$15.57	$8.02	$0.00	$91.70
5	90.00	$62.18	$12.84	$15.57	$8.02	$0.00	$98.61

Apprentice to Journeyworker Ratio: 1:5

TEST BORING DRILLER	12/1/2025	$51.95	$10.65	$9.75	$9.80	$0.00	$82.15
LABORERS	6/1/2026	$53.50	$10.65	$9.75	$9.80	$0.00	$83.70
LABORERS - FOUNDATION AND MARINE	12/1/2026	$55.00	$10.65	$9.75	$9.80	$0.00	$85.20
For apprentice rates see "Apprentice- LABORER"							
TEST BORING DRILLER HELPER	12/1/2025	$48.07	$10.65	$9.75	$9.80	$0.00	$78.27
LABORERS	6/1/2026	$49.62	$10.65	$9.75	$9.80	$0.00	$79.82
LABORERS - FOUNDATION AND MARINE	12/1/2026	$51.12	$10.65	$9.75	$9.80	$0.00	$81.32
For apprentice rates see "Apprentice- LABORER"							
TEST BORING LABORER	12/1/2025	$47.95	$10.65	$9.75	$9.80	$0.00	$78.15
LABORERS	6/1/2026	$49.50	$10.65	$9.75	$9.80	$0.00	$79.70
LABORERS - FOUNDATION AND MARINE	12/1/2026	$51.00	$10.65	$9.75	$9.80	$0.00	$81.20
For apprentice rates see "Apprentice- LABORER"							
TRACTORS/PORTABLE STEAM GENERATORS	12/1/2025	$58.02	$16.55	$13.35	$3.25	$0.00	$91.17
OPERATING ENGINEERS LOCAL 4	6/1/2026	$59.30	$16.55	$13.35	$3.25	$0.00	$92.45
OPERATING ENGINEERS LOCAL 4	12/1/2026	$60.74	$16.55	$13.35	$3.25	$0.00	$93.89
For apprentice rates see "Apprentice- OPERATING ENGINEERS"							
TRAILERS FOR EARTH MOVING EQUIPMENT	1/1/2026	$41.82	$16.17	$21.78	$0.00	$0.00	$79.77
TEAMSTERS JOINT COUNCIL NO. 10	6/1/2026	$42.82	$16.17	$21.78	$0.00	$0.00	$80.77
TEAMSTERS JOINT COUNCIL NO. 10 ZONE B	12/1/2026	$42.82	$16.17	$23.52	$0.00	$0.00	$82.51
	1/1/2027	$42.82	$16.77	$23.52	$0.00	$0.00	$83.11
TUNNEL WORK - COMPRESSED AIR	12/1/2025	$60.18	$10.65	$9.75	$10.25	$0.00	$90.83
LABORERS	6/1/2026	$61.73	$10.65	$9.75	$10.25	$0.00	$92.38
LABORERS (COMPRESSED AIR)	12/1/2026	$63.23	$10.65	$9.75	$10.25	$0.00	$93.88
For apprentice rates see "Apprentice- LABORER"							
TUNNEL WORK - COMPRESSED AIR (HAZ. WASTE)	12/1/2025	$62.18	$10.65	$9.75	$10.25	$0.00	$92.83
LABORERS	6/1/2026	$63.73	$10.65	$9.75	$10.25	$0.00	$94.38
LABORERS (COMPRESSED AIR)	12/1/2026	$65.23	$10.65	$9.75	$10.25	$0.00	$95.88
For apprentice rates see "Apprentice- LABORER"							
TUNNEL WORK - FREE AIR	12/1/2025	$52.25	$10.65	$9.75	$10.25	$0.00	$82.90

Construction

Classification	Effective Date	Base Wage	Health	Pension	Annuity	Supplemental Unemployment	Total Rate
LABORERS	6/1/2026	$53.80	$10.65	$9.75	$10.25	$0.00	$84.45
LABORERS (FREE AIR TUNNEL)	12/1/2026	$55.30	$10.65	$9.75	$10.25	$0.00	$85.95
For apprentice rates see "Apprentice- LABORER"							
TUNNEL WORK - FREE AIR (HAZ. WASTE)	12/1/2025	$54.25	$10.65	$9.75	$10.25	$0.00	$84.90
LABORERS	6/1/2026	$55.80	$10.65	$9.75	$10.25	$0.00	$86.45
LABORERS (FREE AIR TUNNEL)	12/1/2026	$57.30	$10.65	$9.75	$10.25	$0.00	$87.95
For apprentice rates see "Apprentice- LABORER"							
VAC-HAUL	1/1/2026	$41.24	$16.17	$21.78	$0.00	$0.00	$79.19
TEAMSTERS JOINT COUNCIL NO. 10	6/1/2026	$42.24	$16.17	$21.78	$0.00	$0.00	$80.19
TEAMSTERS JOINT COUNCIL NO. 10 ZONE B	12/1/2026	$42.24	$16.17	$23.52	$0.00	$0.00	$81.93
	1/1/2027	$42.24	$16.77	$23.52	$0.00	$0.00	$82.53
WAGON DRILL OPERATOR	12/1/2025	$40.72	$10.65	$9.75	$9.11	$0.00	$70.23
LABORERS	6/1/2026	$42.16	$10.65	$9.75	$9.11	$0.00	$71.67
LABORERS - ZONE 2	12/1/2026	$43.60	$10.65	$9.75	$9.11	$0.00	$73.11
	6/1/2027	$45.05	$10.65	$9.75	$9.11	$0.00	$74.56
	12/1/2027	$46.50	$10.65	$9.75	$9.11	$0.00	$76.01
	6/1/2028	$48.00	$10.65	$9.75	$9.11	$0.00	$77.51
	12/1/2028	$49.50	$10.65	$9.75	$9.11	$0.00	$79.01
For apprentice rates see "Apprentice- LABORER"							
WAGON DRILL OPERATOR (HEAVY & HIGHWAY)	12/1/2025	$40.72	$10.65	$9.75	$9.21	$0.00	$70.33
LABORERS	6/1/2026	$42.16	$10.65	$9.75	$9.21	$0.00	$71.77
LABORERS - ZONE 2 (HEAVY & HIGHWAY)	12/1/2026	$43.60	$10.65	$9.75	$9.21	$0.00	$73.21
For apprentice rates see "Apprentice- LABORER (Heavy and Highway)"							
WASTE WATER PUMP OPERATOR	12/1/2025	$58.68	$16.55	$13.35	$3.25	$0.00	$91.83
OPERATING ENGINEERS LOCAL 4	6/1/2026	$59.98	$16.55	$13.35	$3.25	$0.00	$93.13
OPERATING ENGINEERS LOCAL 4	12/1/2026	$61.43	$16.55	$13.35	$3.25	$0.00	$94.58
For apprentice rates see "Apprentice- OPERATING ENGINEERS"							
WATER METER INSTALLER	3/2/2026	$73.89	$14.32	$12.61	$8.00	$0.00	$108.82
PLUMBERS & GASFITTERS LOCAL 12	8/31/2026	$76.04	$14.32	$12.61	$8.00	$0.00	$110.97
PLUMBERS & GASFITTERS LOCAL 12	3/1/2027	$78.19	$14.32	$12.61	$8.00	$0.00	$113.12
	8/30/2027	$80.34	$14.32	$12.61	$8.00	$0.00	$115.27
	2/2/2028	$82.54	$14.32	$12.61	$8.00	$0.00	$117.47
	9/4/2028	$84.74	$14.32	$12.61	$8.00	$0.00	$119.67
	3/5/2029	$86.94	$14.32	$12.61	$8.00	$0.00	$121.87
	9/3/2029	$89.14	$14.32	$12.61	$8.00	$0.00	$124.07
	3/4/2030	$91.09	$14.32	$12.61	$8.00	$0.00	$126.02
For apprentice rates see "Apprentice- PLUMBER/PIPEFITTER" or "PLUMBER/GASFITTER"							

Additional Apprentice Information

All apprentices must be registered with the Division of Apprenticeship Training(DAS) in accordance with M.G.L.c. 23, §§ 11E-11L. Minimum wage rates for apprentices employed on public works projects are listed above as a percentage of the hourly prevailing wage rate established by the Commissioner under the provisions of M.G.L.c. 149, §§ 26-27D.

Apprentice ratios are established by DAS pursuant to M.G.L.c. 23, §§ 11E-11L. Ratios are expressed as the allowable number of apprentices to journeymen or fraction thereof, unless otherwise specified. The ratios listed herein have been taken from relevant private collective bargaining agreements(CBAs) and are provided for illustrative purposes only. They have not been independently verified as being accurate or continuing to be accurate.

Parties having questions regarding what ratio to use should contact DAS.

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October 18, 2022

CERTIFICATE OF THE SECRETARY OF ENERGY AND ENVIRONMENTAL AFFAIRS
ON THE
EXPANDED ENVIRONMENTAL NOTIFICATION FORM

PROJECT NAME	: Little River Dam Removal and River Restoration
PROJECT MUNICIPALITY	: Haverhill
PROJECT WATERSHED	: Merrimack
EEA NUMBER	: 16601
PROJECT PROPONENT	: City of Haverhill
DATE NOTICED IN MONITOR	: September 9, 2022

Pursuant to the Massachusetts Environmental Policy Act (MEPA; M.G.L. c. 30, ss. 61-62L) and Section 11.06 of the MEPA Regulations (301 CMR 11.00), I have reviewed the Expanded Environmental Notification Form (EENF) and hereby determine that this project **requires** a mandatory Environmental Impact Report (EIR). In accordance with Sections 11.06(8) of the MEPA regulations, the Proponent requested that I allow a Single EIR (SEIR) in lieu of the usual two-stage Draft and Final EIR process. I hereby grant the request to file a SEIR, which the Proponent should submit in accordance with the Scope included in this Certificate.

Project Description

As described in the EENF, the project involves the removal of the majority of the Little River Dam in the City of Haverhill (City), restoration of the river, and recreational improvements. Specifically, the project will remove the majority of the dam's existing granite block masonry spillway, construct a stabilized trapezoidal flow channel through the dam, remove contaminated sediment from within the impoundment, and restore the stream channel in the vicinity of the dam breach. The dam removal will include the demolition of 65 feet of the 75-foot-long dam; the dam will be removed to a minimum of 2 feet below the proposed channel elevation, leaving a portion of the lower part of the dam. As described in the EENF, complete

removal of the dam (up to the adjacent Stevens Mill building) would likely jeopardize the integrity of the foundation of the mill, based on the results of a structural inspection. Therefore, approximately 10 feet of the dam is proposed to remain on river left to continue to provide structural support to the building. The EENF states that the stone masonry dam does not meet today's standards for dam design and construction, and as such, poses a hazard to downstream areas. As described in the EENF, failure of the dam could damage the downstream Massachusetts Bay Transportation Authority (MBTA) railroad crossing, as well as cause a partial blockage of a downstream flood conduit which the EENF states is crucial to the protection of a substantial swath of the City from flooding impacts. In addition, a failure of the Little River Dam would result in the spontaneous release of contaminated sediments that are currently impounded by the dam. Channel erosion from the dam failing could also undermine the adjacent mill building and the upstream MBTA bridge crossing.

As described in the EENF, dam removal will result in multiple environmental and community benefits, including the elimination of the above identified potential public safety threats, restoration of the natural flow of the river, removal of a barrier in the river which currently impedes the passage of fish and many other aquatic organisms, and lowering flood elevations in the adjacent Environmental Justice (EJ) neighborhood. In addition to the dam removal, the project will include installation of multiple fish passage structures, stabilization of the bank with over 5,000 live stakes, and enhancements to the riparian corridor through planting of nearly 500 trees and 1,000 native shrubs. The river width will be reduced to approximately 24 feet during base flow conditions from an approximate 75-foot width currently. Two retaining walls will be constructed in the vicinity of the dam to improve structural stability and protect adjacent development, using granite and stone from the demolished dam. Recreational improvements include construction of a canoe launch, fishing platform, pedestrian bridge, trail network, and a low-flow channel area for recreational boater access. As described in the EENF, the project has incorporated years of planning, data collection, and design funded through Municipal Vulnerability Preparedness (MVP) Action Grants awarded to the City. The EENF additionally states that the project meets the definition of an Ecological Restoration Project as defined by the Wetlands Protection Act (WPA) regulations at 310 CMR 10.04.

Project Site

The 157-acre project site includes approximately 12 acres where direct impacts will occur (i.e., the limit of work). This includes the Little River Dam and an approximately 3,600 lf span of the Little River, from south of Winter Street (Route 97) to the MBTA Bridge; approximately 10 acres of this area is within the Little River itself. The remainder of the project site includes areas of the Little River further upstream and associated floodplain that are expected to be indirectly impacted from the dam removal. As described in the EENF, the Little River Dam is a privately-owned stone masonry dam consisting of a cascading granite block masonry gravity structure with a maximum height of 12 feet, and with a granite block crest approximately 75 feet in length. The downstream face of the dam consists of granite blocks or cobbles, over which the spillway flow cascades to dissipate energy before continuing into the downstream channel. The dam was constructed in the 1800's (or earlier) as a source of power for the adjacent mill, the foundation of which is integrated into the dam abutment; the mill is no longer in operation. The Little River Dam is in a highly developed area in the center of the City, with a narrow, linear impoundment

extending upstream approximately 0.5 miles. The most recent Phase I Dam Inspection conducted by Pare Corporation June 19, 2019 indicated that the Little River Dam is a Small Sized Dam with Significant Hazard Potential (Class II) in Fair condition. Significant hazard potential is defined as dams located where failure may cause loss of life and damage to home(s), industrial or commercial facilities, secondary highway(s) or railroad(s) or cause interruption of use or service of relatively important facilities.

Significant areas of wetlands border the river, particularly on river left, north of the MBTA bridge. Several tributaries feed into the Little River upstream of the dam. The west side of the river is primarily developed, with residential neighborhoods and a large cemetery abutting the river corridor. The area below the dam is tidally influenced. The Little River enters a 2,000-foot-long flood conduit approximately 700 feet downstream of the dam, which conveys the Little River the rest of the distance between the dam and the Merrimack River. Wetland resources on site are associated with the dam and impoundment and include Bank, Land Under Water (LUW), Riverfront Area, Bordering Vegetate Wetland (BVW) and Bordering Land Subject to Flooding (BLSF). The Little River is listed as an impaired waterbody due to the presence and/or concentration of several different nutrients or pollutants.

Portions of the project site are mapped as a Regulatory Floodway and as Flood Zone AE (an area inundated during a 100-year storm). The site has a Base Flood Elevation (BFE) of elevation (el.) 22.4 ft NAVD88 in the southern limit of the site extending up to 26.3 ft NAVD88 in the northern limit of the site, as delineated on Federal Emergency Management Agency (FEMA) maps 25009C0089G (effective date July 19, 2018) and 25009C0087F (effective date July 3, 2012). The project site does not contain *Estimated and Priority Habitat of Rare Species* as delineated by the Natural Heritage and Endangered Species Program (NHESP) in the 15th Edition of the Massachusetts Natural Heritage Atlas or an Area of Critical Environmental Concern (ACEC). The site contains three properties listed in the Massachusetts Historical Commission's (MHC) Inventory of Historic and Archaeological Assets of the Commonwealth (Inventory); no impacts to historic resources are anticipated.

The project site is located within one Environmental Justice (EJ) population characterized by Minority and Income criteria and within one mile of 12 additional EJ populations characterized by Minority, and Minority and Income criteria. As described below, the EENF included a review of potential impacts and benefits to EJ populations within one mile of the project site and described public involvement efforts undertaken to date.

Environmental Impacts and Mitigation

Environmental impacts associated with the project include the direct alteration of 12 acres of land and indirect alteration (associated with the elimination of the impoundment area) of 83 acres of land. The project will result in the alteration of 29,950 linear feet (lf) of Inland Bank; 1,841,310 sf (42.2 acres) of BVW; 1,063,690 sf (24.4 acres) of LUW; 2,676,590 sf (61.45 acres) of Riverfront Area; and 1,148,200 sf (26.4 acres) of BLSF (much of which overlaps with Riverfront Area). Included in this alteration is the permanent conversion of some wetland resource areas following removal of the dam. Specifically, the project is expected to result in the elimination of 125,900 sf (2.9 acres) of LUW, 1,900 lf of Inland Bank, and 425,500 sf (9.8 acres)

of BVW; it will also result in creation of 506,500 sf (11.6 acres) of BLSF and 14,100 sf (0.3 acres) of Riverfront Area. The project will dredge approximately 10,680 cubic yards (cy) of sediment.

The project is proposed as an Ecological Restoration Project as defined in wetland regulations, designed to improve wetlands, fish and wildlife habitat, and water quality. Measures to avoid, minimize, and mitigate project impacts during construction include sequencing construction to minimize impacts to wetland resource areas, the use of erosion and sediment controls and coffer dams, implementation of a water control plan, and minimizing the footprint of work. Disturbed areas will be restored with native seed mixes and shrub and tree plantings.

Jurisdiction and Permitting

The project is undergoing MEPA review and is subject to a mandatory EIR pursuant to 301 CMR 11.03(3)(a)(1)(a), 11.03(3)(a)(1)(b), and 11.03(3)(a)(4) of the MEPA regulations because it requires Agency Action and will involve the alteration of one or more acres of BVW, the alteration of 10 or more acres of wetlands, and the structural alteration of an existing dam that causes any decrease in impoundment capacity, respectively.[1] The project additionally exceeds the ENF thresholds at 301 CMR 11.03(3)(b)(1)(b), 11.03(3)(b)(1)(d), 11.03 (3)(b)(1)(e), 11.03(3)(b)(1)(f), and 11.03(3)(b)(3) because it will result in the alteration of 500 or more lf of Inland Bank, the alteration of 5,000 or more sf of BVW, Expansion of existing fill in a regulatory floodway, alteration of one half or more acres of any other wetlands, and dredging of 10,000 or more cy of material, respectively. In addition to exceeding mandatory EIR thresholds, the project requires the preparation of an EIR under 301 CMR 11.06(7)(b) of the MEPA regulations because it is located within one mile of one or more EJ populations.

The EENF states that the project requires a Chapter 253 Dam Safety Permit from the Massachusetts Department of Conservation and Recreation (DCR), a 401 Water Quality Certification (WQC) and Chapter 91 (c.91) License from the Massachusetts Department of Environmental Protection (MassDEP), an Access Permit from the Massachusetts Department of Transportation (MassDOT), and an MBTA Permit from the MBTA. Comments from MassDEP indicate a 401 WQC may not be required, as discussed further below. Comments from the Massachusetts Department of Marine Fisheries (DMF) indicate that a Fishway Construction Permit will be required for the project.

The project requires an Order of Conditions from the Haverhill Conservation Commission (or in the case of an appeal of either, a Superseding Order of Conditions from MassDEP) and a Special Permit from the Haverhill Planning Board. The project requires authorization from the U.S. Army Corps of Engineers (USACE) under the General Permits for Massachusetts in accordance with Section 404 of the Federal Clean Water Act as well as a National Pollutant Discharge Elimination System (NPDES) Construction General Permit (CGP) from the United States Environmental Protection Agency (EPA).

[1] Exceedance of the threshold at 301 CMR 11.03(3)(a)(1)(a) and 11.03(3)(a)(1)(b) are due to indirect impacts upstream of the dam associated with lowered surface water elevations following dam removal. The exceedance of the threshold at 301 CMR 11.03(3)(a)(1)(b) was not identified in the EENF, but appears to be implicated based on the identified impacts to wetland resources.

Because the project will receive Financial Assistance in the form of MVP grants, MEPA jurisdiction is broad in scope and extends to all aspects of the project that may cause Damage to the Environment, as defined in the MEPA regulations.

Request for Single EIR

The MEPA regulations indicate a Single EIR may be allowed provided I find that the EENF:

a) describes and analyzes all aspects of the project and all feasible alternatives, regardless of any jurisdictional or other limitation that may apply to the Scope;
b) provides a detailed baseline in relation to which potential environmental impacts and mitigation measures can be assessed; and,
c) demonstrates that the planning and design of the project use all feasible means to avoid potential environmental impacts.

For any Project for which an EIR is required in accordance with 301 CMR 11.06(7)(b), I must also find that the EENF:

d) describes and analyzes all aspects of the Project that may affect EJ Populations located in whole or in part within the Designated Geographic Area around the project; describes measures taken to provide meaningful opportunities for public involvement by EJ Populations prior to filing the EENF, including any changes made to the project to address concerns raised by or on behalf of EJ Populations; and provides a detailed baseline in relation to any existing unfair or inequitable Environmental Burden and related public health consequences impacting EJ Populations in accordance with 301 CMR 11.07(6)(n)(1)

Consistent with this request, the EENF was subject to an extended comment period under 301 CMR 11.05(7).

Review of the EENF

The EENF provided a description of existing and proposed conditions, preliminary project plans, a hydrologic and hydraulic (H&H) study summary, a sediment analysis, and analysis of environmental impacts. It identified measures to avoid, minimize and mitigate environmental and public health impacts. Consistent with the MEPA Interim Protocol on Climate Change Adaptation and Resiliency, the EENF contained an output report from the MA Climate Resilience Design Standards Tool prepared by the Resilient Massachusetts Action Team (RMAT) (the "MA Resilience Design Tool"),[2] together with information on climate resilience strategies to be undertaken by the project. The EENF also included a description of measures taken to enhance public involvement by EJ populations and a baseline assessment of any existing

[2] https://resilientma.org/rmat_home/designstandards/

unfair or inequitable Environmental Burden and related public health consequences impacting EJ Populations in accordance with 301 CMR 11.07(6)(n)(1).

Comments from State Agencies do not identify any significant impacts that were not reviewed in the EENF, note deficiencies in the alternatives analysis, or identify additional alternatives for further review. Comments from DCR state that the project will likely result in an improvement over existing conditions.

Alternatives Analysis

The Proponent evaluated multiple alternatives for each of the three project components: dam management, channel establishment, and recreational improvements. The EENF identifies the following project objectives:

- Reduce flooding risk from both dam failure and increasing precipitation due to climate change
- Address historic contamination through a plan for sediment management and disposal
- Protect infrastructure from scour once the dam is removed
- Respond to the needs of the adjacent mill owner for redevelopment of the mill, including protecting the building foundation and removing the liability associated with the existing dam
- Respond to the key concerns and desires expressed by neighborhood residents, namely:
    - Maintenance of fishing access and fishing quality
    - Maintenance of opportunities for recreational boating
    - Clean up of all debris and trash exposed by the removal of the dam's impoundment
- Provide additional river access for the neighborhood
- Enhance aquatic connectivity through the river reach and the riparian corridor
- Reestablish a self-sustaining river ecosystem that will require little long-term maintenance or involvement from the City once established

Dam Management

The EENF evaluated a No Action Alternative, Dam Removal Alternative (Preferred Alternative), Dam Rehabilitation Alternative, and Dam Rehabilitation with Habitat Connectivity Features Alternative to address dam management. The No Action Alternative would involve no new work at the dam, and would not result in any immediate new environmental impacts. The system would remain in a degraded state with poor water quality, limited biodiversity, and river discontinuity. As described in the EENF, the No Action Alternative would not serve to minimize flooding risks posed by catastrophic dam failure to surrounding communities, including EJ populations. Such risks would be intensified under future climate conditions. As such, the No Action Alternative was dismissed.

The Dam Rehabilitation Alternative would consist of long-term repairs to improve the useful life of the dam to a minimum of 50 years, and potentially up to 100 years. The EENF states that these repairs include abandoning the mill race, reconstructing training walls and the spillway, installing downstream scour protection and a low-level outlet, dredging and disposing of sediment accumulated against the dam, repointing the stone masonry, and flood proofing the

mill building. As described in the EENF, the Dam Rehabilitation Alternative would reduce, but not eliminate, the risk of flood damage to the MBTA bridge and flood culvert downstream. Direct environmental impacts would be significantly lower than the Preferred Alternative; however, the EENF states that based on the expense of rehabilitation, continued need for dam inspections and maintenance, continued liability associated with the dam, and continued barriers to aquatic movement, this Alternative was dismissed.

The Dam Rehabilitation with Habitat Connectivity Features Alternative would consist of similar work as the Dam Rehabilitation Alternative, but would additionally involve the construction and/or installation of habitat connectivity features like fish ladders or a bypass fishway do improve habitat connectivity; this Alternative was dismissed for similar reasons as the Dam Rehabilitation Alternative. In addition to the drawbacks of the Dam Rehabilitation Alternative, the EENF states that this Alternative would at best require easements or land taking of a significant portion of adjacent properties on river right and may not be feasible due to the constraints of adjacent infrastructure.

As described in the EENF, the Dam Removal Alternative was incorporated into the Preferred Alternative as it meets multiple objectives of the City for climate change mitigation, contamination cleanup, infrastructure protection, recreational enhancement, economic redevelopment, and ecological restoration. The Dam Removal Alternative will also include the construction of a nature-like fishway, in addition to removing the existing barrier to fish migration by removing the dam. Although the Dam Removal Alternative will result in significant alteration of wetland resources (and greater immediate environmental impacts as compared to the other dam management alternatives), the EENF states that the net ecological benefit of restoring the natural flow of the river outweighs these impacts, and further that impacts have been minimized to the maximum extent practicable.

Channel Establishment

The EENF evaluated two alternatives for channel establishment: a Designed Channel Alternative (Preferred Alternative) and the Passive Management Alternative. The Passive Management Alternative would involve minimal grading post-dam removal, and would allow the sediment to passively migrate downriver. The alignment of the river channel would be allowed to develop naturally. As described in the EENF, although it would require less direct alteration of wetland resources (as opposed to the Preferred Alternative), the Passive Management Alternative may result in a river alignment that causes scour at the Winter Street bridge, and in tun public safety concerns. Natural channel development may also not provide appropriate depths and velocities for target fish species or recreational use. As such, this Alternative was dismissed.

The Designed Channel Alternative (which has been incorporated into the Preferred Alternative) proposes instead to take a more active approach to stream alignment, and involves removing and properly disposing of sediment with concentration of hazardous materials. As described in the EENF, in addition to addressing the contaminated sediment upstream of the dam, this Alternative was chosen as it provides the opportunity to include grade control structures to maintain water within a low-flow channel, nature-like fishway; scour protection at bridge crossings; and proper alignment of the stream at the approach to the Winter Street Bridge.

Recreational Improvements

The EENF evaluated a No Action Alternative, Cashman's Field Improvements Only Alternative, and a Proposed Improvements Alternative (the Preferred Alternative) for recreational improvements. The No Action Alternative would involve no additional recreational features to Cashman's Park or other areas along the project site. While it would not result in environmental impacts, the EENF states that this Alternative was dismissed as it does not provide recreational access to the restored river corridor, which is a goal of the project.

The Cashman's Field Improvements Only Alternative would involve construction of the canoe launch and fishing platform only. This Alternative was evaluated as it enhances recreation within City-owned property only, and would not require access agreements or easements (which are required for the Preferred Alternative); however, it would not provide the diverse access and opportunity provided by the Preferred Alternative. The Proposed Improvements Alternative (the Preferred Alternative) was selected for recreational improvements as the proposed recreational features (a canoe/kayak launch, fishing platform, pedestrian bridge, river overlook, and pedestrian trail network) provide access opportunities for community members across age ranges and interests. According to the EENF, this Alternative also makes the recreational amenities (existing and proposed) at Cashman's Park more accessible to a greater number of residents by increasing connectivity to the park from Winter Street. The project site is almost entirely located within an EJ community, which currently has very limited access to the river as a recreational resource.

The EENF states that combined, the three Preferred Alternatives provide a balance between environmental benefits, climate resilience, public benefits (including EJ communities), and projects costs. As described in the EENF, during the planning and design phase, the City considered input from multiple stakeholders including the public, regulators, and state agencies, and the resulting design includes a balanced approach to meet the needs of the City's inhabitants to the extent practicable, while considering short-term and long term environmental and community benefits.

Environmental Justice

Effective January 1, 2022, all new projects in "Designated Geographic Areas" ("DGA," as defined in 301 CMR 11.02, as amended) around EJ populations are subject to new requirements imposed by Chapter 8 of the Acts of 2021: An Act Creating a Next-Generation Roadmap for Massachusetts Climate Policy (the "Climate Roadmap Act") and amended MEPA regulations at 301 CMR 11.00.[3] Two related MEPA protocols – the MEPA Public Involvement Protocol for Environmental Justice Populations (the "MEPA EJ Public Involvement Protocol") and MEPA Interim Protocol for Analysis of project Impacts on Environmental Justice Populations (the "MEPA Interim Protocol for Analysis of EJ Impacts") – are also in effect for new projects filed on or after January 1, 2022.[4] Under the new regulations and protocols, all

[3] MEPA regulations have been amended to implement Sections 55-60 of the Climate Roadmap Act, and took effect on December 24, 2021. More information is available at https://www.mass.gov/service-details/information-about-upcoming-regulatory-updates.

[4] Available at https://www.mass.gov/service-details/eea-policies-and-guidance.

projects located in a DGA around one or more EJ populations must take steps to enhance public involvement opportunities for EJ populations, and must submit analysis of impacts to such EJ populations in the form of an EIR.

The EENF indicates that the DGA for the project is one mile; as noted above, the project site is located within one EJ population characterized by Minority and Income criteria and within one mile of 12 additional EJ populations characterized by Minority, and Minority and Income criteria. Within the census tracts containing the above EJ populations, Spanish or Spanish Creole was identified as a language spoken by 5% of more of residents who also identify as not speaking English very well. The Proponent also reached out to Haverhill Public Schools Office, Haverhill Board of Health, and Haverhill City Clerk to inquire about non-English speaking communities within the City; these offices indicated that Spanish is the most common language used for communication with residents (other than English).

Four outreach events were held between March 2021 and June 2021 to share technical information and develop a conceptual design vision for the dam removal and river restoration project. The outreach events consisted of three community forums held each in English and Spanish and one pop-up question and answer session at Cashman's Park. The EENF describes a diversity of community members that have participating in the project to date, including direct abutters, businesses, anglers, watershed and environmental groups, and other local residents (renters and owners). The EENF states that the Latino Coalition of Haverhill has been a strong supporter of the project and has submitted several letters in support of the City's applications for project funding. The Proponent provided Advance Notification under Part II of the MEPA EJ Public Involvement Protocol through the distribution of an EJ Screening Form, which was provided in both English and Spanish, to a list of community-based organizations (CBOs) and tribes/indigenous organizations provided by the MEPA Office (the "EJ Reference List"). Spanish interpretation services were offered during the MEPA remote consultation session held on September 27, 2022 to promote public involvement during MEPA review of the EENF, but no requests for interpretation were received. As stated in the EENF, the Proponent plans to maintain an active level of consultation and outreach as the project advances through the MEPA review and construction stages.

The EENF contains a baseline assessment of any existing unfair or inequitable Environmental Burden and related public health consequences impacting EJ Populations in accordance with 301 CMR 11.07(6)(n)(1) and the MEPA Interim Protocol for Analysis of EJ Impacts (specifically, the Proponent utilized the checklist available for Ecological Restoration projects under Part V of this protocol). According to the EENF, the data surveyed appear to indicate existing "unfair or inequitable" burdens impacting the identified EJ populations. Specifically, the EENF notes that the DPH EJ Tool identifies municipalities and census tracts surrounding the identified EJ census block groups as exhibiting "vulnerable health EJ criteria"; this term is defined in the DPH EJ Tool to include any one of four environmentally related health indicators that are measured to be greater than 110% of statewide rates based on a five-year rolling average. Specifically, the City of Haverhill exhibits Childhood Blood Lead Levels and Heart Attack rates more than 110% of statewide rates. Additionally, three census tracts containing the identified EJ populations exhibit Elevated Childhood Blood Lead Levels greater

than 110% of the statewide rates, and four census tracts exhibit Low Birth Weight rates greater than 110% of statewide rates.

The EENF included a screening of climate risks for the project site, using the MA Resilience Design Tool (further described below); the project is rated as "High" exposure for extreme precipitation (urban flooding), extreme precipitation (riverine flooding), and extreme heat. The EENF notes that Haverhill's downtown communities are both the most susceptible to flooding based on geographic location, and also the most climate-vulnerable based on demographics. According to the EENF, the project is expected to reduce climate risks to the surrounding EJ community. The dam removal will lower the 100-year flood elevation from present day conditions and for the recommended planning horizon (2070). Th project will therefore eliminate the risks associated with spontaneous failure of the dam, and the proposed shrub and tree plantings and recreational improvement will provide shade and river access for cooling and recreation in the heart of an EJ community.

The EENF describes potential adverse environmental and public health impacts associated with the project as limited to construction-period impacts, including reduced access to Cashman's Park (which will potentially be used for dewatering and/or storage of dredged materials) and the Little River, and an increase in construction-related vehicle trips. Best management practices (BMPs) are proposed to limit impacts associated with construction. The EENF describes benefits to EJ populations associated with the project as reduced neighborhood flood risks, the removal of legacy industrial contaminants, improvement of community aesthetics and quality of life, enhancement of economic vitality, elimination of the risk of dam failure and associated hazards, and alleviation of public health concerns associated with algal blooms. In addition, the project will enhance recreational access to the restored river corridor. Removal of the artificial impoundment will also restore land area along the river's edge, creating additional floodplain storage (which is not currently available as it is permanently inundated). The EENF states that, in addition to providing flood protection, this newly available land can provide additional space in a densely developed urban environment in which to establish healthy, native, riparian corridors, plant trees for shade provision to help counteract urban heat island effects, and stabilize the river's banks. The land area exposed when the impoundment recedes will be cleared of debris and restored with native vegetation to create a natural river border.

Wetland and Waterways

The Haverhill Conservation Commission will review the project for its consistency with the Wetlands Protections Act (WPA), the Wetland Regulations (310 CMR 10.00), and associated performance standards. The removal of the dam and subsequent drawdown of the impoundment will permanently lower base flow water levels within the project site between 3.75 to 8.29 feet. Because of this changed hydrology, wetlands and surface waters within the vicinity of the dam are anticipated to be affected, resulting in the conversion of wetland resources and indirect impacts described above. The project will directly alter 5,100 linear feet (lf) of Inland Bank, 22,570 sf (0.52 acres) of BVW, 415,400 sf (9.54 acres) of LUW, 100,890 sf (2.32 acres) of Riverfront Area, and 10,300 sf (0.24 acres) of BLSF.

Significant riverbank grading is anticipated to be required to construct the new channel and its banks. The channel will be approximately 18 feet wide at the toe of the bank, although the

EENF states that during proposed baseflow water level conditions, the river is anticipated to be approximately 24 feet wide. The channel will generally be located within the center of the currently impounded area. The streambed elevation will range from an elevation of 13.50 feet at the most upstream extent (MBTA bridge) to 6.0 feet at downstream extent at the Winter Street Bridge. The channel bottom will consist of native materials if the required size/gradation criteria is met unless it's determined scour protection is needed; if scour protection is required, the channel bottom will consist of eight inches of three- to eight-inch stone fill and existing sediment material. Approximately 125-feet and 170-feet of low flow channel is proposed to provide access to the mainstem of Little River from Leblanc Street and Hilldale Avenue, respectively.

The project will dredge approximately 10,680 cy of material, 5,500 cy of which will be disposed off-site as hazardous or regulated waste in accordance with local, state, and/or federal regulations. Approximately 4,820 cubic yards of non-hazardous sediment is anticipated to be reused within the (former) impoundment area. Due to the narrow, linear nature of the impoundment, work will occur in one segment of the river at a time, with cofferdams generally placed within the center of the river to isolate work to half of the river width at a time. Flow will be maintained within the remaining half of the river. In addition to cofferdams, water control measures include siphons and/or pumps for dewatering, temporary river crossing with culvert to maintain flow, and turbidity curtains to minimize sediment transport downstream.

The EENF states that a 401 WQC is required (due to the volume of dredging proposed); however, comments from MassDEP state that a 401 WQC is not required for projects that qualify as Ecological Restoration Projects (as identified by the EENF). MassDEP further clarifies that, due to the quantity of permanent loss of resource areas and the conversion of resource area types, the project would need to be filed as a full (i.e., not Limited) Ecological Restoration Project in order to be permitted under the WPA; since the recreational elements of the project are accessory to the ecological restoration aspect, those elements will need to be included in a separate Notice of Intent (NOI) with the Haverhill Conservation Commission. As the project is located within a jurisdictional waterway, a c.91 License will be required. Additionally, the project will require a Chapter 253 Dam Safety Permit from DCR. Comments from DCR state that the project appears to be in the interest of public safety and successful completion is intended to bring the dam into compliance with dam safety regulations.

Fisheries and Wildlife

The Little River is a tributary of the larger Merrimack River; the project site is located approximately 2,000 ft upstream of the confluence of the Little and Merrimack Rivers. Comments from DMF state that the Merrimack River provides essential passage, spawning, and/or nursery habitat for diadromous fish species including alewife (*Alosa pseudoharengus*), blueback herring (*Alosa aestivalis*), American shad (*Alosa sapidissima*), rainbow smelt (*Osmerus mordax*), American eel (*Anguilla rostrata*), white perch (*Morone americana*), Atlantic tomcod (*Microgadus tomcod*), sea lamprey (*Petromyzon marinus*), short-nose sturgeon (*Acipenser brevirostrum*), and Atlantic sturgeon (*Acipenser oxyrinchus*). DMF further states that, at present, the Little River does not provide habitat for passage and spawning of diadromous fish due to the presence of the dam. As noted above, the project is anticipated to enhance the passage of fish and other aquatic organisms through the removal of the dam and the installation of multiple fish passage structures. Comments from DMF identify several fish species to utilize the Little River

for passage, spawning, and nursery habitat following project construction. DMF states that the project will be required to obtain a Fishway Construction Permit for the nature-like fishway and engineered river channel. I refer the Proponent to comments from DMF for recommended changes to proposed surface water elevation and slopes to improve fish passage. DMF also recommends a time of year (TOY) restriction for in-water work from March 1 to June 30 to minimize impacts to fish resources in the downstream Merrimack River.

Historic and Archaeological Resources

As noted above, although the project site contains three listed in MHC's Inventory, no impacts to historic resources are anticipated as a result of the project. Comments from the Massachusetts Board of Underwater and Archaeological Resources (BUAR) indicate that there is no record of any underwater archaeological resources in the project area. However, BUAR states that the area may be archaeologically sensitive, and should heretofore unknown archaeological resources be encountered during the course of work, the Proponent will take steps to limit adverse effects and notify BUAR and MHC, as well as other appropriate agencies, in accordance with the Board's *Policy Guidance for the Discovery of Unanticipated Archaeological Resources*.

Climate Change

The City is a participant in the Commonwealth's Municipal Vulnerability Preparedness (MVP) program. The MVP program is a community-driven process to define natural and climate-related hazards, identify existing and future vulnerabilities and strengths of infrastructure, environmental resources, and vulnerable populations, and develop, prioritize and implement specific actions the City can take to reduce risk and build resilience. Through the MVP program, the City received funding to conduct a planning process for climate change resiliency and implementing priority projects. The results of the initial community-driven process were presented in the "Community Resilience Building Workshop - Summary of Findings" (the Report), dated June 2020.[5] The Report identified flooding, extreme precipitation, extreme temperatures, and major storm events as top climate hazards in Haverhill. As described in the EENF, during the City's MVP planning process, stakeholders identified areas upstream of the Little River Dam as a particular concern in terms of flooding and potential climate change impacts. The dam contributes to upstream flooding at areas along Apple Street and Little River Street, both of which are located within EJ communities. The dam also poses a hazard to downstream areas should it fail. The City was awarded an FY21 MVP Action Grant that assessed the feasibility of removal of the Little River Dam. Building on this work, the City was awarded an FY22/23 MVP Action Grant to fund design and permitting of the Little River Dam Removal and River Restoration with the goal of increasing flood resilience and providing shade and river access for cooling and recreation in the center of an EJ community.

Adaptation and Resiliency

Effective October 1, 2021, all MEPA projects are required to submit an output report from the MA Resilience Design Tool to assess the climate risks of the project. As noted above,

[5] The report can be accessed here: https://www.mass.gov/doc/haverhill-report/download

based on the 50-year useful life of the dam removal/river restoration and the self-assessed criticality of this asset, the project was rated as having a "High" exposure extreme precipitation (urban flooding), extreme precipitation (riverine flooding), and extreme heat, but was also rated "High" for ecosystem benefits. Because dam removals are considered "Natural Resource" projects, the Tool does not provide design recommendations similar to those provide for projects maintaining physical assets like buildings/facilities and infrastructure assets. Protection and restoration of wetlands plays an increasingly important role in promoting ecosystem resiliency and mitigating climate change impacts.

An H&H analysis was developed to assess fish passage suitability, ecological alterations, sediment mobility concerns, structural impacts, and flood protection benefits associated with removing the dam, under pre- and post-conditions. The H&H evaluated 10-, 50-, 100-, and 500-year storm events under present day and 2070 conditions. According to the H&H Analysis, the removal of the dam will reduce flood risks to upstream structures during analyzed flood events between Winter Street and the I-495 bridges in present day conditions and projected 2070 conditions (incorporating sea level rise impacts). Flood reductions are most significant immediately upstream of the dam and during the smaller, more frequent flood events such as the 10-year flood event. Flood reductions are less significant during the larger, more infrequent flood events such as the 50- and 100-year flood events. As noted above, the project will increase the flood storage capacity within the footprint of the existing river.

Greenhouse Gas (GHG) Emissions

This project is subject to review under the May 2010 MEPA Greenhouse Gas Emission (GHG) Policy and Protocol (Policy) because it exceeds thresholds for a mandatory EIR. The GHG Policy includes a de minimis exemption for projects that are expected to produce minimal GHG emissions. The EENF indicates that GHG emissions associated with the project will be limited to the construction period and are de minimis. The Proponent therefore was not required to submit a GHG analysis in conjunction with the EENF. Although drawdown of the impoundment associated with the dam removal is anticipated to result in short-term temporary natural GHG emissions from the sediment, the conversion of previously impounded area to wetlands will promote carbon sequestration in the long-term. As described in the EENF, wetland soils contain some of the highest carbon storage and account for 20-30% of global soil carbon, while only occupying 5-8% of the land surface.

Construction Period

Project construction is anticipated to occur over two years during the low flow season (i.e. July 1 – October 31), commencing in Summer 2024 and concluding in winter 2026. Construction will be conducted in two phases to allow for a controlled and incremental drawdown of the Little River and to minimize the area of disturbance at one time. Phase 1 focuses on select dam removal, targeted sediment removal, and upstream improvements. Phase 2 focuses on remaining dam removal and downstream improvements. Erosion and sediment controls are proposed to minimize sediment migration from upland areas; cofferdams and a turbidity curtain are proposed to minimize the turbidity within Little River during construction/migration of sediment downstream. Stockpiled sediment will be surrounded by erosion control barriers and covered prior to inclement weather. Sedimentation from dewatering

will be minimized with use of a temporary dewatering basin with a filter bag. The EENF notes that materials from the dam removal will be re-used to the extent practicable.

All construction and demolition activities should be managed in accordance with applicable MassDEP's regulations regarding Air Pollution Control (310 CMR 7.01, 7.09-7.10), and Solid Waste Facilities (310 CMR 16.00 and 310 CMR 19.00, including the waste ban provision at 310 CMR 19.017). The project should include measures to reduce construction period impacts (e.g., noise, dust, odor, solid waste management) and emissions of air pollutants from equipment, including anti-idling measures in accordance with the Air Quality regulations (310 CMR 7.11). I encourage the Proponent to require that its contractors use construction equipment with engines manufactured to Tier 4 federal emission standards, or select project contractors that have installed retrofit emissions control devices or vehicles that use alternative fuels to reduce emissions of volatile organic compounds (VOCs), carbon monoxide (CO) and particulate matter (PM) from diesel-powered equipment. Off-road vehicles are required to use ultra-low sulfur diesel fuel (ULSD). If oil and/or hazardous materials are found during construction, the Proponent should notify MassDEP in accordance with the Massachusetts Contingency Plan (310 CMR 40.00). All construction activities should be undertaken in compliance with the conditions of all State and local permits.

Conclusion

The EENF includes an alternatives analysis and an assessment of environmental impacts and mitigation sufficient to justify the request for a Single EIR. Based on review of the EENF and consultation with Agencies, I hereby allow the Proponent to submit a Single EIR in lieu of a Draft and Final EIR.

SCOPE

General

The SEIR should follow Section 11.07 of the MEPA regulations for outline and content and provide the information and analyses required in this Scope. It should clearly demonstrate that the Proponent has sought to avoid, minimize and mitigate Damage to the Environment to the maximum extent practicable.

Project Description and Permitting

The SEIR should identify any changes to the project since the filing of the EENF. It should identify and describe State, federal and local permitting and review requirements associated with the project and provide an update on the status of each of these pending actions. The SEIR should include a description and analysis of applicable statutory and regulatory standards and requirements, and a discussion of the project's consistency with those standards.

The SEIR should include updated site plans (legible and at a reasonable scale) for existing and post-development conditions; this should include the location of cofferdams and other dewatering equipment. The SEIR should address the design recommendations in DMF's

comments, specifically that elevation changes of 6 inches and channel slopes of no more than 3% be targeted. It should identify the proposed location for dredged sediment storage and de-watering locations, including specifically where dredged sediment that has been identified as containing hazardous materials (including specifically polychlorinated biphenyls (PCBs)) will be located prior to being transported off-site. The Proponent should clarify the Permits needed for the project, including whether recreational components of the project will be included in a separate NOI such that a 401 WQC may not be needed. The Proponent should clarity the permitting requirements for a Chapter 91 license, and what standards the project would need to meet to obtain this license. The SEIR should provide an update on any coordination done with State Agencies and/or the City.

Environmental Justice

The SEIR should provide an update on any public outreach conducted since the filing of the EENF, and should describe a plan to maintain the same level of community engagement through subsequent permitting. Any changes made to the project design in response to this coordination should be identified. The SEIR should clarify what EJ communities are present downstream of the dam, and would benefit from the stated flood reduction and climate resiliency goals of the project.

Climate Change Adaptation and Resiliency

The SEIR should identify the precipitation data used in the H&H study modeling, and identify whether increases in the frequency and intensity of storms was evaluated as part of this analysis (in addition to SLR) under modeled 2070 conditions. The EENF indicated that flood reductions under the 50- and 100-year storm conditions are less than those under the modeled 10-year storm. The SEIR should clarify whether residual flooding risks exist for downstream communities under the 50- and 100-year storm events (even with the improvements resulting from this project), and whether these events would correspond to higher frequency event (10-year or 25-year storm) under future climate conditions in 2050 or 2070. I note that the MA Resilience Design Tool now provides 24-hour rainfall volumes for various storm scenarios; these values can be consulted as a resource in responding to this Scope.

Mitigation and Section 61 Findings

The SEIR should include a separate chapter summarizing all proposed mitigation measures including construction-period measures. This chapter should also include a comprehensive list of all commitments made by the Proponent to avoid, minimize and mitigate the impacts of the project, and should include a separate section outlining mitigation commitments relative to EJ populations. The SEIR should contain clear commitments to implement these mitigation measures, estimate the individual costs of each proposed measure, identify the parties responsible for implementation, and contain a schedule for implementation. The list of commitments should be provided in a tabular format organized by subject matter (traffic, water/wastewater, GHG, EJ, etc.) and identify the Agency Action or Permit associated with each category of impact. Draft Section 61 Findings should be separately included for each Agency Action to be taken on the project. The SEIR should clearly indicate which mitigation

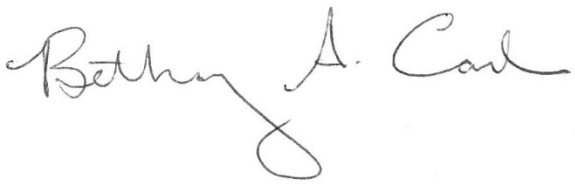
measures will be constructed or implemented based upon project phasing, either tying mitigation commitments to overall project square footage/phase or environmental impact thresholds, to ensure that adequate measures are in place to mitigate impacts associated with each development phase.

Responses to Comments

The SEIR should contain a copy of this Certificate and a copy of each comment letter received. In order to ensure that the issues raised by commenters are addressed, the SEIR should include direct responses to comments to the extent that they are within MEPA jurisdiction. This directive is not intended, and shall not be construed, to enlarge the scope of the SEIR beyond what has been expressly identified in this certificate.

Circulation

In accordance with 301 CMR 11.16(3)(b), the Proponent should circulate the SEIR to each Person or Agency who commented on the EENF, each Agency from which the project will seek Permits, Land Transfers or Financial Assistance, and to any other Agency or Person identified in this Scope. Pursuant to 301 CMR 11.16(5), the Proponent may circulate copies of the SEIR to commenters in a digital format (e.g., CD-ROM, USB drive) or post to an online website. A copy of the SEIR should be made available for review in the Oxford Public Library.



October 18, 2022
Date

Bethany A. Card

Comments received:

10/11/2022 Massachusetts Department of Conservation and Recreation (DCR)
10/11/2022 Massachusetts Division of Marine Fisheries (DMF)
10/11/2022 Massachusetts Department of Environmental Protection (MassDEP) Northeast Regional Office (NERO)
10/12/2022 Massachusetts Board of Underwater Archaeological Resources (BUAR)

BAC/ELV/elv

dcr
Massachusetts

October 11, 2022

Secretary Bethany A. Card
Executive Office of Energy and Environmental Affairs
MEPA Office, Attn: Eva Vaughan
100 Cambridge Street, Suite 900
Boston, Massachusetts 02114

Re: EOEEA #16601 Little River Dam Removal and River Restoration Project EENF

Dear Secretary Card:

The Department of Conservation and Recreation ("DCR") Office of Dam Safety ("ODS") has reviewed the Expanded Environmental Notification Form ("EENF") for the Little River Dam Removal and River Restoration Project (the "Project") located in Haverhill, submitted by Fuss & O'Neill, Inc. on behalf of the City of Haverhill (the "Proponent").

Based upon review of the EENF, ODS understands the Project's scope of work includes removal of the majority of the dam's existing granite block masonry spillway, construction of a stabilized trapezoidal flow channel through the dam, removal of contaminated sediment from within the impoundment, restoration of the stream channel in the vicinity of the dam breach, and construction of recreation amenities. The EENF indicates the Project will yield several public safety and environmental benefits including elimination of the risk of an uncontrolled breach of the dam; improved biodiversity; and restoration of natural water temperatures, dissolved oxygen levels and sediment transport pathways.

Based on review of currently available information, implementation of the Project will likely result in improvement over existing site conditions. This Project appears to be in the interest of public safety and successful completion is intended to bring the dam into compliance with dam safety regulations.

This dam removal project will require a Chapter 253 Dam Safety Permit. The permit application must be submitted to ODS for review. ODS staff will communicate with the Proponent's design engineer as part of the permit process to ensure all required documentation is provided. After receipt of all required technical information demonstrating compliance with ODS regulations, a Chapter 253 Dam Safety Permit will be prepared and issued by ODS. ODS is available to provide additional guidance through the permitting process.

DCR appreciates the opportunity to comment on this project. Please contact David Ouellette at (617) 626-1347 or david.ouellette@mass.gov with any questions or to request additional information or coordination with ODS.

Sincerely,

Douglas Rice

Douglas J. Rice
Commissioner

cc: William Salomaa, Priscilla Geigis, Patrice Kish, Tom LaRosa

The Commonwealth of Massachusetts
Division of Marine Fisheries

251 Causeway Street, Suite 400, Boston, MA 02114
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www.mass.gov/marinefisheries

CHARLES D. BAKER, Governor
KARYN E. POLITO, Lt. Governor
BETHANY A. CARD, Secretary
RONALD S. AMIDON, Commissioner
DANIEL J. MCKIERNAN, Director

October 11, 2022

Bethany A. Card, Secretary
Executive Office of Energy and Environmental Affairs
Attn: MEPA Office, Eva Vaughan
100 Cambridge Street, Suite 900
Boston, MA 02114

RE: EEA# 16601 Little River Dam Removal and River Restoration

Dear Secretary Card:

The Massachusetts Division of Marine Fisheries (MA DMF) has reviewed the proposed dam removal and river restoration project located along 3,600lf of the Little River from approximately 70ft downstream of the Winter Street/Route 97 Bridge to the MBTA Bridge submitted by the City of Haverhill. The project includes removal of the Little River Dam (NID ID#: MA00739), removal and offsite disposal of PCB contaminated sediment, construction of a nature-like fishway and engineered river channel, and recreation access improvements to the restored river corridor.

The Little River is a tributary of the larger Merrimack River and the project site is located approximately 2,000ft upstream of the confluence of the Little and Merrimack Rivers. The Merrimack River provides essential passage, spawning, and/or nursery habitat for diadromous fish species including alewife (*Alosa pseudoharengus*), blueback herring (*Alosa aestivalis*), American shad (*Alosa sapidissima*), rainbow smelt (*Osmerus mordax*), American eel (*Anguilla rostrata*), white perch (*Morone americana*), Atlantic tomcod (*Microgadus tomcod*), sea lamprey (*Petromyzon marinus*), short-nose sturgeon (*Acipenser brevirostrum*), and Atlantic sturgeon (*Acipenser oxyrinchus*) [1]. At present, the Little River does not provide habitat for passage and spawning of diadromous fish due to the presence of the Little River Dam, however, MA DMF diadromous fish biologists expect alewife, blueback herring, American eel and possibly rainbow smelt to utilize the Little River for passage, spawning, and nursery habitat following removal of the Little River Dam. Also of note, the confluence of the Little and Merrimack Rivers is located

within the stretch of the Merrimack River (Kilometers 30-32) that provides the only short-nose sturgeon spawning habitat in Massachusetts.

Based on the information in the Expanded Environmental Notification Form MA DMF offers the following recommendations and comments:

- Based on the expected utilization of the Little River by diadromous fish species following removal of the Little River Dam, this project will be required to obtain a MA DMF Fishway Construction Permit for the proposed nature-like fishway and engineered river channel (i.e. upstream grade control structures) (322 CMR 7.01(4)(d) & 322 CMR 7.01(14)(m)). Please coordinate with Ben Gahagan (ben.gahagan@mass.gov) regarding the DMF Fishway Construction Permit review process.
    - Our preliminary review of the details provided regarding the nature-like fishway and engineered river channel design has identified surface water elevation changes and slopes associated with weirs and grade control structures that may be incompatible with diadromous fish passage. We recommend elevation changes of 6" and channel slopes of no more than 3% be targeted.

- Prior to submission of an Ecological Restoration Limited Project Notice of Intent (NOI) application for this project, the proponent will be required to obtain a written determination from MA DMF regarding compatibility of the project with fish passage (310 CMR 10.11(4)). Please coordinate with the MA DMF Environmental Review Team (dmf.envreview-north@mass.gov) to obtain this written determination.

- MA DMF concurs that in water work be sequenced to occur during periods of low flow stream conditions in the Little River (i.e. July 1 – October 31), downstream turbidity curtains be used, and temporary coffer dams be installed to minimize sedimentation and turbidity in downstream areas. MA DMF recommends a time of year (TOY) restriction for in water work from March 1 to June 30 to minimize impacts to diadromous fish resources in the adjacent Merrimack River from sedimentation and turbidity [1].

Thank you for considering our comments. If you have questions about this review, please email Forest Schenck at Forest.Schenck@mass.gov.

Sincerely,

Daniel J McKiernan

Daniel J. McKiernan
Director

DM/fs/bg/sd

Cc.
C. Jacek, USACE
R. Boeri, MA CZM
K. Shaw, NMFS
B. Gahagan, MA DMF
J. Busa, Fuss & O'Neill

References:
[1] Evans, NT, KH Ford, BC Chase and JJ Sheppard (2011). Recommended Time of Year Restrictions (TOYs) for Coastal Alteration Projects to Protect Marine Fisheries Resources in Massachusetts. Technical Report DMF TR-47.

Commonwealth of Massachusetts
Executive Office of Energy & Environmental Affairs

Department of Environmental Protection
Northeast Regional Office • 205B Lowell Street, Wilmington MA 01887 • 978-694-3200

Charles D. Baker
Governor

Karyn E. Polito
Lieutenant Governor

Bethany A. Card
Secretary

Martin Suuberg
Commissioner

October 11, 2022

Bethany A. Card, Secretary
Executive Office of
Energy & Environmental Affairs
100 Cambridge Street
Boston MA, 02114

Attn: MEPA Unit

RE: Haverhill
Little River Dam Removal and Restoration Project
EEA # 16601

Dear Secretary Card:

The Massachusetts Department of Environmental Protection Northeast Regional Office (MassDEP-NERO) has reviewed the Environmental Notification Form (ENF) for the proposed Little River Dam Removal and Restoration Project in Haverhill. MassDEP provides the following comments.

Wetlands

The project consists of the removal of Little River Dam to restore the Little River corridor to a free-flowing state and eliminate the public health and safety concerns associated with the dam. Additional restoration activities include installation of multiple fish passage structures, removal of sediment containing concentrations of hazardous materials, stabilization of the bank with over 5,000 live stakes, and enhancements to the riparian corridor through planting of nearly 500 trees and 1,000 native shrubs.

The Little River Dam is located in a highly developed area in the center of the City of Haverhill. The dam is immediately adjacent to the Stevens Mill Building (aka Pentucket Mill), the foundation of which is integrated with the left dam abutment. The mill building has long been derelict and unused, but discussions are underway which would lead to the repurposing of the mill building into affordable housing. On river right (the right bank of the river, looking downstream), the dam abuts a vertical channel wall which extends approximately 6 feet above the dam crest. A parking lot and convenience store are located beyond the wall.

This information is available in alternate format. Contact Michelle Waters-Ekanem, Director of Diversity/Civil Rights at 617-292-5751.
TTY# MassRelay Service 1-800-439-2370
MassDEP Website: www.mass.gov/dep

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The stone masonry dam does not meet current standards for dam design and construction, and as such, it poses a hazard to downstream areas, notably the Winter Street Bridge that carries State Route 97, and, further downstream, the MBTA railroad crossing and the Little River Flood Control System Conduit. Failure of the dam could damage the downstream MBTA railroad crossing, as well as cause a partial blockage of the flood conduit

Direct, permanent impacts to wetland resource areas include impacts to approximately 5,100 linear feet of Bank; 22,570 sf of Bordering Vegetated Wetlands (BVW); 415,400 sf of Land Under Water (LUW); 10,300 sf of Bordering Land Subject to Flooding (BLSF); and 83,730 sf of Riverfront Area.

Indirect resource area alterations resulting from this project are anticipated due to the lowering of surface water and groundwater levels, primarily upstream. The removal of the dam and subsequent drawdown of the impoundment will permanently lower base flow water levels within the project site between 3.75 to 8.29 feet. Because of this changed hydrology, wetlands and surface waters within the vicinity of the dam are anticipated to be affected. These indirect impacts may result in conversion of wetland type to another wetland type (e.g., emergent wetland to scrub shrub wetland) or conversion of wetlands to uplands. The anticipated indirect permanent impacts from the permanent drawdown of the river include alterations to approximately 29,950 linear feet of Bank; 1,841,310 sf of BVW; 1,063,690 sf of LUW; 1,148,200 sf of BLSF; and 2,659,430 sf of Riverfront Area.

The project includes recreational elements including a canoe launch, fishing platforms, pedestrian bridge, and a trail network. In order for this project to be permitted under the Wetlands Protection Act, it will need to be filed as a full (i.e. not a limited project) Ecological Restoration Project to allow for the permanent loss of resource areas and the conversion of resource area types. To qualify as an ERP, the project's primary purpose must be to restore or otherwise improve the natural capacity of the resource areas to protect and sustain the interests of the Act. Since the purpose of the recreational elements of the project are accessory to the ecological restoration aspect, those elements will need to be filed for in a separate NOI. A 401 WQC is not required for projects that qualify under the Ecological Restoration Project provisions.

The MassDEP appreciates the opportunity to comment on this proposed project. Please contact Rachel.Freed@mass.gov at (978) 694-3258 for further information on wetlands issues. If you have any general questions regarding these comments, please contact me at John.D.Viola@mass.gov or at (978) 694-3304.

Sincerely,

This final document copy is being provided to you electronically by the Department of Environmental Protection. A signed copy of this document is on file at the DEP office listed on the letterhead.

John D. Viola
Deputy Regional Director

cc: Brona Simon, Massachusetts Historical Commission
Eric Worrall, Rachel Freed, MassDEP-NERO

The COMMONWEALTH OF MASSACHUSETTS
BOARD OF UNDERWATER ARCHAEOLOGICAL RESOURCES
EXECUTIVE OFFICE OF ENERGY AND ENVIRONMENTAL AFFAIRS
251 Causeway Street, Suite 800, Boston, MA 02114-2136
Tel. (617) 626-1014 Fax (617) 626-1240
www.mass.gov/orgs/board-of-underwater-archaeological-resources

October 11, 2022

Bethany A. Card, Secretary
Executive Office of Energy and Environmental Affairs
Attention: Eva Murray, MEPA Unit (via email attachment)
100 Cambridge Street, Suite 1020
Boston, MA 02114

RE: City of Haverhill: EEA #16601 – Little River Dam Removal and River Restoration, Haverhill

Dear Secretary Card,

The staff of the Massachusetts Board of Underwater Archaeological Resources has reviewed the above-referenced proposed project as detailed in the *Environmental Monitor* of September 9, 2022 and offers the following comments.

The Board has conducted a preliminary review of its files and secondary literature sources to identify known and potential underwater archaeological resources within the proposed project area. No record of any underwater archaeological resources was found. Based on the results of this review, the Board expects that this project is unlikely to impact submerged cultural resources.

However, should heretofore-unknown submerged cultural resources be encountered during the course of the project, the Board expects that the project's sponsor will take steps to limit adverse effects and notify the Board and the Massachusetts Historical Commission, as well as other appropriate agencies, immediately, in accordance with the Board's *Policy Guidance for the Discovery of Unanticipated Archaeological Resources*.

The Board appreciates the opportunity to provide these comments as part of the MEPA review process. Should you have any questions regarding this letter, please do not hesitate to contact me at the address above or by email at david.s.robinson@mass.gov.

Sincerely,

David S. Robinson
Director

/dsr
Cc: Brona Simon, MHC

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The Commonwealth of Massachusetts
Executive Office of Energy and Environmental Affairs
100 Cambridge Street, Suite 900
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April 3, 2023

CERTIFICATE OF THE SECRETARY OF ENERGY AND ENVIRONMENTAL AFFAIRS
ON THE
SINGLE ENVIRONMENTAL IMPACT REPORT

PROJECT NAME	: Little River Dam Removal and River Restoration
PROJECT MUNICIPALITY	: Haverhill
PROJECT WATERSHED	: Merrimack
EEA NUMBER	: 16601
PROJECT PROPONENT	: City of Haverhill
DATE NOTICED IN MONITOR	: February 24, 2023

Pursuant to the Massachusetts Environmental Policy Act (MEPA; M.G.L. c. 30, ss. 61-62L) and Section 11.08 of the MEPA regulations (301 CMR 11.00), I have reviewed the Single Environmental Impact Report (Single EIR) and hereby determine that it **adequately and properly complies** with MEPA and its implementing regulations.

Project Description

As described in the Single EIR, the project involves the removal of the majority of the Little River Dam in the City of Haverhill (City), restoration of the river, and recreational improvements. Specifically, the project will remove the majority of the dam's existing granite block masonry spillway, construct a stabilized trapezoidal flow channel through the dam, remove contaminated sediment from within the impoundment, and restore the stream channel in the vicinity of the dam breach. The dam removal will include the demolition of 65 feet of the 75-foot-long dam; the dam will be removed to a minimum of 2 feet below the proposed channel elevation, leaving a portion of the lower part of the dam. As described in the Single EIR, complete removal of the dam (up to the adjacent Stevens Mill building) would likely jeopardize the integrity of the foundation of the mill, based on the results of a structural inspection. Therefore, approximately 10 feet of the dam is proposed to remain on river left to continue to provide structural support to the building. The stone masonry dam does not meet today's

standards for dam design and construction, and as such, poses a hazard to downstream areas which include Environmental Justice (EJ) neighborhoods. As described in the Single EIR, failure of the dam could damage the downstream Massachusetts Bay Transportation Authority (MBTA) railroad crossing, as well as cause a partial blockage of a downstream flood conduit which the Single EIR states is crucial to the protection of a substantial swath of the City from flooding impacts. In addition, a failure of the Little River Dam would result in the spontaneous release of contaminated sediments that are currently impounded by the dam. Channel erosion from the dam failing could also undermine the adjacent mill building and the upstream MBTA bridge crossing.

As described in the Single EIR, dam removal will result in multiple environmental and community benefits, including the elimination of the above identified potential public safety threats, restoration of the natural flow of the river, removal of a barrier in the river which currently impedes the passage of fish and many other aquatic organisms, and lowering flood elevations/risks in the surrounding EJ neighborhoods. In addition to the dam removal, the project will include installation of multiple fish passage structures, stabilization of the bank with over 5,000 live stakes, and enhancements to the riparian corridor through planting of nearly 500 trees and 1,000 native shrubs. The river width will be reduced to approximately 24 feet during base flow conditions from an approximate 75-foot width currently. Two retaining walls will be constructed in the vicinity of the dam to improve structural stability and protect adjacent development, using granite and stone from the demolished dam. Recreational improvements include construction of a canoe launch, fishing platform, pedestrian bridge, trail network, and a low-flow channel area for recreational boater access. As described in the Single EIR, the project has incorporated years of planning, data collection, and design funded through Municipal Vulnerability Preparedness (MVP) Action Grants awarded to the City. The Single EIR additionally states that the project meets the definition of an Ecological Restoration Project as defined by the Wetlands Protection Act (WPA) regulations at 310 CMR 10.04, though, as noted below, the recreational elements of the project will need to be filed separately from the work primarily associated with the dam removal.

Project Site

The 157-acre project site includes approximately 12 acres where direct impacts will occur (i.e., the limit of work). This includes the Little River Dam and an approximately 3,600 lf span of the Little River, from south of Winter Street (Route 97) to the MBTA Bridge; approximately 10 acres of this area is within the Little River itself. The remainder of the project site includes areas of the Little River further upstream and associated floodplain that are expected to be indirectly impacted from the dam removal. As described in the Single EIR, the Little River Dam is a privately-owned stone masonry dam consisting of a cascading granite block masonry gravity structure with a maximum height of 12 feet, and with a granite block crest approximately 75 feet in length. The downstream face of the dam consists of granite blocks or cobbles, over which the spillway flow cascades to dissipate energy before continuing into the downstream channel. The dam was constructed in the 1800's (or earlier) as a source of power for the adjacent mill (no longer in operation), the foundation of which is integrated into the dam abutment. The Little River Dam is in a highly developed area in the center of the City, with a narrow, linear impoundment extending upstream approximately 0.5 miles. The most recent Phase I Dam Inspection conducted by Pare Corporation on June 19, 2019 indicated that the Little River Dam

is a Small Sized Dam with Significant Hazard Potential (Class II) in Fair condition. Significant hazard potential is defined as dams located where failure may cause loss of life and damage to home(s), industrial or commercial facilities, secondary highway(s) or railroad(s), or cause interruption of use or service of relatively important facilities.

Significant areas of wetlands border the river, particularly on river left, north of the MBTA bridge. Several tributaries feed into the Little River upstream of the dam. The west side of the river is primarily developed, with residential neighborhoods and a large cemetery abutting the river corridor. The area below the dam is tidally influenced. The Little River enters a 2,000-foot-long flood conduit approximately 700 feet downstream of the dam, which conveys the Little River the rest of the distance between the dam and the Merrimack River. Wetland resources on site are associated with the dam and impoundment and include Bank, Land Under Water (LUW), Riverfront Area, Bordering Vegetated Wetland (BVW) and Bordering Land Subject to Flooding (BLSF). The Little River is listed as an impaired waterbody due to the presence and/or concentration of several different nutrients or pollutants.

Portions of the project site are mapped as a Regulatory Floodway and as Flood Zone AE (an area inundated during a 100-year storm). The site has a Base Flood Elevation (BFE) of elevation (el.) 22.4 ft NAVD88 in the southern limit of the site extending up to 26.3 ft NAVD88 in the northern limit of the site, as delineated on Federal Emergency Management Agency (FEMA) maps 25009C0089G (effective date July 19, 2018) and 25009C0087F (effective date July 3, 2012). The project site does not contain *Estimated and Priority Habitat of Rare Species* as delineated by the Natural Heritage and Endangered Species Program (NHESP) in the 15th Edition of the Massachusetts Natural Heritage Atlas or an Area of Critical Environmental Concern (ACEC). The site contains three properties listed in the Massachusetts Historical Commission's (MHC) Inventory of Historic and Archaeological Assets of the Commonwealth (Inventory); no impacts to historic resources are anticipated. The project site is located within one Environmental Justice (EJ) population characterized by Minority and Income criteria and within one mile of 13 additional EJ populations characterized by Minority, and Minority and Income criteria.

Environmental Impacts and Mitigation

Environmental impacts associated with the project include the direct alteration of 12 acres of land and indirect alteration (associated with the elimination of the impoundment area) of 83 acres of land. The project will result in the alteration of 29,950 linear feet (lf) of Inland Bank; 1,841,310 sf (42.2 acres) of BVW; 1,063,690 sf (24.4 acres) of LUW; 2,676,590 sf (61.45 acres) of Riverfront Area; and 1,148,200 sf (26.4 acres) of BLSF (much of which overlaps with Riverfront Area). Included in this alteration is the permanent conversion of some wetland resource areas following removal of the dam. Specifically, the project is expected to result in the elimination of 125,900 sf (2.9 acres) of LUW, 1,900 lf of Inland Bank, and 425,500 sf (9.8 acres) of BVW; it will also result in creation of 506,500 sf (11.6 acres) of BLSF and 14,100 sf (0.3 acres) of Riverfront Area. The project will dredge approximately 10,680 cubic yards (cy) of sediment.

The dam removal is proposed as an Ecological Restoration Project as defined in wetland regulations, designed to improve wetlands, fish and wildlife habitat, and water quality. Measures to avoid, minimize, and mitigate project impacts during construction include sequencing construction to minimize impacts to wetland resource areas, the use of erosion and sediment controls and coffer dams, implementation of a water control plan, and minimizing the footprint of work. Disturbed areas will be restored with native seed mixes and shrub and tree plantings.

Jurisdiction and Permitting

The project is undergoing MEPA review and is subject to a mandatory EIR pursuant to 301 CMR 11.03(3)(a)(1)(a), 11.03(3)(a)(1)(b), and 11.03(3)(a)(4) of the MEPA regulations because it requires Agency Action and will involve the alteration of one or more acres of BVW, the alteration of 10 or more acres of wetlands, and the structural alteration of an existing dam that causes any decrease in impoundment capacity, respectively.[1] The project additionally exceeds the ENF thresholds at 301 CMR 11.03(3)(b)(1)(b), 11.03(3)(b)(1)(d), 11.03 (3)(b)(1)(e), 11.03(3)(b)(1)(f), and 11.03(3)(b)(3) because it will result in the alteration of 500 or more lf of Inland Bank, the alteration of 5,000 or more sf of BVW, Expansion of existing fill in a regulatory floodway, alteration of one half or more acres of any other wetlands, and dredging of 10,000 or more cy of material, respectively. In addition to exceeding mandatory EIR thresholds, the project requires the preparation of an EIR under 301 CMR 11.06(7)(b) of the MEPA regulations because it is located within one mile of one or more EJ populations.

The EENF states that the project requires a Chapter 253 Dam Safety Permit from the Massachusetts Department of Conservation and Recreation (DCR), a 401 Water Quality Certification (WQC) and Chapter 91 (c.91) License and Dredge Permit from the Massachusetts Department of Environmental Protection (MassDEP), an Access Permit from the Massachusetts Department of Transportation (MassDOT), and an MBTA Permit from the MBTA. The project will also require Fishway Construction Permit from the Massachusetts Department of Marine Fisheries (DMF).

The project requires an Order of Conditions from the Haverhill Conservation Commission (or in the case of an appeal of either, a Superseding Order of Conditions from MassDEP) and a Special Permit from the Haverhill Planning Board. The project requires authorization from the U.S. Army Corps of Engineers (USACE) under the General Permits for Massachusetts in accordance with Section 404 of the Federal Clean Water Act as well as a National Pollutant Discharge Elimination System (NPDES) Construction General Permit (CGP) from the United States Environmental Protection Agency (EPA).

Because the project will receive Financial Assistance in the form of MVP grants, MEPA jurisdiction is broad in scope and extends to all aspects of the project that may cause Damage to the Environment, as defined in the MEPA regulations.

[1] Exceedance of the threshold at 301 CMR 11.03(3)(a)(1)(a) and 11.03(3)(a)(1)(b) are due to indirect impacts upstream of the dam associated with lowered surface water elevations following dam removal.

Review of the Single EIR

The Single EIR included a project description, existing and proposed conditions plans, estimates of project-related impacts, an update on permitting, a description of public outreach conducted since the filing of the EENF, an update on coordination with Agencies since the filing of the EENF, and response to comments on the EENF.

Comments from DCR state that the project will likely result in improvement over existing site conditions, and appears to be in the interest of public safety. DCR further notes that successful completion of the project is intended to bring the dam into compliance with Dam Safety Regulations. Comments from MassDEP indicate that the dam removal component of the project must be permitted as an Ecological Restoration project due to the permanent loss and/or conversion of resource areas. Comments from MassDEP Waterways Regulation Program (MassDEP-WRP) note that the project will include work in, on, and over flowed tidelands of the Little River, as further discussed below.

Environmental Justice

As noted above, the project site is located within one EJ population characterized by Minority and Income criteria and within one mile of 13 additional EJ populations characterized by Minority, and Minority and Income criteria. The Single EIR states that this is based on the revised mapping published by EEA on November 12, 2022; there is one additional EJ population within one mile of the site as compared to the former map utilized during the preparation of the EENF (submitted in September 2022). As described in the Single EIR, the project has utilized two community liaisons since the filing of the EENF to share information with the public and collect input and feedback on the proposed dam removal and various elements of the river restoration and community improvements. Additionally, the website for the project has continued to provide updates and identifies contact information for those who may have questions on the project. The Single EIR states that no changes to the project design have been made since the filing of the EENF.

Of the 10,680 cy of material proposed to be dredged, the Single EIR indicates that 1,000 cy are impacted by polychlorinated biphenyls (PCBs), based on sediment sampling. The dredged sediment is proposed to be stockpiled and dewatered (when it is not possible to be entirely dewatered within the existing river channel) within the G&C Concrete Construction property located at 30 Stevens Street, on the Stevens Street Mill property, or on City property at the back of Cashman's Field; all of these locations are within EJ census blocks. Almost all areas within one mile of the project site are mapped as EJ populations. The Single EIR states that industrial sites (the Concrete Construction and Steven Street Mill properties) are preferred for the sediment storage, and that the City is engaged in ongoing negotiation of construction access agreements with the private landowners. However, if storage at the rear of Cashman's Field (a public park) becomes necessary, the storage area will be enclosed with security fencing, and dredged material containing hazardous materials will be stockpiled with extra protective measures. These measures may include placement on an impermeable barrier (to prevent seepage into the soils or surrounding waterbodies) with appropriate perimeter controls and application of additives to lock up free liquids. Stockpiled sediment will be surrounded by erosion control barriers and covered

prior to inclement weather. If sufficiently dry, sediment may also be live-loaded for off-site disposal to minimize the need for storage. The duration for which sediments are stored on-site will depend on the time required to sufficiently dry out the material and on coordination with the receiving disposal facility. The City anticipates that the material would be stored on-site for 6 months at most, with a target to remove sediments within 90 days.[2]

As noted in the EENF, Haverhill's downtown communities are susceptible to flooding based on geographic location, and also vulnerable to climate change impacts based on demographics. The project is expected to reduce climate risks to the surrounding EJ community by removing the dam. Specifically, the benefits to EJ populations associated with the project are described as reduced neighborhood flood risks, the removal of legacy industrial contaminants, improvement of community aesthetics and quality of life, enhancement of economic vitality, elimination of the risk of dam failure and associated hazards, and alleviation of public health concerns associated with algal blooms. The Single EIR identified all EJ populations located downstream of the dam would likely benefit from the reduction in flood risk, as requested by the Scope. This includes ten (10) EJ populations within one mile of the site, and seventeen (17) additional EJ populations within five miles of the site. As noted below, the existing flood risks will remain for downstream communities, though the project will remove the risks to downstream communities associated with a catastrophic failure of the dam. The project will significantly reduce flood risks to EJ populations upstream of the dam.

Wetlands and Waterways

The Single EIR provided updated site plans that included the location of cofferdams and other dewatering equipment, as requested by the Scope. It confirmed that the project will require both a 401 WQC and c.91 License and Dredge Permit. Comments from MassDEP-WRP state that based on review of historic resources and licensing records, the former head of the tide in Little River (prior to the construction of the dam in the early 1800s) extended upstream of the dam. As such, the project includes work in, on, and over flowed tidelands of Little River and is therefore subject to licensing and permitting under 310 CMR 9.00. As stated in comments from MassDEP-WRP and in the Single EIR, the entirety of the project has been determined to be water-dependent to Waterways Regulations at 310 CMR 9.12 (further discussed below). The Single EIR notes that the proposed recreational improvements will preserve and enhance public access to Little River and preserve the suitability of Little River for water-dependent uses. The Single EIR also confirms that a Fishway Construction Permit will be required for the project (as noted in comments from DMF submitted on the EENF), and states that the proposed nature-like fishway has been designed to meet fish passage requirements.

Comments from MassDEP state that, in order for the dam removal portion of the project to be permitted under the Wetland Protection Act, it will need to be filed as an Ecological Restoration Project to allow for the permanent loss and/or conversion of resource areas. I note that the definition of "Ecological Restoration Project" under wetlands regulations describes a "project whose *primary purpose* is to restore or otherwise improve the natural capacity of a Resource Area(s) to protect and sustain the interests identified in M.G.L. c. 131, § 40, when such

[2] The duration of sediment storage was described in an email sent from Julianne Busa (Fuss & O'Neill, Inc.) to Eva Vaughan (MEPA Office) on March 31, 3023.

interests have been degraded or destroyed by anthropogenic influences." As stated in comments from MassDEP, the recreational components of the project (which do not serve this purpose) will therefore need to be filed for separately from the work primarily associated with the dam removal. All components are being reviewed under MEPA to avoid segmentation.

As noted above, the project proposes to dredge sediment that has been identified as containing hazardous materials (including PCBs). The Scope on the EENF directed the City to provide additional information about the handling and disposal of these sediments. The Single EIR states that the dredged sediment will be drained/dewatered within the existing Little River channel to the maximum extent practicable before transport in order to minimize the time materials need to be stored on the project site for dewatering prior to off-site transport and disposal. Dredged sediment stockpiling and dewatering (including of sediment containing hazardous materials) is proposed within the G&C Concrete Construction property located at 30 Stevens Street, on the Stevens Street Mill property, or on City property at the back of Cashman's Field.

Public Benefit Determination

The project site is comprised of tidelands subject to the provisions of *An Act Relative to Licensing Requirements for Certain Tidelands* (2007 Mass. Acts ch. 168) and the Public Benefit Determination (PBD) regulations (301 CMR 13.00). A PBD is required for this project as it is subject to preparation of a mandatory EIR. Information on the public benefits provided by the project was provided in the Single EIR and include the following:

- Enhanced public recreation and access to the waterfront and filled tidelands for water-dependent purposes
- Construction of a canoe launch, fishing platform, pedestrian bridge, trail network, and a low-flow channel area for recreational boater access
- Restoration of natural resource areas within historic tidelands

As a water-dependent project, it is presumed that this project will provide adequate public benefit in accordance with 301 CMR 13.04(1); as such this Single EIR Certificate shall serve as the Public Benefit Determination for the project. Furthermore, the site is subject to licensing from MassDEP-WRP. I am satisfied that any impacts to tideland resources can be adequately addressed during the licensing process.

Climate Change Adaptation and Resiliency

The hydrologic and hydraulic (H&H) study included in the EENF indicated that the removal of the dam will reduce flood risks to upstream structures during analyzed flood events (10-, 50-, 100-, and 500-year storm events) under present day conditions and projected 2070 conditions (incorporating sea level rise impacts). As directed by the Scope, the Single EIR clarified that residual flooding risks will exist for downstream communities; specifically, they will remain unchanged from current conditions. Downstream flooding, which is predominantly associated with the much larger Merrimack River, will be unaffected due to the presence of the flood conduit between the dam and the Merrimack River, which controls the flows between the

two rivers, and which will not be altered as part of the project. The Single EIR also clarified the precipitation data used in the H&H study. As described in the Single EIR, FEMA Flood Insurance Study (FIS) data was used to determine water surface elevation for present-day conditions. These flow rates were verified using statistically analyzed data from nearby stream gauges with similar watershed characteristics. Low flow rates were calculated based on USGS flow data from nearby gauge stations using contributing drainage area and relative statistics from each station. Frequency and intensity of storms as well as sea level rise were all evaluated under the modeled 2070 conditions using inflated flow rates (27% for 100-year storm and 20% for more frequent events), in accordance with the MA Climate Resilience Design Standards Tool guidelines. In addition, sea level rise was factored into the 2070 hydraulic model by raising the elevation of the downstream boundary to 5.8 feet (equivalent to the 2070 projected high tide).

Mitigation and Section 61 Findings

The Single EIR provided draft Section 61 Findings for use by Agencies, which are summarized below. The Section 61 Findings should be provided to Agencies to assist in the permitting process and issuance of final Section 61 Findings.

Environmental Justice

- Reduction in flood risks in surrounding EJ neighborhoods
- Removal of legacy industrial contaminants
- Elimination of the risk of dam failure and associated hazards
- Alleviation of public health concerns associated with algal blooms
- Improvement of community aesthetics and quality of life, including improvements to recreational access to the Little River and associated riparian corridor
- Industrial properties (G&C Concrete Construction, Inc and Stevens Mill property) will be utilized for stockpiling contaminated sediment to the maximum extent practicable
- Signage notifying upcoming construction and partial closure of Cashman's Field will be provided for construction and/or sediment stockpiling as applicable

Wetlands and Waterways

- Use of erosion, sediment, and turbidity controls
- Phased construction to minimize area disturbed at once time
- Implementation of a water control plan
- PCB-contaminated sediment will be stockpiled on an impermeable barrier with appropriate perimeter controls, with use of additives as needed to reduce liquid runoff
- Sediment will be drained/dewatered within the existing Little River channel before transport to the maximum extent practicable to minimize the need for dewatering in upland areas
- In water work scheduled during low flow stream conditions (July 1 – October 31)
- Re-use of nonhazardous sediment to maximum extent practicable

- Stabilization of banks with over 5,000 live stakes
- Enhancement of riparian corridor with planting of nearly 500 trees and 1,000 native shrubs
- Restoration of banks and riparian area with native seed mix, live stakes, erosion control blanket, shrub and tree plantings
- Enhancement of public access to Little River through installation of a fishing platform, canoe/kayak launch, pedestrian bridge, pedestrian walking trail, and river overlook
- Installation of multiple fish passage structures in accordance with DMF requirements
- Permitting of the project as an Ecological Restoration Project or Ecological Restoration Limited Project under wetlands regulations

Adaptation and Resiliency

- Removal of dam with significant hazard potential, restoration of free-flowing system, and increase in flood storage capacity within the river corridor
- Reduction in flood risks to upstream structures during 10-, 50-, 100-, and 500-year storm events under present day conditions and projected 2070 conditions
- Tree plantings to counteract urban heat island effects
- Increase in carbon sequestration potential in project site due to conversion of impoundment to stream and forested system

Construction Period

- Operation of equipment will be limited to between 7am and 4pm from Monday to Friday
- Work will be performed in accordance with the City of Haverhill Noise Ordinance
- Use of dust control measures, including wetting agents, truck bed covers, periodic street cleaning
- On and off-road idling will be restricted to the maximum extent practicable
- Contractors will be encouraged to use construction equipment with engines manufactured to Tier 4 federal emission standards
- Project contractors will be selected that have installed retrofit emissions control devices or vehicles that use alternative fuels to reduce emissions of volatile organic compounds (VOCs), carbon monoxide (CO) and particulate matter (PM) from diesel-powered equipment to the maximum extent practicable
- Off-road vehicles will be required to use ultra-low sulfur diesel fuel (ULSD)
- All equipment will be refueled at pre-approved, designated area with appropriate spill prevention and control measures
- Construction equipment and vehicles will not be staged overnight within Little River
- Removal of debris and trash from Little River and proper disposal offsite in accordance with applicable regulations

- Re-use of granite and stone from the demolished dam to construct the retaining wall adjacent to Stevens Mill
- A Stormwater Pollution Prevention Plan (SWPPP) will be developed and implemented during project construction

Conclusion

Based on a review of the Single EIR and consultation with Agencies, I find that the SEIR adequately and properly complies with MEPA and its implementing regulations. The project may proceed to permitting. Participating Agencies should forward copies of the final Section 61 Findings to the MEPA Office for publication in accordance with 301 CMR 11.12.

April 3, 2023
Date

Rebecca L. Tepper

Comments received:

03/27/2023	Massachusetts Department of Environmental Protection (MassDEP) Northeast Regional Office (NERO)
03/27/2023	Massachusetts Department of Conservation and Recreation (DCR)
03/30/2023	Massachusetts Department of Environmental Protection (MassDEP) Waterways Regulation Program (WRP)

RLT/ELV/elv

Commonwealth of Massachusetts
Executive Office of Energy & Environmental Affairs

Department of Environmental Protection

Northeast Regional Office • 150 Presidential Way Woburn, MA 01801 • 978-694-3200

Maura T. Healey
Governor

Kimberley Driscoll
Lieutenant Governor

Rebecca L. Tepper
Secretary

Bonnie Heiple
Commissioner

March 27, 2023

Rebecca L. Tepper, Secretary
Executive Office of
Energy & Environmental Affairs
100 Cambridge Street
Boston MA, 02114

RE: Haverhill
Little River Dam Removal and River Restoration
EEA # 16601

Attn: MEPA Unit

Dear Secretary Tepper:

The Massachusetts Department of Environmental Protection Northeast Regional Office (MassDEP-NERO) has reviewed the Single Environmental Impact Report (SEIR) for the proposed Little River Dam Removal and River restoration project in Haverhill. MassDEP provides the following comments.

Wetlands

Direct, permanent impacts to wetland resource areas include, approximately 5,100 linear feet of impacts to Bank, 22,570 sf of impacts to Bordering Vegetated Wetlands (BVW), 415,400 sf of impacts to Land Under Water (LUW), 10,300 sf of impacts to Bordering Land Subject to Flooding (BLSF), and 83,730 sf of impacts to Riverfront Area.

Indirect impacts for this project are anticipated from the lowering of surface water and groundwater levels, primarily upstream. The removal of the dam and subsequent drawdown of the impoundment will permanently lower base flow water level within the Project Site, by 3.75 to 8.29 feet. Wetlands and surface waters within the vicinity of the dam is anticipated to change because of this changed hydrology resulting from dam removal. These indirect impacts may result in conversion a wetland resource area to another wetland resource area (e.g., emergent wetland to scrub shrub wetland) or conversion of wetlands to uplands. The anticipated indirect permanent

This information is available in alternate format. Please contact Melixza Esenyie at 617-626-1282.
TTY# MassRelay Service 1-800-439-2370
MassDEP Website: www.mass.gov/dep

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impacts from the permanent drawdown of the river, includes approximately 29,950 linear feet of impacts to Bank, 1,841,310 sf of impacts to BVW, 1,063,690 sf of impacts to LUW, 1,148,200 sf of impacts to BLSF; and 2,659,430 sf of impacts to Riverfront Area.

The project includes recreational elements including a canoe launch, fishing platforms, pedestrian bridge, and a trail network. In order for this project to be permitted under the Wetland Protection Act, it will need to be filed as an Ecological Restoration Project to allow for the permanent loss of resource areas and the conversion of resource area type. The project's primary purpose needs to be to restore, or otherwise improve, the natural capacity of the resource areas to protect and sustain the interests of the Act to be considered an Ecological Restoration Project. Since the purpose of the recreational elements of the project are accessory to the ecological restoration aspect, they will need to be filed for separately from the work primarily associated with the dam removal.

Impacts to BVW should be mitigated for to the maximum extent practicable and options should be explored for additional wetland replication.

A Section 401 Water Quality Certification will be required for impacts to vegetated wetlands and LUW greater than 5,000 sf for aspects of the project that are not associated with ecological restoration.

The MassDEP appreciates the opportunity to comment on this proposed project. Please contact Kristin.Divris@mass.gov at (508) 887-0021 for further information on wetlands issues. If you have any general questions regarding these comments, please contact me at John.D.Viola@mass.gov or at (857) 276-3161.

Sincerely,

This final document copy is being provided to you electronically by the Department of Environmental Protection. A signed copy of this document is on file at the DEP office listed on the letterhead.

John D. Viola
Deputy Regional Director

cc: Brona Simon, Massachusetts Historical Commission,
Eric Worrall, Kristin Divris, Jill Provencal, MassDEP-NERO

dcr
Massachusetts

March 27, 2023

Secretary Rebecca L. Tepper
Executive Office of Energy and Environmental Affairs
MEPA Office, Attn: Eva Vaughan
100 Cambridge Street, Suite 900
Boston, Massachusetts 02114

Re: EEA #16601 Little River Dam Removal and River Restoration Project SEIR

Dear Secretary Tepper:

The Department of Conservation and Recreation ("DCR") Office of Dam Safety ("ODS") has reviewed the Single Environmental Impact Report ("SEIR") for the Little River Dam Removal and River Restoration Project (the "Project") located in Haverhill, submitted by Fuss & O'Neill, Inc. on behalf of the City of Haverhill (the "Proponent").

Based upon review of the SEIR, ODS understands the Project's scope of work includes removal of the majority of the dam's existing granite block masonry spillway, construction of a stabilized trapezoidal flow channel through the dam, removal of contaminated sediment from within the impoundment, restoration of the stream channel in the vicinity of the dam breach, and construction of recreation amenities. The SEIR indicates the Project will yield public safety benefits including elimination of the risk of an uncontrolled breach of the dam.

Little River Dam, which is subject to ODS jurisdiction, is classified as a Significant Hazard Potential Dam in Fair condition. A dam is deemed to be of Significant Hazard Potential where dam failure may cause loss of life and damage to home(s), industrial or commercial facilities, secondary highway(s) or railroad(s) or cause interruption of use or service of relatively important facilities. A Fair condition rating is assigned when significant operational and maintenance deficiencies exist, or potential deficiencies exist under unusual loading conditions that may realistically occur.

Based on review of currently available information, implementation of the Project will likely result in improvement over existing site conditions. This Project appears to be in the interest of public safety and successful completion is intended to bring the dam into compliance with dam safety regulations.

This dam removal project will require a Chapter 253 dam safety permit. The permit application must be submitted to ODS for review. ODS staff will communicate with the Proponent's design engineer as part of the permit process to ensure all required documentation is provided. After receipt of all required technical information demonstrating compliance with ODS regulations, a Chapter 253 Dam Safety Permit will be prepared and issued by ODS. ODS is available to provide additional guidance through the permitting process.

DCR appreciates the opportunity to comment on this project. Please contact David Ouellette at (617) 626-1347 or david.ouellette@mass.gov with any questions or to request additional information or coordination with ODS.

Sincerely,

Douglas Rice

Douglas J. Rice
Commissioner

cc: Priscilla Geigis, Patrice Kish, Robert Lowell, Dam Safety File

Commonwealth of Massachusetts
Executive Office of Energy & Environmental Affairs

Department of Environmental Protection
100 Cambridge Street 9th Floor Boston, MA 02114 • 617-292-5500

Maura T. Healey
Governor

Kimberley Driscoll
Lieutenant Governor

Rebecca L. Tepper
Secretary

Bonnie Heiple
Commissioner

Memorandum

To: Eva Vaughan, Environmental Analyst, MEPA/EEA

From: Ivan Morales, Waterways Regulation Program, MassDEP/Boston

Cc: Daniel J. Padien, Chief Waterways Regulation Program

Re: **Little River Dam Removal and River Restoration, Haverhill :**
Single Environmental Impact Report (EEA# 16601)
Comments from the Chapter 91 Waterways Regulation Program

Date: March 30, 2023 (revised)

The Department of Environmental Protection Waterways Regulation Program (WRP) has reviewed the above referenced single EIR (EEA #16601), submitted by Fuss & O'Neill, Inc. on behalf of the City of Haverhill ("the Proponent") for the removal of a dam, construction and maintenance of a pedestrian bridge, river overlook, kayak/canoe, fishways, bank stabilization and improvement dredging, within the waters of the Little River, a tributary to Merrimack River, from the MBTA railroad bridge (East of Hilldale Avenue) to the Winter Street Bridge, adjacent to the Stevens Mill Building, Haverhill, Essex County (the "project site").

Chapter 91 Jurisdiction:

After further review of the Department's licensing records and historic cartographic resources during our review of the SEIR, the Department has determined that Little River, was tidal in 1887 at least and far upstream as Winter Street as evidenced by License 1009 issued by the Massachusetts Board or Harbor and Land Commissioners on July 14, 1887. Historic information further indicates that a dam at or very close to this location was likely constructed by 1832[1]. Considering the close proximity of the dam to Winter Street, the Department's preliminary conclusion is that the former head of the tide in Little River may be as far upstream as the MBTA railroad bridge crossing near Greenfield Farm Road and the St. James Cemetery. The proposed

[1] "Map of Haverhill, Massachusetts, James Gale, 1832; www.DigitalCommonwealth.org

project includes work in, on and over flowed tidelands of Little River and is therefore subject to licensing and permitting under 310 CMR 9.00. The Department has not determined the history high water mark along the banks of the river.

Water Dependency:

The Department has determined that this project is a water-dependent use project pursuant to 310 CMR 9.12(2)(a)(9), (11), (14), (15).

Comments:

In the single EIR, the Proponent proposes the removal of Little River Dam along with river restoration and recreational improvements. The proposed work activities consist of:

- The removal of portions of a 35-feet high by 75-foot-long stone masonry dam with a granite block crest;
- Dredging of 10,680 cubic yards of sediments of which 5,500 cubic yards will be disposed off-site and 4,820 cubic yards will be reused within the existing impoundment area;
- Bank stabilization
- Placement of dredged materials below ordinary high water as part of the restoration;
- Placement of scour protection at Winter Street and MBTA railroad bridges
- Construction of fishways and grade control structures;
- Construction of a sloped gravel canoe/kayak launch access, pedestrian bridge, and fishing platform with associated steps;
- Installation of 2,000-linear feet gravel pedestrian trail on the east bank of the river.

Based on the forgoing, the Department affirms its comments on the Expanded Environmental Notification Form that the proposed work requires authorization through a Chapter 91 Waterways License and Dredge Permit pursuant to 310 CMR 9.05(1)(a) and 310 CMR 9.05(2)(b). These activities include but are not limited to dredging and placement of fill for dam removal, bank stabilization, fishways and grade control structures, construction of a boat launch, pedestrian bridge, fishing platform and steps, dredging of aquatic sediments, placement of fill, etc. occurring below the ordinary high-water mark of Little River.

The Department recommends that the Proponent submits one (1) complete application for a Chapter Waterways License and a Dredge Permit for said work, via the EEA ePLACE permitting portal.

If you have any questions regarding the WRP's comments, please contact Ivan Morales at (857) 276-3013 or Ivan.Morales@mass.gov

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Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands

WPA Form 5A – Restoration Order of Conditions

Massachusetts Wetlands Protection Act M.G.L. c. 131, §40

Provided by MassDEP:
33-1551
MassDEP File #

Haverhill
City/Town

A. General Information

Please note: this form has been modified with added space to accommodate the Registry of Deeds Requirements

1. From: Haverhill
Conservation Commission

2. This issuance is for (check one):

a. ☒ Restoration Order of Conditions b. ☐ Amended Restoration Order of Conditions

3. To: Applicant:

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.

James
a. First Name

Fiorentini
b. Last Name

City of Haverhill
c. Organization

Office of the Mayor, City Hall Room 100, 4 Summer Street
d. Mailing Address

Haverhill
e. City/Town

MA
f. State

01830
g. Zip Code

4. Property Owner (if different from applicant) / Parcels Affected by Dam Removal:

Parcel ID: 307-2-9: Shain Realty Trust, c/o Little River Dam Owner, LLC, Attn: Barry Weiner, 3A Curlew Street, Gloucester, MA 01930

Parcel IDs: 307-2-4 and 307-2-10: G & C Concrete Construction, 19 Hale Street, Haverhill, MA 01830

Parcel ID: 601-453-1: MBTA, Attn: Tess Paganelli, 10 Park Plaza, Boston, MA 02116

Parcel IDs: 523-326-1 and 649-611-7: City of Haverhill, 4 Summer Street, Haverhill, MA 01830

Parcel ID: 516-304-1: New Alpha Bro Property, LLC, 93 Lafayette Square, Haverhill, MA 01832

5. Project Location:

Little River, Winter Street to Whittier Place
a. Street Address

Haverhill
b. City/Town

Parcel ID: 523-326-1, Cashman's Field
c. Assessors Map/Plat Number

(Primary Municipal Parcel)
d. Parcel/Lot Number

A. General Information (cont.)

Latitude and Longitude, if known: 42.77764 (d. Latitude (in decimal)) -71.08868 (e. Longitude (in decimal))

Note: If the Ecological Restoration Project involves work on a stream crossing, baseline photo-points that capture longitudinal views of the crossing inlet, the crossing outlet and the upstream and downstream channel beds during low flow conditions. The latitude and longitude coordinates of the photo-points shall be included in the baseline data.

6. Property recorded at the Registry of Deeds for (attach additional information if more than one parcel):
   Southern Essex District (a. County)
   (b. Certificate Number (if registered land))
   38148 (c. Book)
   422 (d. Page)

7. Dates: June 19, 2023 (a. Date Ecological Restoration NOI Filed) August 3, 2023 (b. Date Public Hearing Closed) 10/18/2023 (c. Issuance Date)

8. Final Approved Plans and Other Documents (attach additional plan or document references as needed):
   See Attachment "A", "Special Conditions", incorporated herein and made part of this Order of Conditions.

b. Prepared By
c. Signed and Stamped by
d. Final Revision Date
e. Scale
f. Additional Plan or Document Title
g. Date

B. Findings

1. Findings pursuant to the Massachusetts Wetlands Protection Act:

Following the review of the Ecological Restoration Notice of Intent described in Section A and based on the information provided in this application and presented at the public hearing, this Commission finds that the areas in which work is proposed is significant to the following interests of the Wetlands Protection Act (the Act). Check all that apply:

a. ☐ Public Water Supply
b. ☒ Private Water Supply
c. ☒ Groundwater Supply
d. ☒ Flood Control
e. ☒ Storm Damage Prevention
f. ☒ Prevention of Pollution
g. ☒ Land Containing Shellfish
h. ☒ Fisheries
i. ☒ Wildlife Habitat

B. Findings (cont.)

2. This Commission hereby finds the project, as proposed, is an Ecological Restoration Project for:

☒ Dam Removal

☐ Freshwater Stream Crossing Repair and Replacement

☐ Stream Daylighting

☐ Tidal Restoration

☐ Rare Species Habitat Restoration

☐ Restoring Fish Passageways

Approved subject to:

☒ The following conditions are required in accordance with the Ecological Restoration eligibility criteria 310 CMR 10.13 (1) through (7) and performance standards set forth in the wetlands regulations. This Commission orders that all work shall be performed in accordance with the Ecological Restoration Notice of Intent for the project described in Section A. The General Conditions in Section C and Special Conditions checked in Section D are incorporated into this Restoration Order. To the extent that the following conditions modify or differ from the plans, specifications, or other proposals submitted with the Ecological Restoration Notice of Intent, these conditions shall control.

Denied because:

☐ The proposed work does not meet the eligibility criteria in 310 CMR 10.13(1) through (7). Therefore, work on this project may not go forward unless and until a new Notice of Intent (WPA Form 3 or 3A) is submitted and a Final Order of Conditions (WPA Form 5 or 5A) has been issued. The Commission has determined that following the eligibility criteria have NOT been met.

B. Findings (cont.)

Inland Resource Area Impacts: Check all that apply below. (For Approvals Only)

Resource Area	Proposed Alteration	Permitted Alteration	Proposed Replacement	Permitted Replacement
4. ☒ Bank	5100 a. linear feet	5100 b. linear feet	~8100 c. linear feet	~8100 d. linear feet
5. ☒ Bordering Vegetated Wetland	22,570 a. square feet	22,570 b. square feet	0 c. square feet	0 d. square feet
6. ☒ Land Under Waterbodies and Waterways	415,400 a. square feet	415,400 b. square feet	~162,000 c. square feet	~162,000 d. square feet
	10,360 e. c/y dredged	10,360 f. c/y dredged		
7. ☒ Bordering Land Subject to	10,300 a. square feet	10,300 b. square feet	0 c. square feet	0 d. square feet
Cubic Feet Flood Storage	0 e. cubic feet	0 f. cubic feet	0 g. cubic feet	0 h. cubic feet
8. ☐ Isolated Land Subject to	a. square feet	b. square feet		
Cubic Feet Flood Storage	c. cubic feet	d. cubic feet	e. cubic feet	f. cubic feet
9. ☒ Riverfront Area	83, 730 a. total sq. feet	83, 730 b. total sq. feet		
Sq ft within 100 ft	c. square feet	d. square feet	e. square feet	f. square feet
Sq ft between 100-200 ft	g. square feet	h. square feet	i. square feet	j. square feet

Coastal Resource Area Impacts: Check all that apply below. (For Approvals Only)

	Proposed Alteration	Permitted Alteration	Proposed Replacement	Permitted Replacement
10. ☐ Designated Port Areas	Indicate size under Land Under the Ocean, below			
11. ☐ Land Under the Ocean	a. square feet	b. square feet		
	c. c/y dredged	d. c/y dredged		
12. ☐ Barrier Beaches	**Note:** *No armoring of a Coastal Dune or Barrier Beach is permitted.* Indicate size under Coastal Beaches and/or Coastal Dunes below			
13. ☐ Coastal Beaches	a. square feet	b. square feet	c/y c. nourishment	c/y d. nourishment

B. Findings (cont.)

14. ☐ Coastal Dunes — a. square feet | b. square feet | c. c/y nourishment | d. c/y nourishment

Note: *No armoring of a Coastal Dune or Barrier Beach is permitted.*

15. ☐ Coastal Banks — a. linear feet | b. linear feet

16. ☐ Rocky Intertidal Shores — a. square feet | b. square feet

17. ☐ Salt Marshes — a. square feet | b. square feet | c. square feet | d. square feet

18. ☐ Land Under Salt Ponds — a. square feet | b. square feet | c. c/y dredged | d. c/y dredged

19. ☐ Land Containing Shellfish — a. square feet | b. square feet | c. square feet | d. square feet

20. ☐ Fish Runs — Indicate size under Coastal Banks, Inland Bank, Land Under the Ocean, and/or inland Land Under Waterbodies and Waterways, above — a. c/y dredged | b. c/y dredged

21. ☐ Land Subject to Coastal Storm Flowage — a. square feet | b. square feet

* If the project is for the purpose of restoring or enhancing a wetland resource area in addition to the square footage that has been entered in Section B.5.c (BVW) or B.17.c (Salt Marsh) above, please enter the additional amount here.

22. ☐ Riverfront Area — a. total sq. feet | b. total sq. feet

Sq ft within 100 ft — c. square feet | d. square feet | e. square feet | f. square feet

Sq ft between 100-200 ft — g. square feet | h. square feet | i. square feet | j. square feet

23. ☐ Restoration/Enhancement *:

a. square feet of BVW | b. square feet of salt marsh | c. square feet of other wetland resource areas

24. ☐ Stream Crossing(s):

a. number of new stream crossings | b. number of replacement stream crossings

C. General Conditions Under Massachusetts Wetlands Protection Act

The following conditions are only applicable to Approved projects.

1. Failure to comply with all conditions stated herein, and with all related statutes and other regulatory measures, shall be deemed cause to revoke or modify this Restoration Order of
2. The Restoration Order does not grant any property rights or any exclusive privileges; it does not authorize any injury to private property or invasion of private rights.

3. This Restoration Order does not relieve the permittee or any other person of the necessity of complying with all other applicable federal, state, or local statutes, ordinances, bylaws, or regulations.

4. The work authorized hereunder shall be completed within three years from the date of this Restoration Order unless either of the following apply:
   a. the work is a maintenance dredging project as provided for in the Act; or
   b. the time for completion has been extended to a specified date more than three years, but less than five years, from the date of issuance. If this Restoration Order is intended to be valid for more than three years, the extension date and the special circumstances warranting the extended time period are set forth as a special condition in this Restoration Order.

5. This Restoration Order may be extended by the issuing authority for one or more periods of up to three years each upon application to the issuing authority at least 30 days prior to the expiration date of the Restoration Order.

6. If this Restoration Order constitutes an Amended Restoration Order of Conditions, this Amended Restoration Order of Conditions does not extend the issuance date of the original Final Order of Conditions and the Restoration Order will expire on October 18, 2026, unless extended in writing by the Department.
7. Any fill used in connection with this project shall be clean fill. Any fill shall contain no trash, refuse, rubbish, or debris, including but not limited to lumber, bricks, plaster, wire, lath, paper, cardboard, pipe, tires, ashes, refrigerators, motor vehicles, or parts of any of the foregoing.

8. This Restoration Order is not final until all administrative appeal periods from this Restoration Order have elapsed, or if such an appeal has been taken, until all proceedings before the Department have been completed.

9. No work shall be undertaken until the Restoration Order has become final and then has been recorded in the Registry of Deeds or the Land Court for the district in which the land is located, within the chain of title of the affected property. In the case of recorded land, the Final Restoration Order shall also be noted in the Registry's Grantor Index under the name of the owner of the land upon which the proposed work is to be done. In the case of the registered land, the Final Restoration Order shall also be noted on the Land Court Certificate of Title of the owner of the land upon which the proposed work is done. The recording information shall be submitted to the Conservation Commission on the form at the end of this Restoration Order, which form must be stamped by the Registry of Deeds, prior to the commencement of work.

C. General Conditions Under Massachusetts Wetlands Protection Act **(cont.)**

10. A sign shall be displayed at the site not less than two square feet or more than three square feet in size bearing the words,

    "Massachusetts Department of Environmental Protection" [or, "MassDEP"]

    "File Number 33-1551 "

11. Where the Department of Environmental Protection is requested to issue a Superseding Restoration Order, the Conservation Commission shall be a party to all agency proceedings and hearings before MassDEP.

12. Upon completion of the work described herein, the applicant shall submit a Request for Certificate of Compliance (WPA Form 8A) to the Conservation Commission.

13. The work shall conform to the plans and special conditions referenced in this order.

14. Any change to the plans identified in Condition #13 above shall require the applicant to inquire of the Conservation Commission in writing whether the change is significant enough to require the filing of a new Notice of Intent.

15. The Agent or members of the Conservation Commission and the Department of Environmental Protection shall have the right to enter and inspect the area subject to this Restoration Order at reasonable hours to evaluate compliance with the conditions stated in this Restoration Order, and may require the submittal of any data deemed necessary by the Conservation Commission or Department for that evaluation.

16. This Restoration Order of Conditions shall apply to any successor in interest or successor in control of the property subject to this Restoration Order and to any contractor or other person performing work conditioned by this Restoration Order.

17. Prior to the start of work, and if the project involves work adjacent to a Bordering Vegetated Wetland, the boundary of the wetland in the vicinity of the proposed work area shall be marked by wooden stakes or flagging. Once in place, the wetland boundary markers shall be maintained until a Certificate of Compliance has been issued by the Conservation Commission.

18. All sedimentation barriers shall be maintained in good repair until all disturbed areas have been fully stabilized with vegetation or other means. At no time shall sediments be deposited in a wetland or water body. During construction, the applicant or his/her designee shall inspect the erosion controls on a daily basis and shall remove accumulated sediments as needed. The applicant shall immediately control any erosion problems that occur at the site and shall also immediately notify the Conservation Commission, which reserves the right to require additional erosion and/or damage prevention controls it may deem necessary. Sedimentation barriers shall serve as the limit of work unless another limit of work line has been approved by this Restoration Order.

C. General Conditions Under Massachusetts Wetlands Protection Act (cont.)

General Conditions for all Ecological Restoration Projects

19. The project shall be conducted in accordance with any preliminary written determination obtained from the Natural Heritage and Endangered Species Program as set forth in 310 CMR 10.11(2) and any time of year restrictions or other conditions recommended in writing by the Division of Marine Fisheries (for projects in coastal Resource Areas) and the Division of Fisheries and Wildlife (for projects in inland Resource Areas) as set forth in 310 CMR 10.11(3), (4) and (5).
20. The applicant shall implement the plan submitted with the Notice of Intent as approved by the Issuing Authority to prevent and control invasive species.
21. If the project involves the dredging of 100 cubic yards or more in a Resource Area or dredging of any amount in an Outstanding Resource Water, the dredging and Dredged Material management shall be performed in accordance with the Water Quality Certification submitted with the Notice of Intent.
22. If the project involves infrastructure, the owner shall operate and maintain the infrastructure in accordance with the operation and maintenance plan submitted with the Notice of Intent as approved by the Issuing Authority. Implementation of the operation and maintenance plan as approved by the Issuing Authority shall be a continuing condition that shall be set forth in the Certificate of Compliance.
23. The work associated with this Order (the "Project")
    (1) ☐ is subject to the Massachusetts Stormwater Standards
    (2) ☒ is NOT subject to the Massachusetts Stormwater Standards

    If the work is subject to the Stormwater Standards, then the project is subject to the following conditions:

    a) All work, including site preparation, land disturbance, construction and redevelopment, shall be implemented in accordance with the construction period pollution prevention and erosion and sedimentation control plan and, if applicable, the Stormwater Pollution Prevention Plan required by the National Pollution Discharge Elimination System Construction General Permit as required by Stormwater Condition 8. Construction period erosion, sedimentation and pollution control measures and best management practices (BMPs) shall remain in place until the site is fully stabilized.

    b) No stormwater runoff may be discharged to the post-construction stormwater BMPs unless and until a Registered Professional Engineer provides a Certification that:

    i. all construction period BMPs have been removed or will be removed by a date certain specified in the Certification. For any construction period BMPs intended to be converted to post construction operation for stormwater attenuation, recharge, and/or treatment, the conversion is allowed by the MassDEP Stormwater Handbook BMP specifications and that the BMP has been properly cleaned or prepared for post construction operation, including removal of all construction period sediment trapped in inlet and outlet control structures;

C. General Conditions Under Massachusetts Wetlands Protection Act (cont.)

ii. as-built final construction BMP plans are included, signed and stamped by a Registered Professional Engineer, certifying the site is fully stabilized;
iii. any illicit discharges to the stormwater management system have been removed, as per the requirements of Stormwater Standard 10;
iv. all post-construction stormwater BMPs are installed in accordance with the plans (including all planting plans) approved by the issuing authority, and have been inspected to ensure that they are not damaged and that they are in proper working condition;
v. any vegetation associated with post-construction BMPs is suitably established to withstand erosion.

c) The landowner is responsible for BMP maintenance until the issuing authority is notified that another party has legally assumed responsibility for BMP maintenance. Prior to requesting a Certificate of Compliance, or Partial Certificate of Compliance, the responsible party (defined in General Condition 18(e)) shall execute and submit to the issuing authority an Operation and Maintenance Compliance Statement ("O&M Statement) for the Stormwater BMPs identifying the party responsible for implementing the stormwater BMP Operation and Maintenance Plan ("O&M Plan") and certifying the following:

i.) the O&M Plan is complete and will be implemented upon receipt of the Certificate of Compliance, and

ii.) the future responsible parties shall be notified in writing of their ongoing legal responsibility to operate and maintain the stormwater management BMPs and implement the Stormwater Pollution Prevention Plan.

d) Post-construction pollution prevention and source control shall be implemented in accordance with the long-term pollution prevention plan section of the approved Stormwater Report and, if applicable, the Stormwater Pollution Prevention Plan required by the National Pollution Discharge Elimination System Multi-Sector General Permit.

e) Unless and until another party accepts responsibility, the landowner, or owner of any drainage easement, assumes responsibility for maintaining each BMP. To overcome this presumption, the landowner of the property must submit to the issuing authority a legally binding agreement of record, acceptable to the issuing authority, evidencing that another entity has accepted responsibility for maintaining the BMP, and that the proposed responsible party shall be treated as a permittee for purposes of implementing the requirements of Conditions 18(f) through 18(k) with respect to that BMP. Any failure of the proposed responsible party to implement the requirements of Conditions 18(f) through 18(k) with respect to that BMP shall be a violation of the Restoration Order of Conditions or Certificate of Compliance. In the case of stormwater BMPs that are serving more than one lot, the legally binding agreement shall also identify the lots that will be serviced by the stormwater BMPs. A plan and easement deed that grants the responsible party access to perform the required operation and maintenance must be submitted along with the legally binding agreement.

C. General Conditions Under Massachusetts Wetlands Protection Act (cont.)

f) The responsible party shall operate and maintain all stormwater BMPs in accordance with the design plans, the O&M Plan, and the requirements of the Massachusetts Stormwater Handbook.

g) The responsible party shall:

1. Maintain an operation and maintenance log for the last three (3) consecutive calendar years of inspections, repairs, maintenance and/or replacement of the stormwater management system or any part thereof, and disposal (for disposal the log shall indicate the type of material and the disposal location);
2. Make the maintenance log available to MassDEP and the Conservation Commission ("Commission") upon request; and
3. Allow members and agents of the MassDEP and the Commission to enter and inspect the site to evaluate and ensure that the responsible party is in compliance with the requirements for each BMP established in the O&M Plan approved by the issuing authority.

h) All sediment or other contaminants removed from stormwater BMPs shall be disposed of in accordance with all applicable federal, state, and local laws and regulations.

i) Illicit discharges to the stormwater management system as defined in 310 CMR 10.04 are prohibited.

j) The stormwater management system approved in the Restoration Order of Conditions shall not be changed without the prior written approval of the issuing authority.

k) Areas designated as qualifying pervious areas for the purpose of the Low Impact Site Design Credit (as defined in the MassDEP Stormwater Handbook, Volume 3, Chapter 1, Low Impact Development Site Design Credits) shall not be altered without the prior written approval of the issuing authority.

l) Access for maintenance, repair, and/or replacement of BMPs shall not be withheld. Any fencing constructed around stormwater BMPs shall include access gates and shall be at least six inches above grade to allow for wildlife passage.

D. Special Conditions for Ecological Restoration Projects

☒ **Dam Removal**

This project involves dam removal and the following special conditions shall apply in addition to the general conditions set forth in 310 CMR 10.14(1):

a) An as-built plan and a written statement from a registered professional engineer or other environmental professional expert in ecological restoration certifying substantial compliance with the design plan and construction specifications approved in the Restoration Order of Conditions shall be submitted to the Issuing Authority within 90 days of completion of the dam removal.

b) The applicant shall monitor the dam removal site during the first two years following completion of the dam removal. Said monitoring shall include a topographic survey of the longitudinal profile and stream cross-sections from downstream of the former dam through the upstream end of the former impoundment. The survey reference point shall comprise a permanent marker or recoverable survey point with known coordinates, such as a fixed point shown on the as-built plan, an existing bench mark, or a new benchmark. That marker should be identified or referenced on the plans and on the as-built plans. The applicant shall establish at least two photo-points for pre- and post-restoration monitoring at the dam removal site. At least one photo-point location shall be chosen to document a view of the dam pre-restoration and to document the same site after the dam is removed. A second location shall be chosen to document a view of the impoundment pre- and post-restoration. Photos shall be taken for two years after the dam removal is completed.

c) The applicant shall submit a report detailing the results of this monitoring within six months of the completion of the two year post-construction monitoring period, or within 30 months after the dam removal is complete whichever is sooner. The report shall include a comparison of post-restoration survey data with pre-restoration survey data as illustrated by the photos taken during the monitoring period.

☐ **Freshwater Stream Crossing Repair and Replacement Projects**

The project involves one or more freshwater crossing repair or replacement and the following special conditions in addition to the general conditions apply:

a) An as-built plan and/or a written statement from a registered professional engineer or other environmental professional expert in ecological restoration certifying substantial compliance with the design plans and construction specifications approved in the Restoration Order of Conditions shall be completed within 90 days of completion of construction. The as-built plan shall include the dimensions of the structure, the invert elevation of the upstream and downstream ends of the structure and the road or other surface elevation above the structure.

D. Special Conditions for Ecological Restoration Projects (cont.)

b) The applicant shall monitor the site by collecting sufficient data within 12 months after construction is complete to evaluate the effect of the structure. At a minimum, when a Certificate of Compliance is requested, the applicant shall provide post-construction photo-points that capture longitudinal views of the crossing inlet, the crossing outlet and the upstream and downstream channel beds during low flow conditions. The photo-points shall be located at the same geographic photo-point latitude and longitude coordinates as required in the Notice of Intent per 310 CMR 10.12(1)(n). The applicant shall submit a report to the Issuing Authority detailing the results of this monitoring within 18 months after construction is complete. The report shall include a comparison of the post-restoration data with pre-restoration data.

☐ **Stream Daylighting**

The project involves stream daylighting and the following special conditions in addition to the general conditions apply:

a) An as-built plan and a written statement from a registered professional engineer or other environmental professional expert in ecological restoration certifying substantial compliance with the design plan and construction specifications approved in the Restoration Order of Conditions shall be submitted to the Issuing Authority within 90 days of completion of the project. At a minimum, when a Certificate of Compliance is requested, the applicant shall provide post-construction photo-points that capture longitudinal views of the upstream and downstream channel beds of the daylighted reach during low flow conditions.

b) The applicant shall conduct photo-point monitoring by establishing at least three photo-points for pre- and post-restoration monitoring at the stream daylighting site. One photo-point location shall be chosen to document the upstream end of the site and one photo-point location shall be chosen to document the downstream end of the site. A third photo-point shall be chosen to document conditions in the restored channel. Photos shall be taken during high flow and low (summer) flow of each year during the two years following completion of the project.

c) Within 30 months after the completion of the project, the applicant shall submit a report describing the ecological changes observed at the project site during the two years following completion of the project, as illustrated by the photos.

D. Special Conditions for Ecological Restoration Projects (cont.)

☐ **Tidal Restoration Projects**

The project involves restoration of tidal influence and the following special conditions in addition to the general conditions apply:

a) If the project is a culvert or bridge replacement or repair project, an as-built plan and a written statement from a registered professional engineer or other environmental professional expert in ecological restoration certifying substantial compliance with the design plans and construction specifications approved in the Restoration Order of Conditions shall be submitted to the Issuing Authority within 90 days of completion of construction. The as-built plan shall include the dimensions of the structure, the invert elevation of the upstream and downstream ends of the structure and the road or other surface elevation above the structure.

b) The applicant shall monitor pre- and post-construction tidal conditions upstream and downstream of the tidal restriction with water level readings measured at an interval no greater than every 10 minutes over a minimum of a one-week period that includes a spring tide. Pre- and post-construction water level readings shall be taken at approximately the same locations and shall be referenced to the same vertical elevation datum. The applicant shall prepare a report detailing the results of this monitoring within 12 months after construction is complete. The report shall include and compare pre- and post-construction tidal elevation monitoring data to assess attainment of the project's predicted post-restoration tidal conditions.

☐ **Rare Species Habitat Restoration**

The project is a Rare Species Habitat Restoration Project and in addition to the general conditions the following special conditions apply:

a) An as-built plan and a written statement from a registered professional engineer or other environmental professional expert in ecological restoration certifying substantial compliance with the design plan, construction specifications, and the Habitat Management Plan submitted with the Notice of Intent as approved in the Restoration Order of Conditions shall be submitted to the Issuing Authority within 90 days of completion of the project.

b) The applicant shall establish at least two photo-points for pre- and post-restoration monitoring at the project site. Photos shall be taken for two years after construction is complete. Within 30 months of completion of the project, the applicant shall submit to the Issuing Authority a report describing the ecological changes observed at the project site as illustrated by the photos.

D. Special Conditions for Ecological Restoration Projects (cont.)

☐ **Fish Passageway Restoration**

The project involves the repair or replacement of a fish passageway and in addition to the general conditions the following special conditions:

a) The property owner is responsible for maintaining and repairing the fishway in good condition so that it will support safe and efficient fish passage in accordance with an operation and maintenance plan approved by the Division of Marine Fisheries. This requirement is a continuing condition that shall be set forth in the Certificate of Compliance.

b) a post-construction project summary using surveys, a narrative and photographs as needed, that confirm the fishway slope and entrance and exit elevations shall be submitted to and approved by the Division of Marine Fisheries, prior to submittal of a request for a Certificate of Compliance.

E. Findings Under Municipal Wetlands Bylaw or Ordinance

1. Is a municipal wetlands bylaw or ordinance applicable? ☒ Yes ☐ No

2. The Haverhill Conservation Commission hereby finds (check one that applies):

   a. ☐ that the proposed work cannot be conditioned to meet the standards set forth in a municipal ordinance or bylaw, specifically:

   _____ (1. Municipal Ordinance or Bylaw) _____ (2. Citation)

   Therefore, work on this project may not go forward unless and until a revised Notice of Intent is submitted which provides measures which are adequate to meet these standards, and a final Order of Conditions is issued.

   b. ☒ that the following additional conditions are necessary to comply with a municipal ordinance or bylaw:

   An Ordinance to Protect the Wetlands, Related Water Resources and Adjoining Land Areas (1. Municipal Ordinance or Bylaw) Chapter 253 (2. Citation)

3. The Commission orders that all work shall be performed in accordance with the following conditions and with the Notice of Intent referenced above. To the extent that the following conditions modify or differ from the plans, specifications, or other proposals submitted with the Notice of Intent, the conditions shall control.

   The special conditions relating to municipal ordinance or bylaw are as follows (if you need more space for additional conditions, attach a text document):
   See Attachment "A", "Special Conditions", incorporated herein and made part of this Order of Conditions.

F. Signatures

This Restoration Order is valid for three years, unless otherwise specified as a special condition pursuant to General Conditions #4, from the date of issuance.

October 18, 2023
1. Date of Issuance

Please indicate the number of members who will sign this form.
This Restoration Order must be signed by a majority of the Conservation Commission.

four
2. Number of Signers

The Restoration Order must be mailed by certified mail (return receipt requested) or hand delivered to the applicant. A copy also must be mailed or hand delivered at the same time to the appropriate Department of Environmental Protection Regional Office and the property owner, if different from applicant.

Pursuant to the vote taken by the Conservation Commission on May 7, 2020, the following signatures are made in accordance with M.G.L. c.110G and pursuant to said Commission's electronic signature authorization vote recorded on May 21, 2020, with the Southern Essex District Registry of Deeds in Book 38538, Page 455.

Signatures:

/Frederick Clark/	Frederick Clark
/Thomas Wylie/	Thomas Wylie
/Phillip LaCroix/	Phillip LaCroix
/Harmony Wilson/	Harmony Wilson

☒ by hand delivery on
October 18, 2023
Date

☐ by certified mail, return receipt requested, on
Date

G. Appeals

The applicant, the owner, any person aggrieved by this Restoration Order, any owner of land abutting the land subject to this Restoration Order, or any ten residents of the city or town in which such land is located, are hereby notified of their right to request the appropriate MassDEP Regional Office to issue a Superseding Restoration Order of Conditions. The request must be made by certified mail or hand delivery to the Department, with the appropriate filing fee and a completed Request for Departmental Action Fee Transmittal Form, as provided in 310 CMR 10.03(7) within ten business days from the date of issuance of this Restoration Order. A copy of the request shall at the same time be sent by certified mail or hand delivery to the Conservation Commission and to the applicant, if he/she is not the appellant.

Any appellants seeking to appeal the Department's Superseding Restoration Order of Conditions associated with this appeal will be required to demonstrate prior participation in the review of this project. Previous participation in the permit proceeding means the submission of written information to the Conservation Commission prior to the close of the public hearing, requesting a Superseding Restoration Order, or providing written information to the Department prior to issuance of a Superseding Restoration Order.

The request shall state clearly and concisely how the project permitted under the Restoration Order which is being appealed does or does not meet the eligibility criteria in 310 CMR 10.13(1) and the relevant provisions of 310 CMR 10.13(2) through (7). To the extent that the Restoration Order is based on a municipal ordinance or bylaw, and not on the Massachusetts Wetlands Protection Act or regulations, the Department has no appellate jurisdiction.

H. Recording Information

Prior to commencement of work, this Restoration Order of Conditions must be recorded in the Registry of Deeds or the Land Court for the district in which the land is located, within the chain of title of the affected property. In the case of recorded land, the Final Restoration Order shall also be noted in the Registry's Grantor Index under the name of the owner of the land subject to the Restoration Order. In the case of registered land, this Restoration Order shall also be noted on the Land Court Certificate of Title of the owner of the land subject to the Restoration Order of Conditions. The recording information on this page shall be submitted to the Conservation Commission listed below.

Haverhill
Conservation Commission

Detach on dotted line, have stamped by the Registry of Deeds and submit to the Conservation Commission.

To:

Haverhill
Conservation Commission

Please be advised that the Restoration Order of Conditions for the Project at:

Little River, Winter Street to Whittier Place
Parcel ID: 523-326-1

33-1551
MassDEP File Number

Has been recorded at the Registry of Deeds of:

Southern Essex District
County

Book

Page

For City of Haverhill
Property Owner

and has been noted in the chain of title of the affected property in:

Book

Page

In accordance with the Restoration Order of Conditions issued on:

Date

If recorded land, the instrument number identifying this transaction is:

Instrument Number

If registered land, the document number identifying this transaction is:

Document Number

Signature of Applicant

Haverhill

Conservation Department
Phone: 978-374-2334 Fax: 978-374-2366
rmoore@cityofhaverhill.com
conservation@cityofhaverhill.com

ATTACHMENT A: SPECIAL CONDITIONS

MassDEP FILE #33-1551

ISSUING AUTHORITY: Haverhill Conservation Commission ("HCC")

APPLICANT: City of Haverhill

PROJECT LOCATION: Little River, Winter Street to Whittier Place – Parcel ID: 523-326-1

PROJECT DESCRIPTION
The proposed project consists of the removal of Little River Dam, and associated restoration. This dam removal and restoration project includes the following elements: dredging sediment for targeted sediment cleanup; installation of fish passage structures; construction of low flow channel downstream of Winter Street Bridge; installation of bioengineered slope stabilization and scour protection; and installation of native plantings. The project is designed in accordance with the ecological restoration project requirements under 310 CMR 10.12 and 10.13.

RESOURCE AREA FINDINGS
The Haverhill Conservation Commission finds this site to contain, at a minimum, the following resource areas: land under water, bank, riverfront area, bordering vegetated wetlands, and bordering land subject to flooding, all associated with the Little River, along with associated buffer zones.

EXPIRATION DATE
Unless extended, this Order of Conditions ("OOC") will expire October 18, 2026.

PLANS AND DOCUMENTS
Work on this project site shall be performed according to the following listed plans and documents on file with the HCC. Should any conflicts be found to exist between these plans and documents and the conditions of this OOC, the HCC shall be contacted for clarification.

a) "Little River Dam Removal and River Restoration – Preliminary Design Development Plans", site plan prepared by Fuss & O'Neill (1550 Main Street, Suite 400, Springfield, MA 01103), plan set dated June 30, 2022; and
b) "Little River Dam Removal and River Restoration Notice of Intent" (including Appendix D, "Invasive Species Control Plan" and Section 6, "Maintenance and Operation Plan"), document prepared by Fuss & O'Neill, dated June 12, 2023.

Pursuant to the Massachusetts Wetlands Protection Act (M.G.L. Chapter 131, Section 40), its Regulations (310 CMR 10.00), and Haverhill City Code Chapter 253 ("An Ordinance to Protect the Wetlands, Related Water Resources and Adjoining Land Areas"), the Commission orders that all work shall be performed in accordance with the following additional, special conditions:

GENERAL CONSTRUCTION

21. The HCC may designate one or more Conservation Department Officials as its agent ("HCC Official"), with full powers to act on its behalf in administering and enforcing this OOC.

22. Work on this project shall be performed in accordance with Haverhill Municipal Ordinances Chapter 253 – "An Ordinance to Protect the Wetlands, Related Water Resources, and Adjoining Land Areas".

23. In accordance with Haverhill Municipal Ordinance Chapter 253, there shall be no activities allowed within 25' of the delineated wetland resource areas and no building construction within 50' of these same areas, except as shown on the approved plans referenced above.

24. All wetland resource areas shall be visibly flagged and/or staked every 25 feet along the resource area boundaries to assure that no intrusion into these areas occurs. Flagging and staking used to identify wetland resource areas shall be of a color different from any others used on the site and shall be maintained until the work is complete.

25. The rows of erosion control devices, as shown on the site plan, shall also act as a limit of site activity.

26. The MassDEP File Number sign shall not be attached to a live tree.

27. Any changes proposed under this OOC might require the Applicant to file a "Request for a Modification to the Order of Conditions" with the HCC.

28. While all activities regulated by this Order are being performed and during the construction phase of this project, an on-site foreman, directing engineer, or designated construction manager, shall have a copy of this permit and its associated plans and documents at the site, familiarize him or herself with the conditions of this permit, and adhere to such conditions. This OOC shall be made part of all construction-related documents for this project. All contractors working at the site shall be made aware of the provisions contained within this OOC and adhere to them.

29. The Applicant shall secure an Environmental Monitor ("EM") for this project. The EM shall be, at a minimum, a professional with experience in Resource Area Protection; Erosion, Sedimentation, and Pollution Prevention; and Stormwater Management. The EM shall have, at a minimum, a working knowledge of botany, hydrology, and general construction practices. The Applicant may designate the EM as responsible for fulfilling the requirements of the Pollution Prevention and Erosion and Sedimentation Control ("PPESC") Monitor under this OOC. Otherwise, the EM shall establish an appropriate working relationship with the PPESC Monitor to ensure the project's complete compliance with this OOC. The Applicant shall give the EM authority to stop construction for PPESC purposes.
    a) On the Monday of every week throughout the life of this project, the EM shall provide the HCC with a status report of the project. This report shall indicate the functions of the PPESC devices and any need for maintenance, replacement, augmentation, emergency placement, and any other corrective action of

PPESC devices; the activities completed the previous week; and the activities planned for the current week. The report shall also mention any deviations from the previous week's report and any environmental mitigation measures that have been undertaken. The report shall include representative photographs of deviations, needed repairs, and on-going work. The frequency of this reporting may be altered as site conditions warrant, upon concurrence between the HCC and the EM.

b) In addition to this reporting, the EM shall be responsible for all inspections and reporting as outlined in this OOC and the referenced plans and documents pertaining to Resource Area Activities; Erosion, Sedimentation, and Pollution Prevention; and Stormwater Management. The EM shall be on site as necessary to ensure proper implementation of the conditions of this OOC and the work outlined in the referenced plans and documents.

CONSTRUCTION SEQUENCING

30. Prior to the commencement of work, the Applicant shall provide the HCC with electronic copies of all other applicable federal, state, and local permits for this project.

31. The Applicant shall adhere to the Time of Year restriction recommended by the MA Division of Marine Fisheries for this project. No in-water work shall occur during March 1 to June 30 of each project year for the purpose of minimizing impacts to diadromous fish resources in the adjacent Merrimack River from sedimentation and turbidity. In-water work shall be sequenced to occur during periods of low flow stream conditions in Little River (i.e., July 1 to October 31). To minimize sedimentation and turbidity in downstream areas, the Applicant shall deploy such measures as downstream turbidity curtains and temporary coffer dams. The Applicant shall obtain the Fishway Construction Permit from DMF that is required for this project.

32. A minimum of two (2) business days in advance, the Applicant shall provide the HCC with written notification of the commencement of work on site. At this time, the Applicant shall also supply the HCC with a list of names, addresses, and emergency phone numbers (including evenings and weekends) for those parties responsible for compliance with this OOC on the site, including the Environmental Monitor and the Pollution Prevention and Erosion and Sedimentation Control Monitor.

33. Prior to the commencement of work on this site, the Applicant shall schedule a pre-construction meeting with the site contractor, the Applicant's engineers/consultants, the EM, the PPESC Monitor, and the HCC. The purpose of the meeting is to review this OOC and resolve any outstanding issues at that time.

34. The Applicant shall make every effort to ensure that no invasive plant species, as defined and listed by the Massachusetts Invasive Plant Advisory Group, are introduced to, or moved around the site by construction activities, including importation of infected materials such as borrow, compost, nursery stock, seed, or hay bales. Corrective measures, if necessary, shall be made by the Applicant as directed by the EM. Corrective measures shall be implemented for as long as necessary to eliminate the introduced invasive plant species and prevent re-establishment of same. The Applicant shall satisfactorily dispose of all cleared, invasive plant material (seeds, roots, woody vegetation, associated soils, etc.). The Applicant shall take measures to prevent viable, invasive plant materials from leading to further infestations while stockpiled, in transit, or at final disposal locations. All precautions shall be taken to avoid contamination of natural landscapes with invasive plants or invasive plant material.

Prior to the commencement of work on site, the EM shall survey this site for the presence of invasive plant species within the approved limits of work. If found, the EM shall provide the HCC with an updated, as necessary, written Invasive Species Control Plan ("ISCP") proposal and schedule of control. The ISCP is critical for identifying pre-construction conditions, as well as strategies for minimizing import or spread of invasive plants. All materials and methods proposed shall be consistent with the conditions of this OOC. The ISCP shall include, but not be limited to, the following:

a) Description of treatment areas, including identification of targeted invasive plant species, locations, approximate size of areas, and digital photos with time/date stamp.
b) Delineation of treatment areas with polygons outlining their perimeter or locations of individual plants. A free-hand sketch drawn on construction plans, or an aerial photo can be used to show locations.
c) Proposed methods of treatment for each species or area, such as manual removal, cutting, or herbicides.
   i. If herbicides are proposed, the IPMS shall include the product label, including application methods and rates for each. MSDS information shall also be provided for each herbicide.
d) Proposed time of treatment based on target plan species and construction schedule.
e) Method for disposing of invasive plant materials.
f) General monitoring schedule.
g) Preliminary re-treatment schedule. Re-treatment shall be based on assessment of initial results and time of year.
h) Proposed performance metrics, or measure of treatment success, which shall be agreed upon with HCC.

Control of invasive plant species shall begin immediately with the initiation of construction and continue for a minimum of five (5) years, after which time a Complete Certificate of Compliance may be pursued for this project. The EM shall report on the success of the ISCP in the work area in the weekly, seasonal, and final EM reports required under this OOC. If necessary, the corrective measures shall be outlined in the reporting in a manner consistent with the ISCP requirements.

35. Immediately upon completion of this project, the Applicant shall provide the HCC with an as-built drawing showing, at a minimum, the following information as it pertains to the subject property. This plan shall be stamped by a MA-registered Professional Engineer. This plan shall be subject to the review and approval of the HCC.
    a) Wetland resource areas subject to protection under this OOC and their approved delineations;
    b) Limits of all Buffer Zones, including No-Disturbance and No-Build Zones;
    c) Planted trees and shrubs;
    d) Structures, including fishways, new walls, and drainage features;
    e) Existing limits of lawn/landscaped, pavement, … areas;
    f) Date(s) of survey fieldwork; and
    g) A statement by the Professional Engineer certifying compliance with the approved plans and conditions of this OOC and setting forth deviations from same, if any exist.

CONSTRUCTION PERIOD EROSION, SEDIMENTATION, AND POLLUTION PREVENTION

36. The Applicant, site contractor, and their assigns shall implement Construction Period Pollution Prevention and Erosion and Sedimentation Control measures from the commencement of work until the site is fully and permanently stabilized and the temporary erosion and sedimentation controls are removed, upon HCC approval.

37. All vegetation cutting associated with the construction of this project shall be subject to the prior review and approval of the HCC. Prior to the commencement of work, the Applicant's surveyor shall stake out, flag, or mark by other appropriate means, the locations of the approved limits of cutting and the locations of the proposed PPESC devices for inspection by the site contractor, EM, PPESC Monitor, and the HCC. The commencement of vegetation cutting work shall be contingent upon the approval of the HCC at that time.

38. Prior to the commencement of work, the Applicant shall install the initial PPESC devices. The Applicant shall schedule an inspection of the installed devices by the site contractor, EM, PPESC Monitor, and the HCC. Should any of these devices be considered insufficient, the PPESC Monitor shall immediately propose augmentation or other corrective measures to address areas of concern. The continuation of on-site work shall be contingent upon HCC approval of the devices at that time.

39. The Applicant shall designate a PPESC Monitor for the site. This Monitor shall be a professional with experience in PPESC practices. This Monitor shall inspect PPESC devices daily for proper function and maintenance, including the proper disposal of waste products. This Monitor shall immediately arrange for the maintenance, replacement, augmentation, emergency placement, and any other corrective action of PPESC devices on site. Areas of construction shall remain in a stable condition at the end of each day. The Applicant shall give this Monitor authority to stop construction for PPESC purposes.

40. An adequate stockpile of PPESC materials shall be always on site for emergency or routine replacement and shall include materials to repair silt fences, straw bales, stone riprap, filter dikes or any other devices planned for use during construction.

41. PPESC devices may be modified based on experience at the site. Approval of the HCC must be obtained prior to any non-emergency modification of the approved PPESC measures.

42. The HCC reserves the right to impose additional conditions on portions of this project to mitigate any impacts which could result from site erosion or any noticeable degradation of surface water quality discharging from the site.

43. The locations of long term (greater than 30 days) stockpiles and the locations and construction methods of temporary construction entrances, if not addressed in the Construction Period PPESC Plan, shall receive the prior approval of the PPESC monitor and the HCC.

44. During all phases of construction, all disturbed or exposed soil surfaces shall be brought to final finished grade and either a) covered with loam and seeded in accordance with the Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas (or equivalent document) for permanent stabilization or b) stabilized in another way approved by the HCC. Bare ground that cannot be permanently stabilized within 30 days shall be stabilized with mulch or any other protective covering and/or method approved by the USDA Soil Conservation Service.

45. Upon completion of the project all disturbed areas shall be permanently stabilized with rapidly growing vegetative cover with sufficient topsoil to assure long term stabilization of disturbed areas. After seeding, disturbed areas shall be covered with straw mulch, netting, or other protective covering to provide a suitable surface cover until seed germination.

46. All dewatering activities shall be controlled by implementing Best Management Practices. Dewatered fluids shall be prevented from flowing directly into resource areas. Discharge structures, such as temporary sediment basins or other Best Management Practices shall be configured to maximize sediment removal. If discharge towards resource areas cannot be avoided, it shall be via a maximized distance of overland upland sheet flow unless the HCC approves an alternative in advance. The PPESC Monitor shall review and approve all dewatering methods prior to implementation.

47. Soils, stumps, slash, timber, construction materials, debris, or other waste products shall not be deposited, stored, or otherwise accumulated within 100' of a wetland resource area or within land subject to flooding, unless approved in advance by the HCC.

48. Covered dumpsters shall be maintained on site for appropriate materials. The Applicant shall conduct routine litter pick-ups throughout construction to prevent trash and loose, synthetic debris from entering the resource areas and buffer zones.

49. All pumps, drilling machines, and their surrounding areas, whether used for dewatering or other purposes, shall be properly contained to limit the potential for environmental impacts due to fuel leakage, pump leakage, or other failures.

50. Refueling of equipment shall not be done within 100' of a wetland resource area. Fuel, oil, or other potential pollutants shall not be stored within 100' of a wetland resource area.

51. Equipment and vehicles staged overnight shall be stored on an impervious containment surface to prevent drippings and spills from leaching into the soil. The PPESC Monitor shall inspect this surface daily and take prompt action to address all pollution prevention concerns in accordance with this Order.

52. Any spills of hazardous materials, including but not limited to diesel fuel and hydraulic oil, shall be appropriately and promptly cleaned up. The Applicant shall notify Federal, Commonwealth, and/or Local agencies of such spills as may be applicable by law. The Applicant or PPESC Monitor shall notify the HCC, within one hour, of any spills within wetland resource areas or buffer zones. Onsite emergency spill kits shall always be available.

53. The Applicant shall ensure a hazardous materials spill containment kit is always maintained on site throughout construction. The kit shall be appropriately sized for the cumulative volumetric capacity of hazardous fluids contained by equipment on site at any one time.

RESOURCE AREA ACTIVITIES

54. All work proposed within the wetland resource areas and 100'-Buffer Zone shall be performed according to the plans and documents submitted as part of the Notice of Intent filing, unless specified otherwise in this Order. These areas shall meet or exceed the General Performance Standards outlined in 310 CMR 10.00 and Haverhill Municipal Ordinances Chapter 253. Should these areas fail to meet any of these standards, the HCC reserves the right to require those measures necessary to achieve compliance.

55. The Applicant shall ensure the EM is on site sufficiently throughout construction and restoration to provide supervision and inspect resource area activities for compliance with this Order.

56. The site contractor shall not disturb any area of protected or regulated Federal, State, and/or Local wetland resource area or buffer zone except for that which has been permitted by this Order.

57. The site contractor shall restore all temporarily disturbed resource areas and buffer zones to the satisfaction of the HCC and the EM. The EM shall ensure that 75 percent of the surface area of all temporarily disturbed and restoration areas is reestablished with indigenous plant species within two growing seasons of their planting or replanting. If at the end of one growing season it is evident, in the opinion of the EM or the HCC, that a disturbed area is not likely to be successfully reestablished within this time frame, the EM shall submit to the HCC a corrective plan of action detailing supplements to the planting, soils, and/or grading, as necessary, to achieve the required coverage. This plan shall be implemented upon HCC approval.

58. The contractor shall follow the directions of the EM, whether given prior to, or during, construction of any restoration area(s). If feasible, the contractor shall propose alternative mitigation and environmental protection techniques that provide cost or time savings, improved environmental protection, or enhanced mitigation, provided (1) they provide equivalent or greater wetland protection and mitigation than afforded by the methods contained in this Order and NOI and provided by the EM; (2) they receive prior approval by the HCC and the EM; and (3) they meet the Performance Standards of the MA Wetland Protection Regulations (310 CMR 10.00) and the requirements of Haverhill Municipal Ordinance Chapter 253.

59. The Applicant shall sequence all in-water work to occur during periods of low flow stream conditions. Turbidity barriers shall be deployed to reduce the potential for downstream sedimentation impacts.

60. Excavation equipment brought onto the site shall be cleaned at an off-site location prior to commencement of site work to remove any soil which may contain noxious plant remains.

61. The Applicant is to contact the HCC immediately upon completion of the restoration work; an appointment for inspection by an HCC Official shall be arranged with the EM.

62. Immediately following the completion of work, the Applicant shall submit a status report, written by the EM, describing to the HCC the status of the resource areas and their immediate surroundings. This report shall be accompanied by the as-built drawing required under Condition #37.

63. The EM, prior to and following each growing season for a minimum of five (5) years and until a Certificate of Compliance is issued, shall submit monitoring reports to the HCC. Monitoring reports shall describe, using narratives, plans, and color photographs, the physical characteristics of the areas within the limits of work with respect to soils, hydrology, habitat value, stability, survivorship of vegetation and plant mortality, aerial extent and distribution, species diversity and vertical stratification (i.e., the herb, shrub, and tree layers), the presence of invasive plant species, etc. These monitoring reports shall be submitted by May 31 and September 30 of each year. Applicable General Performance standards as outlined in 310 CMR are to be met within two years of completion. A Certificate of Compliance is to be issued ONLY AFTER the General Performance Standards and reporting requirements have been met.

64. A color photographic log of the site shall be kept with associated text by the EM. This log shall show pre-restoration through post-restoration views of the areas within the limits of work, undisturbed adjacent resource areas and buffer zones, and erosion/sedimentation control devices. A current log shall be

submitted with the status and monitoring reports required above and with the Request for a Certificate of Compliance.

WILDLIFE HABITAT PROTECTION

65. The Applicant shall abide by the March 1 to June 30 Time of Year restriction recommended by the MA Division of Marine Fisheries for this project.

OTHER CONDITIONS

66. If any unforeseen problem occurs during construction, which affects any of the eight statutory interests of the Wetlands Protection Act, M.G.L. Chapter 131, Section 40, upon discovery, the Applicant shall notify the HCC and an immediate meeting shall be held between the Commission, the Applicant, the engineer, contractor, and other concerned parties to determine the corrective measures to be employed. The Applicant shall then act to correct the problems using the corrective measures agreed upon.

67. Upon completion of the project, the Applicant shall request a Certificate of Compliance from the Commission and shall submit the following information with the request in both paper form and in an electronic form found acceptable to an HCC Official:
    a) A written statement by a professional engineer registered in the Commonwealth of Massachusetts certifying compliance with the approved plans referenced above and this OOC and setting forth deviations, if any exist.
    b) A final monitoring report and current photo log prepared by the EM.
    c) Two sets of as-built drawings prepared by the professional engineer showing resource areas, plantings, and detailed landscaping (i.e., all wetland resource areas, limits of work, etc.). These plans shall include the date(s) of fieldwork and shall be prepared in accordance with the "Plot Plan Standards" of the HCC Policy - P2000-02 "Occupancy Permit Checklist Endorsement".

ONGOING CONDITIONS

Certain conditions are ongoing and do not expire upon the completion of the project or the issuance of a Certificate of Compliance. These conditions shall remain in effect after the issuance of a Certificate of Compliance for the project and shall be referenced in the chain of title for the property. These conditions are:

68. The HCC reserves the right to enforce all restrictions and/or requirements established for this property within this OOC under the enforcement powers of the City's wetlands protection ordinance, Municipal Ordinance Chapter 253.

69. The HCC reserves the right to schedule an annual inspection with the Applicant and/or Property Owner(s) (as may be determined through a post-dam-removal land ownership finding) as part of a long-term management program to inspect the site for permanent stability and proper maintenance. The Applicant/Property Owner shall maintain the restored channel, fishway structures, and stone walls as outlined in the "Maintenance and Operation Plan" included under Section 6 of the Notice of Intent project narrative. The Applicant/Property Owner shall schedule a site meeting with an HCC Official prior to conducting any maintenance activities that exceed a "by hand" level of labor.

--- END ---

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands

Request for Departmental Action Fee Transmittal Form

Massachusetts Wetlands Protection Act M.G.L. c. 131, §40

DEP File Number:

Provided by DEP

A. Request Information

1. Location of Project

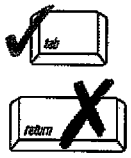
a. Street Address

b. City/Town, Zip

c. Check number

d. Fee amount

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.



2. Person or party making request (if appropriate, name the citizen group's representative):

Name

Mailing Address

City/Town

State

Zip Code

Phone Number

Fax Number (if applicable)

3. Applicant (as shown on Determination of Applicability (Form 2), Order of Resource Area Delineation (Form 4B), Order of Conditions (Form 5), Restoration Order of Conditions (Form 5A), or Notice of Non-Significance (Form 6)):

Name

Mailing Address

City/Town

State

Zip Code

Phone Number

Fax Number (if applicable)

4. DEP File Number:

B. Instructions

1. When the Departmental action request is for (check one):

☐ Superseding Order of Conditions – Fee: $120.00 (single family house projects) or $245 (all other projects)

☐ Superseding Determination of Applicability – Fee: $120

☐ Superseding Order of Resource Area Delineation – Fee: $120

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands

Request for Departmental Action Fee Transmittal Form

Massachusetts Wetlands Protection Act M.G.L. c. 131, §40

DEP File Number:

Provided by DEP

B. Instructions (cont.)

Send this form and check or money order, payable to the *Commonwealth of Massachusetts,* to:

Department of Environmental Protection
Box 4062
Boston, MA 02211

2. On a separate sheet attached to this form, state clearly and concisely the objections to the Determination or Order which is being appealed. To the extent that the Determination or Order is based on a municipal bylaw, and not on the Massachusetts Wetlands Protection Act or regulations, the Department has no appellate jurisdiction.

3. Send a **copy** of this form and a **copy** of the check or money order with the Request for a Superseding Determination or Order by certified mail or hand delivery to the appropriate DEP Regional Office (see http://www.mass.gov/eea/agencies/massdep/about/contacts/).

4. A copy of the request shall at the same time be sent by certified mail or hand delivery to the Conservation Commission and to the applicant, if he/she is not the appellant.

SO.ESSEX #18 Bk:41861 Pg:423
11/16/2023 08:13 AM CONDN Pg 1/23
eRecorded

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands

WPA Form 5 – Order of Conditions

Massachusetts Wetlands Protection Act M.G.L. c. 131, §40

Provided by MassDEP:
33-1552
MassDEP File #

eDEP Transaction #

Haverhill
City/Town

A. General Information

Please note: this form has been modified with added space to accommodate the Registry of Deeds Requirements

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.

1. From: Haverhill
Conservation Commission

2. This issuance is for (check one): a. ☒ Order of Conditions b. ☐ Amended Order of Conditions

3. To: Applicant:

James
a. First Name

Fiorentini
b. Last Name

City of Haverhill
c. Organization

Office of the Mayor, City Hall Room 100, 4 Summer Street
d. Mailing Address

Haverhill
e. City/Town

MA
f. State

01830
g. Zip Code

4. Property Owner (if different from applicant):

Parcel ID: 602-461-5: Leo J. Serratore 1996 Revocable Trust, c/o Matilda Quinn, Trustee, 21 West Gile Street, Haverhill, MA 01830

Parcel IDs: 307-2-4 & 307-2-10: G & C Concrete Construction, 19 Hale St, Haverhill, MA 01830

Parcel IDs: 600-452-1 & 601-453-1: MBTA, Attn: Tess Paganelli, 10 Park Plaza, Boston, MA 02116

Parcel ID: 523-326-1: City of Haverhill, 4 Summer Street, Haverhill, MA 01830

Parcel ID: 516-304-1: New Alpha Bro Property, LLC, 93 Lafayette Square, Haverhill, MA 01832

5. Project Location:

Little River Corridor
Winter Street to Whittier Place
a. Assessors Map/Plat Number

Haverhill
b. City/Town

(Primary Municipal Parcel)
c. Parcel/Lot Number

Latitude and Longitude, if known: 42.77764
d. Latitude

-71.08868
e. Longitude

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands
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Provided by MassDEP:
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A. General Information (cont.)

6. Property recorded at the Registry of Deeds for (attach additional information if more than one parcel):
Southern Essex District
a. County
b. Certificate Number (if registered land)
38148
c. Book
422
d. Page

7. Dates: June 19, 2023 (a. Date Notice of Intent Filed) August 3, 2023 (b. Date Public Hearing Closed) October 18, 2023 (c. Date of Issuance)

8. Final Approved Plans and Other Documents (attach additional plan or document references as needed):
See Attachment "A", "Special Conditions", incorporated herein and made part of this Order of Conditions.

b. Prepared By
c. Signed and Stamped by
d. Final Revision Date
e. Scale
f. Additional Plan or Document Title
g. Date

B. Findings

1. Findings pursuant to the Massachusetts Wetlands Protection Act:

Following the review of the above-referenced Notice of Intent and based on the information provided in this application and presented at the public hearing, this Commission finds that the areas in which work is proposed is significant to the following interests of the Wetlands Protection Act (the Act). Check all that apply:

a. ☐ Public Water Supply b. ☒ Land Containing Shellfish c. ☒ Prevention of Pollution
d. ☒ Private Water Supply e. ☒ Fisheries f. ☒ Protection of Wildlife Habitat
g. ☒ Groundwater Supply h. ☒ Storm Damage Prevention i. ☒ Flood Control

2. This Commission hereby finds the project, as proposed, is: (check one of the following boxes)

Approved subject to:

a. ☒ the following conditions which are necessary in accordance with the performance standards set forth in the wetlands regulations. This Commission orders that all work shall be performed in accordance with the Notice of Intent referenced above, the following General Conditions, and any other special conditions attached to this Order. To the extent that the following conditions modify or differ from the plans, specifications, or other proposals submitted with the Notice of Intent, these conditions shall control.

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands
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B. Findings (cont.)

Denied because:

b. ☐ the proposed work cannot be conditioned to meet the performance standards set forth in the wetland regulations. Therefore, work on this project may not go forward unless and until a new Notice of Intent is submitted which provides measures which are adequate to protect the interests of the Act, and a final Order of Conditions is issued. **A description of the performance standards which the proposed work cannot meet is attached to this Order.**

c. ☐ the information submitted by the applicant is not sufficient to describe the site, the work, or the effect of the work on the interests identified in the Wetlands Protection Act. Therefore, work on this project may not go forward unless and until a revised Notice of Intent is submitted which provides sufficient information and includes measures which are adequate to protect the Act's interests, and a final Order of Conditions is issued. **A description of the specific information which is lacking and why it is necessary is attached to this Order as per 310 CMR 10.05(6)(c).**

3. ☒ Buffer Zone Impacts: Shortest distance between limit of project disturbance and the wetland resource area specified in 310 CMR 10.02(1)(a) — 0 a. linear feet

Inland Resource Area Impacts: Check all that apply below. (For Approvals Only)

Resource Area	Proposed Alteration	Permitted Alteration	Proposed Replacement	Permitted Replacement
4. ☒ Bank	103 a. linear feet	103 b. linear feet	103 c. linear feet	103 d. linear feet
5. ☒ Bordering Vegetated Wetland	525 a. square feet	525 b. square feet	0 c. square feet	0 d. square feet
6. ☒ Land Under Waterbodies and Waterways	1460 a. square feet	1460 b. square feet	1460 c. square feet	1460 d. square feet
	0 e. c/y dredged	0 f. c/y dredged		
7. ☒ Bordering Land Subject to Flooding	16,911 a. square feet	16,911 b. square feet	16,911 c. square feet	16,911 d. square feet
Cubic Feet Flood Storage	0 e. cubic feet	0 f. cubic feet	0 g. cubic feet	0 h. cubic feet
8. ☐ Isolated Land Subject to Flooding	a. square feet	b. square feet		
Cubic Feet Flood Storage	c. cubic feet	d. cubic feet	e. cubic feet	f. cubic feet
9. ☒ Riverfront Area	67,995 a. total sq. feet	67,995 b. total sq. feet		
Sq ft within 100 ft	56,426 c. square feet	56,426 d. square feet	56,426 e. square feet	56,426 f. square feet
Sq ft between 100-200 ft	11,569 g. square feet	11,569 h. square feet	11,569 i. square feet	11,569 j. square feet

Massachusetts Department of Environmental Protection
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B. Findings (cont.)

Coastal Resource Area Impacts: Check all that apply below. (For Approvals Only)

	Proposed Alteration	Permitted Alteration	Proposed Replacement	Permitted Replacement
10. ☐ Designated Port Areas	Indicate size under Land Under the Ocean, below			
11. ☐ Land Under the Ocean	a. square feet	b. square feet		
	c. c/y dredged	d. c/y dredged		
12. ☐ Barrier Beaches	Indicate size under Coastal Beaches and/or Coastal Dunes below			
13. ☐ Coastal Beaches	a. square feet	b. square feet	c. nourishment cu yd	d. nourishment cu yd
14. ☐ Coastal Dunes	a. square feet	b. square feet	c. nourishment cu yd	d. nourishment cu yd
15. ☐ Coastal Banks	a. linear feet	b. linear feet		
16. ☐ Rocky Intertidal Shores	a. square feet	b. square feet		
17. ☐ Salt Marshes	a. square feet	b. square feet	c. square feet	d. square feet
18. ☐ Land Under Salt Ponds	a. square feet	b. square feet		
	c. c/y dredged	d. c/y dredged		
19. ☐ Land Containing Shellfish	a. square feet	b. square feet	c. square feet	d. square feet
20. ☐ Fish Runs	Indicate size under Coastal Banks, Inland Bank, Land Under the Ocean, and/or inland Land Under Waterbodies and Waterways, above			
	a. c/y dredged	b. c/y dredged		
21. ☐ Land Subject to Coastal Storm Flowage	a. square feet	b. square feet		
22. ☐ Riverfront Area	a. total sq. feet	b. total sq. feet		
Sq ft within 100 ft	c. square feet	d. square feet	e. square feet	f. square feet
Sq ft between 100-200 ft	g. square feet	h. square feet	i. square feet	j. square feet

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B. Findings (cont.)

* #23. If the project is for the purpose of restoring or enhancing a wetland resource area in addition to the square footage that has been entered in Section B.5.c (BVW) or B.17.c (Salt Marsh) above, please enter the additional amount here.

23. ☐ Restoration/Enhancement *:

a. square feet of BVW | b. square feet of salt marsh

24. ☐ Stream Crossing(s):

a. number of new stream crossings | b. number of replacement stream crossings

C. General Conditions Under Massachusetts Wetlands Protection Act

The following conditions are only applicable to Approved projects.

1. Failure to comply with all conditions stated herein, and with all related statutes and other regulatory measures, shall be deemed cause to revoke or modify this Order.
2. The Order does not grant any property rights or any exclusive privileges; it does not authorize any injury to private property or invasion of private rights.
3. This Order does not relieve the permittee or any other person of the necessity of complying with all other applicable federal, state, or local statutes, ordinances, bylaws, or regulations.
4. The work authorized hereunder shall be completed within three years from the date of this Order unless either of the following apply:
   a. The work is a maintenance dredging project as provided for in the Act; or
   b. The time for completion has been extended to a specified date more than three years, but less than five years, from the date of issuance. If this Order is intended to be valid for more than three years, the extension date and the special circumstances warranting the extended time period are set forth as a special condition in this Order.
   c. If the work is for a Test Project, this Order of Conditions shall be valid for no more than one year.
5. This Order may be extended by the issuing authority for one or more periods of up to three years each upon application to the issuing authority at least 30 days prior to the expiration date of the Order. An Order of Conditions for a Test Project may be extended for one additional year only upon written application by the applicant, subject to the provisions of 310 CMR 10.05(11)(f).
6. If this Order constitutes an Amended Order of Conditions, this Amended Order of Conditions does not extend the issuance date of the original Final Order of Conditions and the Order will expire on October 18, 2026, unless extended in writing by the Department.
7. Any fill used in connection with this project shall be clean fill. Any fill shall contain no trash, refuse, rubbish, or debris, including but not limited to lumber, bricks, plaster, wire, lath, paper, cardboard, pipe, tires, ashes, refrigerators, motor vehicles, or parts of any of the foregoing.

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C. General Conditions Under Massachusetts Wetlands Protection Act

8. This Order is not final until all administrative appeal periods from this Order have elapsed, or if such an appeal has been taken, until all proceedings before the Department have been completed.

9. No work shall be undertaken until the Order has become final and then has been recorded in the Registry of Deeds or the Land Court for the district in which the land is located, within the chain of title of the affected property. In the case of recorded land, the Final Order shall also be noted in the Registry's Grantor Index under the name of the owner of the land upon which the proposed work is to be done. In the case of the registered land, the Final Order shall also be noted on the Land Court Certificate of Title of the owner of the land upon which the proposed work is done. The recording information shall be submitted to the Conservation Commission on the form at the end of this Order, which form must be stamped by the Registry of Deeds, prior to the commencement of work.

10. A sign shall be displayed at the site not less then two square feet or more than three square feet in size bearing the words,

"Massachusetts Department of Environmental Protection" [or, "MassDEP"]

"File Number 33-1552 "

11. Where the Department of Environmental Protection is requested to issue a Superseding Order, the Conservation Commission shall be a party to all agency proceedings and hearings before MassDEP.

12. Upon completion of the work described herein, the applicant shall submit a Request for Certificate of Compliance (WPA Form 8A) to the Conservation Commission.

13. The work shall conform to the plans and special conditions referenced in this order.

14. Any change to the plans identified in Condition #13 above shall require the applicant to inquire of the Conservation Commission in writing whether the change is significant enough to require the filing of a new Notice of Intent.

15. The Agent or members of the Conservation Commission and the Department of Environmental Protection shall have the right to enter and inspect the area subject to this Order at reasonable hours to evaluate compliance with the conditions stated in this Order, and may require the submittal of any data deemed necessary by the Conservation Commission or Department for that evaluation.

16. This Order of Conditions shall apply to any successor in interest or successor in control of the property subject to this Order and to any contractor or other person performing work conditioned by this Order.

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C. General Conditions Under Massachusetts Wetlands Protection Act (cont.)

17. Prior to the start of work, and if the project involves work adjacent to a Bordering Vegetated Wetland, the boundary of the wetland in the vicinity of the proposed work area shall be marked by wooden stakes or flagging. Once in place, the wetland boundary markers shall be maintained until a Certificate of Compliance has been issued by the Conservation Commission.

18. All sedimentation barriers shall be maintained in good repair until all disturbed areas have been fully stabilized with vegetation or other means. At no time shall sediments be deposited in a wetland or water body. During construction, the applicant or his/her designee shall inspect the erosion controls on a daily basis and shall remove accumulated sediments as needed. The applicant shall immediately control any erosion problems that occur at the site and shall also immediately notify the Conservation Commission, which reserves the right to require additional erosion and/or damage prevention controls it may deem necessary. Sedimentation barriers shall serve as the limit of work unless another limit of work line has been approved by this Order.

19. The work associated with this Order (the "Project")
    (1) ☐ is subject to the Massachusetts Stormwater Standards
    (2) ☒ is NOT subject to the Massachusetts Stormwater Standards

    If the work is subject to the Stormwater Standards, then the project is subject to the following conditions:

    a) All work, including site preparation, land disturbance, construction and redevelopment, shall be implemented in accordance with the construction period pollution prevention and erosion and sedimentation control plan and, if applicable, the Stormwater Pollution Prevention Plan required by the National Pollution Discharge Elimination System Construction General Permit as required by Stormwater Condition 8. Construction period erosion, sedimentation and pollution control measures and best management practices (BMPs) shall remain in place until the site is fully stabilized.

    b) No stormwater runoff may be discharged to the post-construction stormwater BMPs unless and until a Registered Professional Engineer provides a Certification that:
    i. all construction period BMPs have been removed or will be removed by a date certain specified in the Certification. For any construction period BMPs intended to be converted to post construction operation for stormwater attenuation, recharge, and/or treatment, the conversion is allowed by the MassDEP Stormwater Handbook BMP specifications and that the BMP has been properly cleaned or prepared for post construction operation, including removal of all construction period sediment trapped in inlet and outlet control structures;
    ii. as-built final construction BMP plans are included, signed and stamped by a Registered Professional Engineer, certifying the site is fully stabilized;
    iii. any illicit discharges to the stormwater management system have been removed, as per the requirements of Stormwater Standard 10;

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C. General Conditions Under Massachusetts Wetlands Protection Act (cont.)

iv. all post-construction stormwater BMPs are installed in accordance with the plans (including all planting plans) approved by the issuing authority, and have been inspected to ensure that they are not damaged and that they are in proper working condition;

v. any vegetation associated with post-construction BMPs is suitably established to withstand erosion.

c) The landowner is responsible for BMP maintenance until the issuing authority is notified that another party has legally assumed responsibility for BMP maintenance. Prior to requesting a Certificate of Compliance, or Partial Certificate of Compliance, the responsible party (defined in General Condition 18(e)) shall execute and submit to the issuing authority an Operation and Maintenance Compliance Statement ("O&M Statement) for the Stormwater BMPs identifying the party responsible for implementing the stormwater BMP Operation and Maintenance Plan ("O&M Plan") and certifying the following:

i.) the O&M Plan is complete and will be implemented upon receipt of the Certificate of Compliance, and

ii.) the future responsible parties shall be notified in writing of their ongoing legal responsibility to operate and maintain the stormwater management BMPs and implement the Stormwater Pollution Prevention Plan.

d) Post-construction pollution prevention and source control shall be implemented in accordance with the long-term pollution prevention plan section of the approved Stormwater Report and, if applicable, the Stormwater Pollution Prevention Plan required by the National Pollution Discharge Elimination System Multi-Sector General Permit.

e) Unless and until another party accepts responsibility, the landowner, or owner of any drainage easement, assumes responsibility for maintaining each BMP. To overcome this presumption, the landowner of the property must submit to the issuing authority a legally binding agreement of record, acceptable to the issuing authority, evidencing that another entity has accepted responsibility for maintaining the BMP, and that the proposed responsible party shall be treated as a permittee for purposes of implementing the requirements of Conditions 18(f) through 18(k) with respect to that BMP. Any failure of the proposed responsible party to implement the requirements of Conditions 18(f) through 18(k) with respect to that BMP shall be a violation of the Order of Conditions or Certificate of Compliance. In the case of stormwater BMPs that are serving more than one lot, the legally binding agreement shall also identify the lots that will be serviced by the stormwater BMPs. A plan and easement deed that grants the responsible party access to perform the required operation and maintenance must be submitted along with the legally binding agreement.

f) The responsible party shall operate and maintain all stormwater BMPs in accordance with the design plans, the O&M Plan, and the requirements of the Massachusetts Stormwater Handbook.

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C. General Conditions Under Massachusetts Wetlands Protection Act (cont.)

g) The responsible party shall:
1. Maintain an operation and maintenance log for the last three (3) consecutive calendar years of inspections, repairs, maintenance and/or replacement of the stormwater management system or any part thereof, and disposal (for disposal the log shall indicate the type of material and the disposal location);
2. Make the maintenance log available to MassDEP and the Conservation Commission ("Commission") upon request; and
3. Allow members and agents of the MassDEP and the Commission to enter and inspect the site to evaluate and ensure that the responsible party is in compliance with the requirements for each BMP established in the O&M Plan approved by the issuing authority.

h) All sediment or other contaminants removed from stormwater BMPs shall be disposed of in accordance with all applicable federal, state, and local laws and regulations.

i) Illicit discharges to the stormwater management system as defined in 310 CMR 10.04 are prohibited.

j) The stormwater management system approved in the Order of Conditions shall not be changed without the prior written approval of the issuing authority.

k) Areas designated as qualifying pervious areas for the purpose of the Low Impact Site Design Credit (as defined in the MassDEP Stormwater Handbook, Volume 3, Chapter 1, Low Impact Development Site Design Credits) shall not be altered without the prior written approval of the issuing authority.

l) Access for maintenance, repair, and/or replacement of BMPs shall not be withheld. Any fencing constructed around stormwater BMPs shall include access gates and shall be at least six inches above grade to allow for wildlife passage.

Special Conditions (if you need more space for additional conditions, please attach a text document):

See Attachment "A", "Special Conditions", incorporated herein and made part of this Order of Conditions.

20. For Test Projects subject to 310 CMR 10.05(11), the applicant shall also implement the monitoring plan and the restoration plan submitted with the Notice of Intent. If the conservation commission or Department determines that the Test Project threatens the public health, safety or the environment, the applicant shall implement the removal plan submitted with the Notice of Intent or modify the project as directed by the conservation commission or the Department.

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D. Findings Under Municipal Wetlands Bylaw or Ordinance

1. Is a municipal wetlands bylaw or ordinance applicable? ☒ Yes ☐ No

2. The Haverhill Conservation Commission hereby finds (check one that applies):

   a. ☐ that the proposed work cannot be conditioned to meet the standards set forth in a municipal ordinance or bylaw, specifically:

   _____ (1. Municipal Ordinance or Bylaw) _____ (2. Citation)

   Therefore, work on this project may not go forward unless and until a revised Notice of Intent is submitted which provides measures which are adequate to meet these standards, and a final Order of Conditions is issued.

   b. ☒ that the following additional conditions are necessary to comply with a municipal ordinance or bylaw:

   An Ordinance to Protect the Wetlands, Related Water Resources and Adjoining Land Areas (1. Municipal Ordinance or Bylaw) Chapter 253 (2. Citation)

3. The Commission orders that all work shall be performed in accordance with the following conditions and with the Notice of Intent referenced above. To the extent that the following conditions modify or differ from the plans, specifications, or other proposals submitted with the Notice of Intent, the conditions shall control.

   The special conditions relating to municipal ordinance or bylaw are as follows (if you need more space for additional conditions, attach a text document):

   See Attachment "A", "Special Conditions", incorporated herein and made part of this Order of Conditions.

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E. Signatures

This Order is valid for three years, unless otherwise specified as a special condition pursuant to General Conditions #4, from the date of issuance.

October 18, 2023
1. Date of Issuance

Please indicate the number of members who will sign this form.
This Order must be signed by a majority of the Conservation Commission.

four
2. Number of Signers

The Order must be mailed by certified mail (return receipt requested) or hand delivered to the applicant. A copy also must be mailed or hand delivered at the same time to the appropriate Department of Environmental Protection Regional Office, if not filing electronically, and the property owner, if different from applicant.

Pursuant to the vote taken by the Conservation Commission on May 7, 2020, the following signatures are made in accordance with M.G.L. c.110G and pursuant to said Commission's electronic signature authorization vote recorded on May 21, 2020, with the Southern Essex District Registry of Deeds in Book 38538, Page 455.

/Frederick Clark/	Frederick Clark
Signature	Printed Name
/Harmony Wilson/	Harmony Wilson
Signature	Printed Name
/Thomas Wylie/	Thomas Wylie
Signature	Printed Name
/Phillip LaCroix/	Phillip LaCroix
Signature	Printed Name
Signature	Printed Name
Signature	Printed Name
Signature	Printed Name
Signature	Printed Name

☒ by hand delivery on

October 18, 2023
Date

☐ by certified mail, return receipt requested, on

Date

F. Appeals

The applicant, the owner, any person aggrieved by this Order, any owner of land abutting the land subject to this Order, or any ten residents of the city or town in which such land is located, are hereby notified of their right to request the appropriate MassDEP Regional Office to issue a Superseding Order of Conditions. The request must be made by certified mail or hand delivery to the Department, with the appropriate filing fee and a completed Request for Departmental Action Fee Transmittal Form, as provided in 310 CMR 10.03(7) within ten business days from the date of issuance of this Order. A copy of the request shall at the same time be sent by certified mail or hand delivery to the Conservation Commission and to the applicant, if he/she is not the appellant.

Any appellants seeking to appeal the Department's Superseding Order associated with this appeal will be required to demonstrate prior participation in the review of this project. Previous participation in the permit proceeding means the submission of written information to the Conservation Commission prior to the close of the public hearing, requesting a Superseding Order, or providing written information to the Department prior to issuance of a Superseding Order.

The request shall state clearly and concisely the objections to the Order which is being appealed and how the Order does not contribute to the protection of the interests identified in the Massachusetts Wetlands Protection Act (M.G.L. c. 131, § 40), and is inconsistent with the wetlands regulations (310 CMR 10.00). To the extent that the Order is based on a municipal ordinance or bylaw, and not on the Massachusetts Wetlands Protection Act or regulations, the Department has no appellate jurisdiction.

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands
WPA Form 5 – Order of Conditions
Massachusetts Wetlands Protection Act M.G.L. c. 131, §40

Provided by MassDEP:
33-1552
MassDEP File #

eDEP Transaction #

Haverhill
City/Town

G. Recording Information

Prior to commencement of work, this Order of Conditions must be recorded in the Registry of Deeds or the Land Court for the district in which the land is located, within the chain of title of the affected property. In the case of recorded land, the Final Order shall also be noted in the Registry's Grantor Index under the name of the owner of the land subject to the Order. In the case of registered land, this Order shall also be noted on the Land Court Certificate of Title of the owner of the land subject to the Order of Conditions. The recording information on this page shall be submitted to the Conservation Commission listed below.

Haverhill
Conservation Commission

Detach on dotted line, have stamped by the Registry of Deeds and submit to the Conservation Commission.

To:

Haverhill
Conservation Commission

Please be advised that the Order of Conditions for the Project at:

Little River, Winter Street to Whittier Place
Parcel ID: 523-326-1

33-1552
MassDEP File Number

Has been recorded at the Registry of Deeds of:

Southern Essex District
County

Book

Page

for: City of Haverhill
Property Owner

and has been noted in the chain of title of the affected property in:

Book

Page

In accordance with the Order of Conditions issued on:

Date

If recorded land, the instrument number identifying this transaction is:

Instrument Number

If registered land, the document number identifying this transaction is:

Document Number

Signature of Applicant

Haverhill

Conservation Department
Phone: 978-374-2334 Fax: 978-374-2366
rmoore@cityofhaverhill.com
conservation@cityofhaverhill.com

ATTACHMENT A: SPECIAL CONDITIONS

MassDEP FILE #33-1552

ISSUING AUTHORITY: Haverhill Conservation Commission ("HCC")

APPLICANT: City of Haverhill

PROJECT LOCATION: Little River Corridor, Winter Street to Whittier Place – Parcel ID: 523-326-1

PROJECT DESCRIPTION
The proposed recreational project builds on the removal of Little River Dam and the subsequent restoration of the river permitted under DEP File #33-1551. The recreational access improvements include construction of a canoe launch and fishing platform; installation of a pedestrian walking trail and bridge; and construction of a river overlook pocket park off Winter Street. The pedestrian footbridge is designed to comply with the limited project criteria of 310 CMR 10.53(3)(j).

RESOURCE AREA FINDINGS
The Haverhill Conservation Commission finds this site to contain, at a minimum, the following resource areas: land under water, bank, riverfront area, bordering vegetated wetlands, and bordering land subject to flooding, all associated with the Little River, along with associated buffer zones.

EXPIRATION DATE
Unless extended, this Order of Conditions ("OOC") will expire October 18, 2026.

PLANS AND DOCUMENTS
Work on this project site shall be performed according to the following listed plans and documents on file with the HCC. Should any conflicts be found to exist between these plans and documents and the conditions of this OOC, the HCC shall be contacted for clarification.

a) "Little River Community Access Improvements – Preliminary Design Development Plans", site plan prepared by Fuss & O'Neill (1550 Main Street, Suite 400, Springfield, MA 01103), plan set dated June 30, 2022; and
b) "Little River Community Access Improvements Notice of Intent" (including Appendix C, "Invasive Species Control Plan" and Section 5, "Maintenance and Operation Plan"), document prepared by Fuss & O'Neill, dated June 12, 2023.

Pursuant to the Massachusetts Wetlands Protection Act (M.G.L. Chapter 131, Section 40), its Regulations (310 CMR 10.00), and Haverhill City Code Chapter 253 ("An Ordinance to Protect the Wetlands, Related Water Resources and Adjoining Land Areas"), the Commission orders that all work shall be performed in accordance with the following additional, special conditions:

GENERAL CONSTRUCTION

21. The HCC may designate one or more Conservation Department Officials as its agent ("HCC Official"), with full powers to act on its behalf in administering and enforcing this OOC.

22. Work on this project shall be performed in accordance with Haverhill Municipal Ordinances Chapter 253 – "An Ordinance to Protect the Wetlands, Related Water Resources, and Adjoining Land Areas".

23. In accordance with Haverhill Municipal Ordinance Chapter 253, there shall be no activities allowed within 25' of the delineated wetland resource areas and no building construction within 50' of these same areas, except as shown on the approved plans referenced above.

24. All wetland resource areas shall be visibly flagged and/or staked every 25 feet along the resource area boundaries to assure that no intrusion into these areas occurs. Flagging and staking used to identify wetland resource areas shall be of a color different from any others used on the site and shall be maintained until the work is complete.

25. The rows of erosion control devices, as shown on the site plan, shall also act as a limit of site activity.

26. The MassDEP File Number sign shall not be attached to a live tree.

27. Any changes proposed under this OOC might require the Applicant to file a "Request for a Modification to the Order of Conditions" with the HCC.

28. While all activities regulated by this Order are being performed and during the construction phase of this project, an on-site foreman, directing engineer, or designated construction manager, shall have a copy of this permit and its associated plans and documents at the site, familiarize him or herself with the conditions of this permit, and adhere to such conditions. This OOC shall be made part of all construction-related documents for this project. All contractors working at the site shall be made aware of the provisions contained within this OOC and adhere to them.

29. The Applicant shall secure an Environmental Monitor ("EM") for this project. The EM shall be, at a minimum, a professional with experience in Resource Area Protection; Erosion, Sedimentation, and Pollution Prevention; and Stormwater Management. The EM shall have, at a minimum, a working knowledge of botany, hydrology, and general construction practices. The Applicant may designate the EM as responsible for fulfilling the requirements of the Pollution Prevention and Erosion and Sedimentation Control ("PPESC") Monitor under this OOC. Otherwise, the EM shall establish an appropriate working relationship with the PPESC Monitor to ensure the project's complete compliance with this OOC. The Applicant shall give the EM authority to stop construction for PPESC purposes.
    a) On the Monday of every week throughout the life of this project, the EM shall provide the HCC with a status report of the project. This report shall indicate the functions of the PPESC devices and any need for maintenance, replacement, augmentation, emergency placement, and any other corrective action of

PPESC devices; the activities completed the previous week; and the activities planned for the current week. The report shall also mention any deviations from the previous week's report and any environmental mitigation measures that have been undertaken. The report shall include representative photographs of deviations, needed repairs, and on-going work. The frequency of this reporting may be altered as site conditions warrant, upon concurrence between the HCC and the EM.

b) In addition to this reporting, the EM shall be responsible for all inspections and reporting as outlined in this OOC and the referenced plans and documents pertaining to Resource Area Activities; Erosion, Sedimentation, and Pollution Prevention; and Stormwater Management. The EM shall be on site as necessary to ensure proper implementation of the conditions of this OOC and the work outlined in the referenced plans and documents.

CONSTRUCTION SEQUENCING

30. Prior to the commencement of work, the Applicant shall provide the HCC with electronic copies of all other applicable federal, state, and local permits for this project.

31. The Applicant shall adhere to the Time of Year restriction recommended by the MA Division of Marine Fisheries for this project. No in-water work shall occur during March 1 to June 30 of each project year for the purpose of minimizing impacts to diadromous fish resources in the adjacent Merrimack River from sedimentation and turbidity. In-water work shall be sequenced to occur during periods of low flow stream conditions in Little River (i.e., July 1 to October 31). To minimize sedimentation and turbidity in downstream areas, the Applicant shall deploy such measures as downstream turbidity curtains and temporary coffer dams. The Applicant shall obtain the Fishway Construction Permit from DMF that is required for this project.

32. A minimum of two (2) business days in advance, the Applicant shall provide the HCC with written notification of the commencement of work on site. At this time, the Applicant shall also supply the HCC with a list of names, addresses, and emergency phone numbers (including evenings and weekends) for those parties responsible for compliance with this OOC on the site, including the Environmental Monitor and the Pollution Prevention and Erosion and Sedimentation Control Monitor.

33. Prior to the commencement of work on this site, the Applicant shall schedule a pre-construction meeting with the site contractor, the Applicant's engineers/consultants, the EM, the PPESC Monitor, and the HCC. The purpose of the meeting is to review this OOC and resolve any outstanding issues at that time.

34. The Applicant shall make every effort to ensure that no invasive plant species, as defined and listed by the Massachusetts Invasive Plant Advisory Group, are introduced to, or moved around the site by construction activities, including importation of infected materials such as borrow, compost, nursery stock, seed, or hay bales. Corrective measures, if necessary, shall be made by the Applicant as directed by the EM. Corrective measures shall be implemented for as long as necessary to eliminate the introduced invasive plant species and prevent re-establishment of same. The Applicant shall satisfactorily dispose of all cleared, invasive plant material (seeds, roots, woody vegetation, associated soils, etc.). The Applicant shall take measures to prevent viable, invasive plant materials from leading to further infestations while stockpiled, in transit, or at final disposal locations. All precautions shall be taken to avoid contamination of natural landscapes with invasive plants or invasive plant material.

Prior to the commencement of work on site, the EM shall survey this site for the presence of invasive plant species within the approved limits of work. If found, the EM shall provide the HCC with an updated, as necessary, written Invasive Species Control Plan ("ISCP") proposal and schedule of control. The ISCP is critical for identifying pre-construction conditions, as well as strategies for minimizing import or spread of invasive plants. All materials and methods proposed shall be consistent with the conditions of this OOC. The ISCP shall include, but not be limited to, the following:

a) Description of treatment areas, including identification of targeted invasive plant species, locations, approximate size of areas, and digital photos with time/date stamp.
b) Delineation of treatment areas with polygons outlining their perimeter or locations of individual plants. A free-hand sketch drawn on construction plans, or an aerial photo can be used to show locations.
c) Proposed methods of treatment for each species or area, such as manual removal, cutting, or herbicides.
    i. If herbicides are proposed, the IPMS shall include the product label, including application methods and rates for each. MSDS information shall also be provided for each herbicide.
d) Proposed time of treatment based on target plan species and construction schedule.
e) Method for disposing of invasive plant materials.
f) General monitoring schedule.
g) Preliminary re-treatment schedule. Re-treatment shall be based on assessment of initial results and time of year.
h) Proposed performance metrics, or measure of treatment success, which shall be agreed upon with HCC.

Control of invasive plant species shall begin immediately with the initiation of construction and continue for a minimum of five (5) years, after which time a Complete Certificate of Compliance may be pursued for this project. The EM shall report on the success of the ISCP in the work area in the weekly, seasonal, and final EM reports required under this OOC. If necessary, the corrective measures shall be outlined in the reporting in a manner consistent with the ISCP requirements.

35. Immediately upon completion of this project, the Applicant shall provide the HCC with an as-built drawing showing, at a minimum, the following information as it pertains to the subject property. This plan shall be stamped by a MA-registered Professional Engineer. This plan shall be subject to the review and approval of the HCC.
    a) Wetland resource areas subject to protection under this OOC and their approved delineations;
    b) Limits of all Buffer Zones, including No-Disturbance and No-Build Zones;
    c) Planted trees and shrubs;
    d) Structures installed as part of this project;
    e) Existing limits of lawn/landscaped, pavement, … areas;
    f) Date(s) of survey fieldwork; and
    g) A statement by the Professional Engineer certifying compliance with the approved plans and conditions of this OOC and setting forth deviations from same, if any exist.

CONSTRUCTION PERIOD EROSION, SEDIMENTATION, AND POLLUTION PREVENTION

36. The Applicant, site contractor, and their assigns shall implement Construction Period Pollution Prevention and Erosion and Sedimentation Control measures from the commencement of work until the site is fully and permanently stabilized and the temporary erosion and sedimentation controls are removed, upon HCC approval.

37. All vegetation cutting associated with the construction of this project shall be subject to the prior review and approval of the HCC. Prior to the commencement of work, the Applicant's surveyor shall stake out, flag, or mark by other appropriate means, the locations of the approved limits of cutting and the locations of the proposed PPESC devices for inspection by the site contractor, EM, PPESC Monitor, and the HCC. The commencement of vegetation cutting work shall be contingent upon the approval of the HCC at that time.

38. Prior to the commencement of work, the Applicant shall install the initial PPESC devices. The Applicant shall schedule an inspection of the installed devices by the site contractor, EM, PPESC Monitor, and the HCC. Should any of these devices be considered insufficient, the PPESC Monitor shall immediately propose augmentation or other corrective measures to address areas of concern. The continuation of on-site work shall be contingent upon HCC approval of the devices at that time.

39. The Applicant shall designate a PPESC Monitor for the site. This Monitor shall be a professional with experience in PPESC practices. This Monitor shall inspect PPESC devices daily for proper function and maintenance, including the proper disposal of waste products. This Monitor shall immediately arrange for the maintenance, replacement, augmentation, emergency placement, and any other corrective action of PPESC devices on site. Areas of construction shall remain in a stable condition at the end of each day. The Applicant shall give this Monitor authority to stop construction for PPESC purposes.

40. An adequate stockpile of PPESC materials shall be always on site for emergency or routine replacement and shall include materials to repair silt fences, straw bales, stone riprap, filter dikes or any other devices planned for use during construction.

41. PPESC devices may be modified based on experience at the site. Approval of the HCC must be obtained prior to any non-emergency modification of the approved PPESC measures.

42. The HCC reserves the right to impose additional conditions on portions of this project to mitigate any impacts which could result from site erosion or any noticeable degradation of surface water quality discharging from the site.

43. The locations of long term (greater than 30 days) stockpiles and the locations and construction methods of temporary construction entrances, if not addressed in the Construction Period PPESC Plan, shall receive the prior approval of the PPESC monitor and the HCC.

44. During all phases of construction, all disturbed or exposed soil surfaces shall be brought to final finished grade and either a) covered with loam and seeded in accordance with the Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas (or equivalent document) for permanent stabilization or b) stabilized in another way approved by the HCC. Bare ground that cannot be permanently stabilized within 30 days shall be stabilized with mulch or any other protective covering and/or method approved by the USDA Soil Conservation Service.

45. Upon completion of the project all disturbed areas shall be permanently stabilized with rapidly growing vegetative cover with sufficient topsoil to assure long term stabilization of disturbed areas. After seeding, disturbed areas shall be covered with straw mulch, netting, or other protective covering to provide a suitable surface cover until seed germination.

46. All dewatering activities shall be controlled by implementing Best Management Practices. Dewatered fluids shall be prevented from flowing directly into resource areas. Discharge structures, such as temporary sediment basins or other Best Management Practices shall be configured to maximize sediment removal. If discharge towards resource areas cannot be avoided, it shall be via a maximized distance of overland upland sheet flow unless the HCC approves an alternative in advance. The PPESC Monitor shall review and approve all dewatering methods prior to implementation.

47. Soils, stumps, slash, timber, construction materials, debris, or other waste products shall not be deposited, stored, or otherwise accumulated within 100' of a wetland resource area or within land subject to flooding, unless approved in advance by the HCC.

48. Covered dumpsters shall be maintained on site for appropriate materials. The Applicant shall conduct routine litter pick-ups throughout construction to prevent trash and loose, synthetic debris from entering the resource areas and buffer zones.

49. All pumps, drilling machines, and their surrounding areas, whether used for dewatering or other purposes, shall be properly contained to limit the potential for environmental impacts due to fuel leakage, pump leakage, or other failures.

50. Refueling of equipment shall not be done within 100' of a wetland resource area. Fuel, oil, or other potential pollutants shall not be stored within 100' of a wetland resource area.

51. Equipment and vehicles staged overnight shall be stored on an impervious containment surface to prevent drippings and spills from leaching into the soil. The PPESC Monitor shall inspect this surface daily and take prompt action to address all pollution prevention concerns in accordance with this Order.

52. Any spills of hazardous materials, including but not limited to diesel fuel and hydraulic oil, shall be appropriately and promptly cleaned up. The Applicant shall notify Federal, Commonwealth, and/or Local agencies of such spills as may be applicable by law. The Applicant or PPESC Monitor shall notify the HCC, within one hour, of any spills within wetland resource areas or buffer zones. Onsite emergency spill kits shall always be available.

53. The Applicant shall ensure a hazardous materials spill containment kit is always maintained on site throughout construction. The kit shall be appropriately sized for the cumulative volumetric capacity of hazardous fluids contained by equipment on site at any one time.

RESOURCE AREA ACTIVITIES

54. All work proposed within the wetland resource areas and 100'-Buffer Zone shall be performed according to the plans and documents submitted as part of the Notice of Intent filing, unless specified otherwise in this Order. These areas shall meet or exceed the General Performance Standards outlined in 310 CMR 10.00 and Haverhill Municipal Ordinances Chapter 253. Should these areas fail to meet any of these standards, the HCC reserves the right to require those measures necessary to achieve compliance.

55. The Applicant shall ensure the EM is on site sufficiently throughout construction and restoration to provide supervision and inspect resource area activities for compliance with this Order.

56. The site contractor shall not disturb any area of protected or regulated Federal, State, and/or Local wetland resource area or buffer zone except for that which has been permitted by this Order.

57. The site contractor shall restore all temporarily disturbed resource areas and buffer zones to the satisfaction of the HCC and the EM. The EM shall ensure that 75 percent of the surface area of all temporarily disturbed and restoration areas is reestablished with indigenous plant species within two growing seasons of their planting or replanting. If at the end of one growing season it is evident, in the opinion of the EM or the HCC, that a disturbed area is not likely to be successfully reestablished within this time frame, the EM shall submit to the HCC a corrective plan of action detailing supplements to the planting, soils, and/or grading, as necessary, to achieve the required coverage. This plan shall be implemented upon HCC approval.

58. The contractor shall follow the directions of the EM, whether given prior to, or during, construction of any restoration area(s). If feasible, the contractor shall propose alternative mitigation and environmental protection techniques that provide cost or time savings, improved environmental protection, or enhanced mitigation, provided (1) they provide equivalent or greater wetland protection and mitigation than afforded by the methods contained in this Order and NOI and provided by the EM; (2) they receive prior approval by the HCC and the EM; and (3) they meet the Performance Standards of the MA Wetland Protection Regulations (310 CMR 10.00) and the requirements of Haverhill Municipal Ordinance Chapter 253.

59. The Applicant shall sequence all in-water work to occur during periods of low flow stream conditions. Turbidity barriers shall be deployed to reduce the potential for downstream sedimentation impacts.

60. Excavation equipment brought onto the site shall be cleaned at an off-site location prior to commencement of site work to remove any soil which may contain noxious plant remains.

61. The Applicant is to contact the HCC immediately upon completion of the restoration work; an appointment for inspection by an HCC Official shall be arranged with the EM.

62. Immediately following the completion of work, the Applicant shall submit a status report, written by the EM, describing to the HCC the status of the resource areas and their immediate surroundings. This report shall be accompanied by the as-built drawing required under Condition #37.

63. The EM, prior to and following each growing season for a minimum of five (5) years and until a Certificate of Compliance is issued, shall submit monitoring reports to the HCC. Monitoring reports shall describe, using narratives, plans, and color photographs, the physical characteristics of the areas within the limits of work with respect to soils, hydrology, habitat value, stability, survivorship of vegetation and plant mortality, aerial extent and distribution, species diversity and vertical stratification (i.e., the herb, shrub, and tree layers), the presence of invasive plant species, etc. These monitoring reports shall be submitted by May 31 and September 30 of each year. Applicable General Performance standards as outlined in 310 CMR are to be met within two years of completion. A Certificate of Compliance is to be issued ONLY AFTER the General Performance Standards and reporting requirements have been met.

64. A color photographic log of the site shall be kept with associated text by the EM. This log shall show pre-restoration through post-restoration views of the areas within the limits of work, undisturbed adjacent resource areas and buffer zones, and erosion/sedimentation control devices. A current log shall be

submitted with the status and monitoring reports required above and with the Request for a Certificate of Compliance.

WILDLIFE HABITAT PROTECTION

65. The Applicant shall abide by the March 1 to June 30 Time of Year restriction recommended by the MA Division of Marine Fisheries for this project.

OTHER CONDITIONS

66. If any unforeseen problem occurs during construction, which affects any of the eight statutory interests of the Wetlands Protection Act, M.G.L. Chapter 131, Section 40, upon discovery, the Applicant shall notify the HCC and an immediate meeting shall be held between the Commission, the Applicant, the engineer, contractor, and other concerned parties to determine the corrective measures to be employed. The Applicant shall then act to correct the problems using the corrective measures agreed upon.

67. Upon completion of the project, the Applicant shall request a Certificate of Compliance from the Commission and shall submit the following information with the request in both paper form and in an electronic form found acceptable to an HCC Official:
    a) A written statement by a professional engineer registered in the Commonwealth of Massachusetts certifying compliance with the approved plans referenced above and this OOC and setting forth deviations, if any exist.
    b) A final monitoring report and current photo log prepared by the EM.
    c) Two sets of as-built drawings prepared by the professional engineer showing resource areas, plantings, and detailed landscaping (i.e., all wetland resource areas, limits of work, etc.). These plans shall include the date(s) of fieldwork and shall be prepared in accordance with the "Plot Plan Standards" of the HCC Policy - P2000-02 "Occupancy Permit Checklist Endorsement".

ONGOING CONDITIONS

Certain conditions are ongoing and do not expire upon the completion of the project or the issuance of a Certificate of Compliance. These conditions shall remain in effect after the issuance of a Certificate of Compliance for the project and shall be referenced in the chain of title for the property. These conditions are:

68. The HCC reserves the right to enforce all restrictions and/or requirements established for this property within this OOC under the enforcement powers of the City's wetlands protection ordinance, Municipal Ordinance Chapter 253.

69. The HCC reserves the right to schedule an annual inspection with the Applicant and/or Property Owner(s) (as may be determined through a post-dam-removal land ownership finding) as part of a long-term management program to inspect the site for permanent stability and proper maintenance. The Applicant shall maintain the fishing platform, canoe/kayak launch, pedestrian bridge and walkway, and Winter Street pocket park overlook as outlined in the "Maintenance and Operation Plan" included under Section 5 of the Notice of Intent project narrative. The Applicant/Property Owner shall schedule a site meeting with an HCC Official prior to conducting any maintenance activities that exceed a routine "by hand" level of labor.

--- END ---

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands

Request for Departmental Action Fee Transmittal Form

Massachusetts Wetlands Protection Act M.G.L. c. 131, §40

DEP File Number:

Provided by DEP

A. Request Information

1. Location of Project

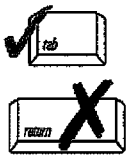
a. Street Address

b. City/Town, Zip

c. Check number

d. Fee amount

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.



2. Person or party making request (if appropriate, name the citizen group's representative):

Name

Mailing Address

City/Town

State

Zip Code

Phone Number

Fax Number (if applicable)

3. Applicant (as shown on Determination of Applicability (Form 2), Order of Resource Area Delineation (Form 4B), Order of Conditions (Form 5), Restoration Order of Conditions (Form 5A), or Notice of Non-Significance (Form 6)):

Name

Mailing Address

City/Town

State

Zip Code

Phone Number

Fax Number (if applicable)

4. DEP File Number:

B. Instructions

1. When the Departmental action request is for (check one):

☐ Superseding Order of Conditions – Fee: $120.00 (single family house projects) or $245 (all other projects)

☐ Superseding Determination of Applicability – Fee: $120

☐ Superseding Order of Resource Area Delineation – Fee: $120

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands

Request for Departmental Action Fee Transmittal Form

Massachusetts Wetlands Protection Act M.G.L. c. 131, §40

DEP File Number:

Provided by DEP

B. Instructions (cont.)

Send this form and check or money order, payable to the *Commonwealth of Massachusetts,* to:

Department of Environmental Protection
Box 4062
Boston, MA 02211

2. On a separate sheet attached to this form, state clearly and concisely the objections to the Determination or Order which is being appealed. To the extent that the Determination or Order is based on a municipal bylaw, and not on the Massachusetts Wetlands Protection Act or regulations, the Department has no appellate jurisdiction.

3. Send a **copy** of this form and a **copy** of the check or money order with the Request for a Superseding Determination or Order by certified mail or hand delivery to the appropriate DEP Regional Office (see https://www.mass.gov/service-details/massdep-regional-offices-by-community).

4. A copy of the request shall at the same time be sent by certified mail or hand delivery to the Conservation Commission and to the applicant, if he/she is not the appellant.

DEPARTMENT OF THE ARMY
US ARMY CORPS OF ENGINEERS
NEW ENGLAND DISTRICT
696 VIRGINIA ROAD
CONCORD MA 01742-2751

January 9, 2024

Regulatory Division
File Number: NAE-2022-00119

Mayor James Fiorentini
City of Haverhill
4 Summer Street
Haverhill, Massachusetts 01083
Sent by email: mayor@cityofhaverhill.com

Dear Mayor Fiorentini:

The U.S. Army Corps of Engineers (USACE) has reviewed your application for discharges of fill below the ordinary high water mark in order to remove the Little River Dam and restore the Little River through completing the following: dredging of 5,500 CY of sediment for targeted sediment cleanup to be disposed of in an upland location and 4,820 CY of sediment to be re-used within the project area, installation of fish passage structures, construction of low flow channel downstream of Winter Street Bridge, installation of bioengineered slope stabilization and scour protection, placement of native plantings. Recreational components include: constructing a canoe launch, fishing platform, pedestrian bridge, and trail network. See the attached information for a detailed project narrative and detailed impacts. Impacts are anticipated from the removal of Little River Dam, dewatering of a portion of Little River during construction, dredging and removal of contaminated sediment, grading of the former impoundment area, installation of a retaining wall and scour protection, and construction of the recreational improvements. Temporary impacts will total 90,183 square feet below the ordinary high water mark, permanent impacts will total 339,058 square feet below the ordinary high water mark. The project will also result in 315 square feet of permanent wetlands loss. This project is located in the Little River north of Winter Street, Haverhill, Massachusetts. The work is shown on the enclosed plans titled “LITTLE RIVER DAM REMOVAL AND RIVER RESTORATION,” on thirty eight (38) sheets, and dated “JUNE 30, 2022.”

Based on the information that you have provided, we verify that the activity is authorized under General Permit # 10 of the June 2, 2023, federal permit known as the Massachusetts General Permits (GPs). The GPs are available at https://www.nae.usace.army.mil/Missions/Regulatory/State-General-Permits/Massachusetts-General-Permit.

Please review the enclosed GPs carefully, in particular the general conditions beginning on page 35, and ensure that you and all personnel performing work authorized by the GPs are fully aware of and comply with its terms and conditions. A copy of the

GPs and this verification letter shall be available at the work site as required by General Condition 17. You must perform this work in compliance with the following special condition:

The work authorized herein shall not be conducted during the time of year (TOY) restriction of 1 March to 30 June of any year in order to minimize adverse impacts to anadromous fisheries.

This authorization expires on June 1, 2028. You must commence or have under contract to commence the work authorized herein by June 1, 2028, and complete the work by June 1, 2029. If not, you must contact this office to determine the need for further authorization and we recommend you contact us *before* the work authorized herein expires. Please contact us immediately if you change the plans or construction methods for work within our jurisdiction as we must approve any changes before you undertake them. Performing work within our jurisdiction that is not specifically authorized by this determination or failing to comply with the special condition(s) provided above or all the terms and conditions of the GPs may subject you to the enforcement provisions of our regulations.

This authorization does not obviate the need to obtain other federal, state, or local authorizations required by law. Applicants are responsible for applying for and obtaining any other approvals.

We continually strive to improve our customer service. To better serve you, we would appreciate your completing our Customer Service Survey located at https://regulatory.ops.usace.army.mil/customer-service-survey.

Please contact Christine Jacek of my staff at (978) 318-8026 or Christine.M.Jacek@usace.army.mil if you have any questions.

Sincerely,

Paul Maniccia

Paul Maniccia
Chief, Massachusetts Branch
Regulatory Division

Enclosures

cc:

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City of Haverhill Conservation Commission, conservation@cityofhaverhill.com

LITTLE RIVER DAM REMOVAL AND RIVER RESTORATION

HAVERHILL · MASSACHUSETTS

PRELIMINARY DESIGN DEVELOPMENT PLANS

JUNE 30, 2022

PREPARED FOR

CITY OF HAVERHILL
DEPT. OF PUBLIC WORKS
500 PRIMROSE STREET
HAVERHILL, MA 01830-2660

PREPARED BY

FUSS & O'NEILL
1550 MAIN STREET, SUITE 400
SPRINGFIELD, MA 01103
413.452.0445
www.fando.com

SHEET INDEX

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PROJECT TEAM

MUNICIPAL VULNERABILITY PREPAREDNESS PROGRAM (MVP)
MASSACHUSETTS EXECUTIVE OFFICE OF ENERGY AND ENVIRONMENTAL AFFAIRS
SALTONSTALL BUILDING
100 CAMBRIDGE STREET SUITE 900
BOSTON, MA 02114
617.626.1000

O'REILLY, TALBOT & OKUN ENGINEERING ASSOCIATES
293 BRIDGE STREET SUITE 500
SPRINGFIELD, MA 01103
413.788.6222

TG & B MARINE SERVICES, INC.
P.O. BOX 767
NORTH FALMOUTH, MA 02556-0767
508.326.3685

LOCATION MAP
SCALE: 1" = 2,000'

COMMONWEALTH OF MASSACHUSETTS
DEAN E. AUDET
CIVIL
No. 46977
REGISTERED PROFESSIONAL ENGINEER

PROJ. No.: 20170390.U30
DATE: JUNE 2022

GI-001

File: J:\DWG\P2017\0390\U30\Civil\Plan\20170390U30_COV01.dwg Layout: 11X17 GI-001 Plotted: 2022-12-08 3:12 PM Saved: 2022-12-08 1:38 PM User: CNauman

LEGEND

EXIST	PROP	
		PROPERTY LINE/RIGHT-OF-WAY
		CENTERLINE
		LIMIT OF DISTURBANCE
		EASEMENT
		BASELINE
		GRAVEL ROAD
		EDGE OF PAVEMENT
		VERT. GRAN. CURB
		SAW CUT
		MATCH LINE
		FEMA FLOODWAY
		100-YEAR FLOOD ELEVATION
		500-YEAR FLOOD ELEVATION
AA100		WETLAND DELINEATION FLAG
		BANK/MEAN ANNUAL HIGH WATER
		BORDERING VEGETATED WETLANDS
		25' NO DISTURBANCE ZONE
		50' NO BUILD ZONE
		100' BUFFER ZONE
		200' RIVERFRONT AREA
		BASE CONDITION FLOW LIMITS / MEAN ANNUAL LOW WATER
		LITTLE RIVER DAM
		EDGE OF WATER
		BUFFER ZONE
		GUARD RAIL
		STOCKADE FENCE
		WIRE FENCE
		CHAIN LINK FENCE
		TREE LINE
		SHRUB LINE
		STONE WALL
		RETAINING WALL
		MINOR CONTOUR
		MAJOR CONTOUR
		BUILDING
		BOLLARD
		SIGN
		CONC. PAVEMENT
		NORMAL PAVEMENT
		HEAVY DUTY PAVEMENT
		ADA OR ACCESSIBLE RAMP
		HANDICAP PARKING
		VAN-ACCESSIBLE HANDICAP PARKING
		TOP OF SEDIMENT ELEVATION (DEPTH OF SEDIMENT) - APPROXIMATE FROM BOAT DEPTH MEASUREMENTS
		TOP OF SEDIMENT ELEVATION (FROM FIELD SURVEY)
		BOTTOM OF SEDIMENT ELEVATION (FROM FIELD SURVEY)
		GROUND OR BOTTOM OF RIVER SPOT ELEVATION (FROM FIELD SURVEY)
		SPOT ELEVATION w/LEADER
		IRON PIPE
		DRILL HOLE
		IRON PIN
		MONUMENT
		CONTROL POINT
		WETLAND SEED MIX
		WETLAND SEED MIX AND LIVE STAKES
		CONSERVATION SEED MIX
		SIDE-SHADE SEED MIX
		SHOWY WILDFLOWER SEED MIX
		UPLAND/PARK SEED MIX

EXIST	PROP	
		DRAIN/CBO LINE
		SEWER LINE
		OVERHEAD ELECTRIC, TELEPHONE & FIRE ALARM
		WATER LINE
		GAS LINE
		UNDERGROUND ELECTRIC
		TELEPHONE LINE
		CABLE TV
		ELECTRIC, TELEPHONE & CABLE TV LINES
		CATCH BASIN
		DOUBLE CATCH BASIN
		DRAIN INLET
		DRAIN MANHOLE
		HEADWALL
		SEWER MANHOLE
		CLEAN OUT
		WATER MANHOLE
		WATER GATE
		FIRE HYDRANT
		WATER METER
		POST INDICATOR VALVE
		WELL
		GAS GATE
		GAS METER
		ELECTRIC MANHOLE
		ELECTRIC BOX
		ELECTRIC METER
		TRANSFORMER
		LIGHT POST
		TELEPHONE MANHOLE
		TRAFFIC SIGNAL
		SIGNAL BOX
		FIRE ALARM CONTROL PANEL
		FIRE ALARM BOX
		UTILITY POLE
		GUY POLE
		HAND HOLE
		PULL BOX
		SILT FENCE
		BIODEGRADABLE COIR ROLLS
		TEMPORARY COFFERDAM
		CONSTRUCTION ENTRANCE/ TEMPORARY HAUL ROAD
		STAGING AREA
		TEMPORARY GRAVEL WALKWAY
		BASE CONDITION WATER LEVEL
		LOWER RIVERBANK STABILIZATION
		UPPER RIVERBANK STABILIZATION
		GRAVEL WALKING TRAIL
		SCOUR POOL

LEGEND NOTE

SYMBOLS AND LEGENDS OF PROJECT FEATURES ARE GRAPHIC REPRESENTATIONS AND ARE NOT NECESSARILY SHOWN ON THE DRAWINGS TO SCALE OR TO THEIR ACTUAL DIMENSION OR LOCATION. COOPERATE DETAIL SHEET DIMENSIONS, MANUFACTURERS' LITERATURE, SHOP DRAWINGS, AND FIELD MEASUREMENTS OF SUPPLIED PRODUCTS FOR LAYOUT OF THE PROJECT FEATURES.

MAP NOTES AND REFERENCES

1. REFERENCES.
   A. COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF TRANSPORTATION STANDARD SPECIFICATIONS FOR HIGHWAY AND BRIDGES, 2022 EDITION, REVISIONS AND ALL CURRENT ADDENDA, ARE MADE A PART HEREOF, AS IF ATTACHED HERETO. ALL REFERENCES TO "THE STANDARD SPECIFICATIONS" SHALL REFER TO THE LATEST EDITION OF THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF TRANSPORTATION STANDARD SPECIFICATIONS FOR HIGHWAYS AND BRIDGES CONSTRUCTION.
   B. THE MASSACHUSETTS DEPARTMENT OF TRANSPORTATION CONSTRUCTION STANDARD DETAILS, 2017 EDITION, AND ALL CURRENT REVISIONS, ARE MADE A PART HEREOF, AS IF ATTACHED HERETO.
   C. THE MASSACHUSETTS EROSION AND SEDIMENT CONTROL GUIDELINES FOR URBAN AND SUBURBAN AREAS, 2013 EDITION, REVISIONS AND ALL CURRENT ADDENDA, ARE MADE A PART HEREOF, AS IF ATTACHED HERETO. ALL REFERENCES TO "NPDES, EROSION AND SEDIMENT CONTROL HANDBOOK" SHALL REFER TO THE LATEST EDITION OF THE MASSACHUSETTS EROSION AND SEDIMENT CONTROL GUIDELINES FOR URBAN AND SUBURBAN AREAS.
2. EXISTING CONDITIONS.
   A. SURVEY: CONTOURS SHOWN ON THIS PLAN THAT ARE OUTSIDE OF THE RIVER AND CASHMAN PARK AREA ARE APPROXIMATE ONLY AND WERE OBTAINED FROM 2013-2014 LIDAR DATA OBTAINED FROM NOAA'S ONLINE DATA ACCESS VIEWER. TOPOGRAPHY WITHIN CASHMAN PARK, BATHYMETRIC SPOT ELEVATIONS (WITHIN THE RIVER), AND SEDIMENT DEPTHS (WITHIN THE RIVER) WERE OBTAINED FROM THE FOLLOWING COMBINATION OF FIELD INVESTIGATIONS AND RESEARCH:
   A.A. ELEVATIONS SHOWN WITHIN RIVER WITH ASTERISKS ARE APPROXIMATE AND WERE OBTAINED ON NOVEMBER 6, 2020 AND ON NOVEMBER 17, 2020 FROM DEPTH MEASUREMENTS TAKEN BY BOAT BY FUSS & O'NEILL AND TOAR MARINE SERVICES, INC.
   A.B. ELEVATIONS IN RIVER AND AT WINTER STREET THAT DO NOT INCLUDE ASTERISKS WERE OBTAINED FROM ACTUAL FIELD SURVEY PERFORMED BY FUSS & O'NEILL IN FALL OF 2021 AND WINTER OF 2022. ELEVATION WITH "I" DESIGNATION REFERS TO TOP OF SEDIMENT ELEVATION. ELEVATION WITH "B" DESIGNATION REFERS TO BOTTOM OF SEDIMENT. ELEVATIONS THAT DO NOT HAVE ASTERISKS OR "I" OR "B" DESIGNATION WERE ALSO OBTAINED FROM ACTUAL FIELD SURVEY.
   A.C. ELEVATION AND BATHYMETRIC DATA WITHIN CASHMAN PARK WAS OBTAINED FROM AN EXISTING CONDITIONS SURVEY PLAN OF CASHMAN PARK, DATED JUNE 1, 2017, AND PREPARED BY BSC SURVEYING AND MAPPING CONSULTANTS.
   B. TOPOGRAPHIC INFORMATION (CONTOURS), BUILDING FOOTPRINTS, EXISTING FEATURES SHOWN OUTSIDE OF THE PROJECT'S RIGHTS OF WAY ARE APPROXIMATE ONLY AND WERE OBTAINED FROM A COMBINATION OF 2013-2014 USGS CMGP LIDAR DATA (OBTAINED FROM NOAA'S ONLINE DATA ACCESS VIEWER) AND MASSGIS DATA LAYER.
   C. WETLAND FLAGGING ALONG LITTLE RIVER WITHIN THE DIRECT PROJECT LIMITS WAS PERFORMED BY FUSS & O'NEILL, INC. (MICHAEL BOMZE, WETLAND SCIENTIST) ON SEPTEMBER 27, 2021 AND APRIL 29, 2022. THE WETLAND FLAGS WERE THEN LOCATED VIA SUB-METER GPS DUE TO SPECIFIC SITE RESTRICTIONS OR SAFETY CONCERNS, IT WAS NOT POSSIBLE TO ACCESS AND FIELD-DELINEATE SOME SEGMENTS OF RIVERBANK AND BORDERING WETLANDS. IN LOCATIONS WHERE A TYPICAL FIELD DELINEATION OF THE BANK, LIVING, AND/OR BVW WAS NOT PRACTICABLE, BOUNDARIES OF RESOURCE AREAS BETWEEN FIELD DELINEATED SEGMENTS WERE COMPLETED IN GIS THROUGH A REVIEW OF AERIAL IMAGERY (2014-2021, SPRING AND SUMMER), FEDERAL AND STATE WETLANDS MAPPING (NATIONAL WETLANDS INVENTORY AND MASS DEP, RESPECTIVELY), AND 1-FOOT CONTOURS (DERIVED FROM 2013-2014 LIDAR). STATE-REGULATED RIVERFRONT AREA MEASURED HORIZONTALLY FROM BANK OF LITTLE RIVER. THE MODIFIED STATE-REGULATED BUFFER ZONE IS MEASURED HORIZONTALLY FROM THE BOUNDARIES OF BVW IDENTIFIED AT THE SITE.
   D. ASSESSOR'S PARCELS, WETLAND BOUNDARIES (UPSTREAM OF THE MBTA BRIDGE AND THE PROJECT'S LIMIT OF DIRECT IMPACTS), POTENTIAL & CERTIFIED VERNAL POOLS. SHOWN ON THESE PLANS ARE APPROXIMATE AND WERE OBTAINED FROM MASSACHUSETTS GEOGRAPHIC INFORMATION SYSTEM (MASSGIS).
3. FLOOD ZONE.
   A. SPECIAL FLOOD HAZARD AREAS (SFHAS), INCLUDING FLOODWAY INFORMATION, SHOWN ON THIS PLAN WERE INITIALLY OBTAINED FROM FEMA FLOOD INSURANCE RATE MAP (FIRM) PANEL NUMBER 25009C0359G WITH AN EFFECTIVE DATE OF JULY 16, 2012 AND FIRM PANEL NUMBERS 25009C0357F, 25009C0358F, AND 25009C0377F WITH AN EFFECTIVE DATE OF JULY 3, 2012 FOR ESSEX COUNTY, MASSACHUSETTS. THESE FLOOD HAZARD AREAS WERE THEN MODIFIED BASED ON THE RESULTS OF MORE DETAILED HYDROLOGIC AND HYDRAULIC ANALYSES (OR PRE-DAM REMOVAL) HYDRAULIC ANALYSIS PERFORMED BY FUSS & O'NEILL USING HEC-RAS. IN ORDER TO ASSESS ANTICIPATED HYDRAULIC IMPACTS AS A RESULT OF THE PROPOSED REMOVAL OF THE DAM. A POST-CONDITIONS (OR POST-DAM REMOVAL) HYDRAULIC MODEL WAS ALSO PREPARED. HORIZONTALLY, THE MODIFIED PRE-CONDITIONS SPECIAL FLOOD AREA BOUNDARIES ARE REFLECTED ON THE EXISTING CONDITIONS PLANS. THE POST-CONDITIONS (OR POST-DAM REMOVAL) SPECIAL FLOOD AREA BOUNDARIES ARE REFLECTED ON THE SITE LAYOUT AND GRADING PLANS.
4. NATURAL HERITAGE DATA:
   THERE ARE NO NHESP PRIORITY HABITATS OF RARE SPECIES, ESTIMATED HABITATS OF RARE WILDLIFE, OR NATURAL COMMUNITIES LOCATED ALONG THE LITTLE RIVER. THERE ARE ALSO NO AREAS OF CRITICAL ENVIRONMENTAL CONCERN ALONG LITTLE RIVER. THERE ARE, HOWEVER, POTENTIAL VERNAL POOLS LOCATED ALONG LITTLE RIVER TO THE SOUTH OF THE RIVER'S CROSSING WITH MAIN AND NORTH OF THE RIVER'S RAILROAD BRIDGE CROSSING. THESE POTENTIAL VERNAL POOLS WERE OBTAINED FROM MASSGIS.
5. UTILITIES.
   UTILITIES SHOWN ON THIS PLAN WERE APPROXIMATED FROM FIELD OBSERVATIONS AND A COLLECTIVE REVIEW OF THE FOLLOWING DOCUMENTS: (1) WINTER STREET AND HALE STREET SEWER DIVERSION PLAN PREPARED BY METCALF & EDDY (DATED JULY 1937), (2) FLOOD PROTECTION SYSTEM IMPROVEMENT PLANS (CWSP-3992, SHEETS 13) PREPARED BY ARCOM ENGINEERING (FEBRUARY 14, 2013), AND (3) ESTIMATED TREE LINE DERIVED UNDER ONEPLOW LONG-TERM CONTROL PLAN AND SUPPLEMENTAL ENVIRONMENTAL IMPACT REPORT PREPARED BY CDM SMITH (DATED FEBRUARY 2017).
6. ACTIVITY AND USE LIMITATION AREAS AND UNDERGROUND STORAGE TANKS:
   ALL PROPERTIES WHERE WORK IS PROPOSED DO NOT HAVE UNDERGROUND STORAGE TANKS. HOWEVER, PARCEL 018-304-1 (83 LAFAYETTE SQUARE) IS CONSIDERED AN AUL (ACTIVITY AND USE LIMITATION) PROPERTY.

GENERAL CONSTRUCTION AND COORDINATION REQUIREMENTS

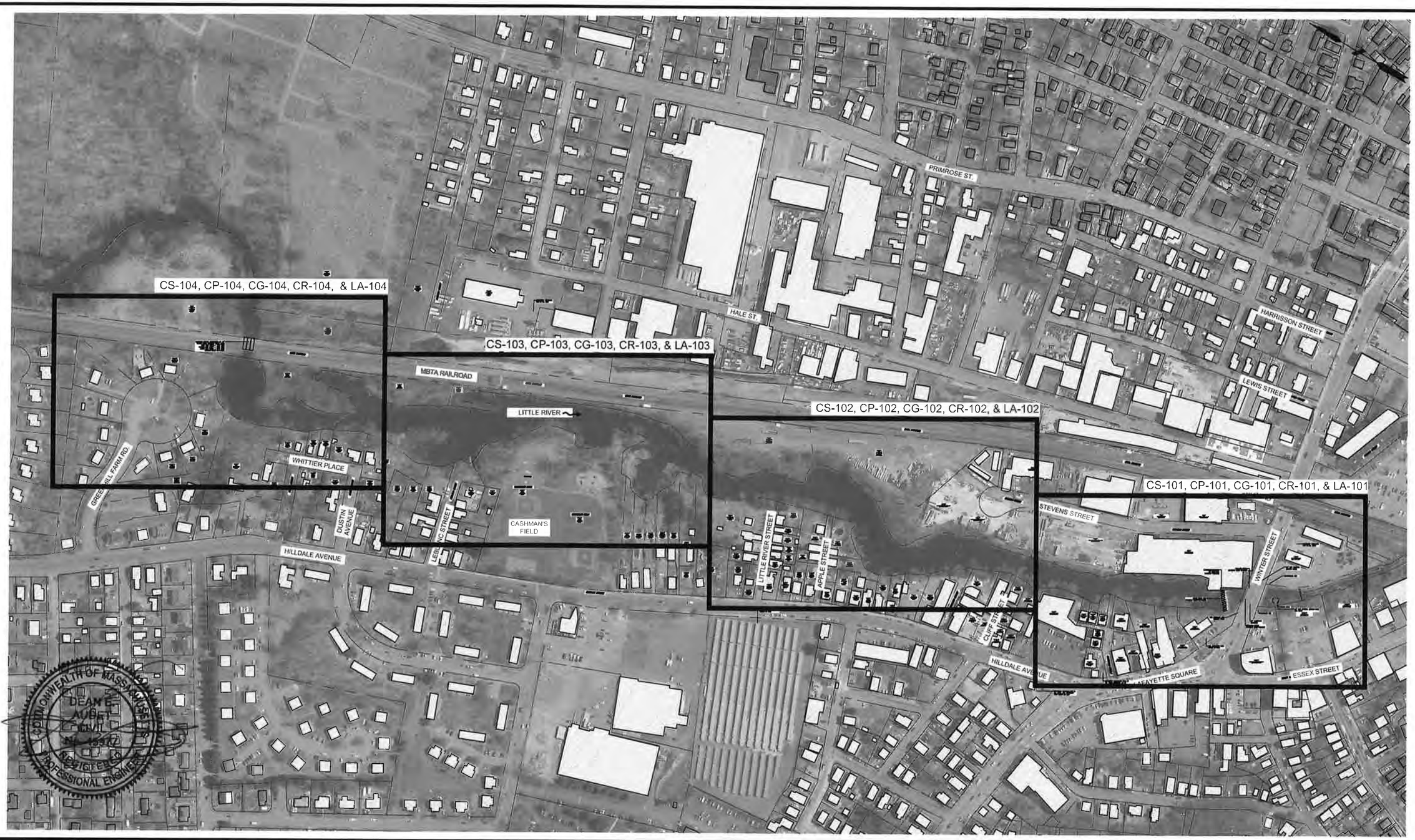
1. THE CONTRACTOR SHALL VERIFY THE LOCATION OF THE EXISTING DAM TO BE REMOVED, EXISTING ADJACENT STRUCTURES, AND THE PROPOSED LAYOUT OF THE RIVER CHANNEL IMPROVEMENTS WITH ITS RELATIONSHIP TO THE EXISTING SITE SURVEY. THE CONTRACTOR SHALL ALSO VERIFY ALL DIMENSIONS, SITE CONDITIONS, AND MATERIAL SPECIFICATIONS AND SHALL NOTIFY THE OWNER AND ENGINEER OF ANY ERRORS, OMISSIONS OR DISCREPANCIES BEFORE COMMENCING OR PROCEEDING WITH WORK.
2. THE CONTRACTOR SHALL TAKE FIELD MEASUREMENTS AS REQUIRED TO FIT THE WORK PROPERLY. RECHECK MEASUREMENTS BEFORE CONSTRUCTING EACH WORK ITEM. WHERE PORTIONS OF THE WORK ARE INDICATED TO FIT TO OTHER CONSTRUCTION, VERIFY DIMENSIONS OF OTHER CONSTRUCTION BY FIELD MEASUREMENTS BEFORE FABRICATION. COORDINATE FABRICATION SCHEDULE WITH CONSTRUCTION PROGRESS TO AVOID DELAYING THE WORK.
3. THE LOCATION OF EXISTING UTILITIES ARE APPROXIMATE, HAVE BEEN PLOTTED FROM THE LATEST AVAILABLE INFORMATION, AND MAY NOT BE ALL INCLUSIVE. THE CONTRACTOR SHALL CHECK AND VERIFY THE LOCATIONS OF ALL EXISTING UTILITIES, BOTH OVERHEAD AND UNDERGROUND, AND "DIG-SAFE" MUST BE NOTIFIED PRIOR TO COMMENCING ANY CONSTRUCTION OPERATIONS. RESTORATION AND REPAIR OF DAMAGE TO EXISTING UTILITIES SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR WITH NO ADDITIONAL COST TO THE OWNER. NO EXCAVATION SHALL COMMENCE UNTIL ALL INVOLVED UTILITY COMPANIES AND/OR TOWN WHOSE FACILITIES MIGHT BE AFFECTED BY ANY WORK TO BE PERFORMED BY THE CONTRACTOR ARE NOTIFIED AT LEAST 72 HOURS IN ADVANCE. RELOCATION OF ANY UTILITIES SHALL BE BY THE OWNERS EXPENSE AND COMPLETED WITH THE UTILITY WORK. THE OWNER SHALL BE NOTIFIED AS TO THE RELOCATIONS REQUIRED PRIOR TO THE START OF CONSTRUCTION.
4. DEVIATIONS OR CHANGES FROM THESE PLANS WILL NOT BE ALLOWED UNLESS APPROVED BY THE ENGINEER/CONTRACT OWNER.
5. THE CONTRACTOR SHALL MAKE EXPLORATORY EXCAVATIONS AND LOCATE ANY EXISTING UTILITIES SUFFICIENTLY AHEAD OF CONSTRUCTION TO PERMIT REVISIONS TO PLANS IF NECESSARY. HOWEVER, EXPLORATORY EXCAVATIONS AND OTHER ACTIVITIES INVOLVING SOIL DISTURBANCES WITHIN THE RIVER OR OTHER ADJACENT WATERCOURSES SHALL BE LIMITED TO THE LOW-FLOW PERIOD (I.E. THE PERIOD FROM JULY 1 TO OCTOBER 31 OF ANY CALENDAR YEAR).
6. THE EXISTENCE AND/OR LOCATION OF UTILITIES SHOWN ON THESE PLANS MAY BE ONLY APPROXIMATELY CORRECT AND THE CONTRACTOR IS REQUIRED TO TAKE PRECAUTIONARY MEASURES TO PROTECT THE UTILITIES SHOWN HEREON AND ANY OTHER EXISTING UTILITIES NOT OF RECORD OR NOT SHOWN ON THESE PLANS. THE CONTRACTOR SHALL BE RESPONSIBLE FOR REPAIRING, AT HIS/HER EXPENSE, ANY EXISTING UTILITIES DAMAGED DURING CONSTRUCTION.
7. THE CONTRACTOR SHALL BE RESPONSIBLE FOR REPLACING, WITH MATCHING MATERIALS, ANY PAVEMENT, WALKS, CURBS, WALLS, FENCES, ETC., THAT MUST BE CUT OR THAT ARE DAMAGED DURING CONSTRUCTION.
8. THE CONTRACTOR SHALL BE RESPONSIBLE FOR OBTAINING ALL REMAINING NECESSARY PERMITS, INSPECTIONS, BONDS, ETC. AND OTHER APPROVAL RELATED ITEMS WITH THE LOCAL AND STATE/FEDERAL MUNICIPALITIES. NO CONSTRUCTION SHALL COMMENCE UNTIL ALL PERMITS HAVE BEEN SECURED AND THE CONTRACTOR IS SUPPLIED THE REQUIRED NOTICES.
9. WORK ON MBTA PROPERTY CAN ONLY BE UNDERTAKEN UPON RECEIPT OF A LICENSE FROM MBTA.
10. AN APPROVED SET OF PLANS AND ALL APPLICABLE PERMITS MUST BE AVAILABLE AT THE SITE THROUGH THE ENTIRE PERIOD OF CONSTRUCTION WHEN WORK IS ACTIVELY OCCURING.
11. CONTRACTOR AGREES THAT HE/SHE SHALL ASSUME SOLE AND COMPLETE RESPONSIBILITY FOR JOB SITE CONDITIONS DURING THE COURSE OF CONSTRUCTION OF THIS PROJECT, INCLUDING SAFETY OF ALL PERSONS AND PROPERTY; THAT THIS REQUIREMENT SHALL APPLY CONTINUOUSLY AND NOT BE LIMITED TO NORMAL WORKING HOURS; AND THAT THE CONTRACTOR SHALL DEFEND, INDEMNIFY AND HOLD THE CONTRACT OWNER (CITY OF HAVERHILL), PROPERTY OWNERS AND THE ENGINEER HARMLESS FROM ANY AND ALL LIABILITY, REAL OR ALLEGED, IN CONNECTION WITH THE PERFORMANCE OF WORK ON THIS PROJECT, EXCEPTING FOR LIABILITY ARISING FROM "THE SOLE NEGLIGENCE OF THE CONTRACT OWNER, PROPERTY OWNER OR THE ENGINEER."
12. PHOTOGRAPHS, VIDEOTAPING, AND SKETCHES (AS NECESSARY) MUST BE TAKEN OF ADJOINING CONSTRUCTION AND SITE IMPROVEMENTS WITHIN 200 FEET OF EXCAVATION LIMITS ASSOCIATED WITH THE DAM REMOVAL AND RIVER CHANNEL IMPROVEMENTS PRIOR TO EXCAVATION AND THE INSTALLATION OF EXCAVATION SUPPORT SYSTEMS. SUCH DOCUMENTATION SHALL ILLUSTRATE EXISTING SURFACES THAT MAY BE MISCONSTRUED AS DAMAGE CAUSED BY THIS PROJECT CONSTRUCTION OPERATIONS.
13. METHODS AND MATERIALS USED IN THE CONSTRUCTION OF IMPROVEMENTS FOR THIS PROJECT SHALL CONFORM TO THE CURRENT CONSTRUCTION STANDARDS AND SPECIFICATIONS OF THE CITY OF HAVERHILL AND THE MASSACHUSETTS DEPARTMENT OF TRANSPORTATION.
14. VERIFY SPACE REQUIREMENTS AND DIMENSIONS OF ITEMS SHOWN ON DRAWINGS. CHECK THE LOCATION, LEVEL AND GRADE, OF EVERY MAJOR ELEMENT AS THE WORK PROGRESSES.
15. ESTABLISH BENCHMARKS AND CONTROL POINTS IN ADDITION TO THOSE INDICATED TO SET LINES, GRADES, AND LEVELS AT EACH STAGE OF CONSTRUCTION. LOCATE THE WORK AND COORDINATE OF THE WORK ACCURATELY, IN CORRECT ALIGNMENT AND ELEVATION, AS INDICATED BOUNDS OR MONUMENTATION DISTURBED DURING CONSTRUCTION SHALL BE SET OR RESET BY A PROFESSIONAL LICENSED SURVEYOR AT NO COST TO THE OWNER.
16. COMPLY WITH MANUFACTURERS' WRITTEN INSTRUCTIONS AND RECOMMENDATIONS FOR INSTALLING MATERIALS AND PRODUCTS. INSTALL PRODUCTS IN STRICT ACCORDANCE WITH THESE INSTRUCTIONS AND UNDER CONDITIONS THAT WILL ENSURE THE BEST POSSIBLE RESULTS. MAINTAIN CONDITIONS REQUIRED FOR PRODUCT PERFORMANCE UNTIL SUBSTANTIAL COMPLETION.
17. USE PRODUCTS, CLEANERS, AND INSTALLATION MATERIALS THAT ARE NOT CONSIDERED HAZARDOUS.
18. CONTRACTOR SHALL IDENTIFY TREES TO BE REMOVED PRIOR TO CONSTRUCTION AND MARK THEM WITH CONSTRUCTION TAPE FOR REVIEW BY THE OWNER/ENGINEER. BRUSH AND OTHER EXISTING VEGETATION SHALL BE RETAINED WHEREVER FEASIBLE. CONTRACTOR SHALL NOT REMOVE TREES UNTIL REVIEWED AND APPROVED BY THE OWNER/ENGINEER.
19. THE CONTRACTOR SHALL RESTORE DISTURBED LANDSCAPE AREAS TO ORIGINAL CONDITION (I.E. SEEDED, SODDED, PLANTED), UNLESS OTHERWISE DIRECTED WITHIN CONTRACT DOCUMENTS.
20. ALL EXCESS EXCAVATED MATERIALS, EXCESS FILL, EXCESS CONSTRUCTION MATERIALS, DEBRIS, AND WASTE (INCLUDING IDENTIFIED CONTAMINATED SOILS WITHIN RIVER) SHALL BE REMOVED FROM THE SITE AND SHALL BE DISPOSED OF IN ACCORDANCE WITH APPLICABLE LAWS.
21. DO NOT CLOSE OR OBSTRUCT ROADWAYS, SIDEWALKS, FIRE HYDRANTS, AND UTILITIES WITHOUT APPROPRIATE PERMITS.
22. WORK IS RESTRICTED TO THE HOURS OF 7 AM TO 5 PM ON MONDAY THROUGH FRIDAY, EXCLUDING HOLIDAYS, UNLESS OTHERWISE APPROVED BY THE OWNER.
23. PRIOR TO CONSTRUCTION, ADDITIONAL CONSTRUCTION ACCESSES AND/OR CONSTRUCTION EASEMENTS NOT SHOWN ON THIS PLAN (AGREED UPON THROUGH COORDINATION BETWEEN CONTRACTOR AND PROPERTY OWNER) MUST BE GRANTED IN WRITING BY PROPERTY OWNER.
24. STOP WORK IN THE VICINITY OF SUSPECTED CONTAMINATED SOIL, GROUNDWATER, OR OTHER MEDIA OUTSIDE OF THE AREA OF CONTAMINATED SOIL AREA IDENTIFIED WITHIN. IMMEDIATELY NOTIFY THE ENGINEER AND OWNER SO THAT APPROPRIATE TESTING AND SUBSEQUENT ACTION CAN BE TAKEN. RESUME WORK IN THE IMMEDIATE VICINITY ONLY UPON DIRECTION BY THE OWNER.

PROTECTION OF WORK REQUIREMENTS

1. THE WORK AND SITE SHALL BE PROTECTED AT ALL TIMES UNTIL FINAL ACCEPTANCE BY THE OWNER. CARE SHALL BE EXERCISED WHILE OPERATING EQUIPMENT ON, AND ADJACENT TO, THE WORK AREA. THE CONTRACTOR SHALL BE RESPONSIBLE TO ASSURE THE UTILIZED EQUIPMENT DOES NOT CAUSE DAMAGE TO EXISTING AND ADJACENT FEATURES NOT SCHEDULED FOR DEMOLITION OR REMOVAL.
2. ACCESS TO VARIOUS PORTIONS OF THE SITE SHALL BE UNDERTAKEN IN SUCH A MANNER THAT THE WORK AND SITE ARE PROTECTED AT ALL TIMES. ACCESS WAYS SHALL BE CONSTRUCTED, ACCESS MAINTAINED, AND PROTECTED WITH SEDIMENT CONTROLS TO PREVENT DAMAGE FROM EROSION DURING MAJOR STORM EVENTS.
3. PLACEMENT AND COMPACTION OF FILL MATERIALS SHALL BE COMPLETED IN ACCORDANCE WITH THE PROJECT MANUAL AND IN SUCH A MANNER THAT THE WORK AND ADJACENT PROPERTIES ARE PROTECTED FROM DAMAGE AT ALL TIMES.
4. CONSTRUCT IN-RIVER IMPROVEMENTS AND MAINTAIN IN-RIVER WORK AREAS IN ACCORDANCE WITH THE PROJECT'S APPROVED WATER CONTROL & CONSTRUCTION SEQUENCING PLANS. IN THE EVENT THAT FLOOD FLOWS ARE EXPECTED TO EXCEED THE ELEVATIONS OF THE PROPOSED TEMPORARY RIVER CROSSINGS AND COFFERDAM SYSTEMS, PROTECT ANY NON-STABLE OR ERODIBLE IMPROVEMENTS USING APPROPRIATELY SIZED STONE RIPRAP MATERIAL (OR SIMILAR) AND REMOVE ALL EQUIPMENT AND PERSONNEL FROM IN-RIVER LOCATIONS.

EROSION AND SEDIMENT CONTROL

1. PRIOR TO THE COMMENCEMENT OF CONSTRUCTION ACTIVITIES, INSTALL ALL EROSION AND SEDIMENT CONTROL DEVICES AS SHOWN ON THE PLAN OR AS REQUIRED BY SITE CONDITIONS. ALL EROSION CONTROL DEVICES WILL BE MAINTAINED THROUGHOUT CONSTRUCTION.
2. DISTURBANCE OF SOIL SURFACES IS REGULATED BY STATE LAW AND LOCAL ORDINANCE. ALL WORK SHALL COMPLY WITH THESE REGULATIONS. SEDIMENT CONTROL NOTES AND OTHER PERMIT CONDITIONS TO PREVENT OR MINIMIZE SOIL EROSION AND SEDIMENTATION TO OFF-SITE AREAS.
3. THE CONTRACTOR SHALL COMPLY WITH THE LATEST EDITION OF THE "MASSACHUSETTS EROSION AND SEDIMENT CONTROL GUIDELINES FOR URBAN AND SUBURBAN AREAS" IN CONSTRUCTING THE EROSION AND SEDIMENT CONTROLS INDICATED ON THE PLANS. ALL EROSION AND SEDIMENT CONTROL MEASURES OR MODES AND REHABILITATION MEASURES MUST CONFORM TO OR EXCEED THE SPECIFICATIONS OR STANDARDS SET OUT IN THIS DOCUMENT.
4. THE CONTRACTOR IS RESPONSIBLE FOR THE TIMELY INSTALLATION, INSPECTION, MAINTENANCE, AND/OR REPLACEMENT OF ALL TEMPORARY AND PERMANENT EROSION CONTROL DEVICES SHOWN ON THESE PLANS TO ENSURE PROPER OPERATION THROUGHOUT THE LIFE OF THE PROJECT. REMOVE EROSION AND SEDIMENTATION CONTROLS AFTER STABLE VEGETATIVE GROWTH IS ESTABLISHED BY THE OWNER, ENGINEER OR LANDSCAPE ARCHITECT.
5. THE CONTRACTOR SHALL INSPECT EROSION AND SEDIMENT CONTROL DEVICES ON A WEEKLY BASIS, AFTER EACH STORM EVENT, AND AT LEAST DAILY DURING PROLONGED RAINFALL. CLEAN OUT ACCUMULATED SEDIMENT BEHIND CONTROLS. REPAIR OR REPLACE CONTROLS PROMPTLY AS NEEDED. REMOVE ACCUMULATED SEDIMENT FROM BEHIND PERIMETER CONTROLS (I.E. BIODEGRADABLE COIR ROLLS AND SILT FENCES) WHEN ONE-THIRD OF THE ORIGINAL HEIGHT OF THE CONTROLS BECOME FILLED WITH SEDIMENT. DISPOSE OF REMOVED SEDIMENT IN ON-SITE FILL AREAS OR LAWFULLY OFF-SITE.
6. TREES AND OTHER EXISTING VEGETATION NOT WITHIN THE LIMITS OF DISTURBANCE SHALL BE PROTECTED FROM DAMAGE. VEGETATED AREAS AND/OR TREES DAMAGED THAT ARE NOT PLANNED FOR REMOVAL SHALL BE RESTORED TO THEIR ORIGINAL CONDITION OR BETTER TO THE SATISFACTION OF THE CITY.
7. IT SHALL BE THE CONTRACTOR'S RESPONSIBILITY TO CLEAN ROADS, CONTROL DUST, AND TAKE ALL NECESSARY MEASURES TO ENSURE THAT THE SITE AND ALL ADJACENT ROADS AND PARKING AREAS BE MAINTAINED IN A MUD- AND DUST-FREE CONDITION AT ALL TIMES THROUGHOUT THE LIFE OF THE CONTRACT. DUST CONTROL SHALL INCLUDE, BUT IS NOT LIMITED TO, WATER AND/OR CRUSHED STONE OR CRUSHED GRAVEL.
8. ALL PROPOSED TEMPORARY STONE CONSTRUCTION ENTRANCES SHALL BE CONSTRUCTED AS SHOWN ON THE PLANS AND DETAILS. ALL VEHICLE TRAFFIC ENTERING OR EXITING THE PROJECT SITE SHALL PASS OVER THE CONSTRUCTION ENTRANCES TO REDUCE THE TRACKING OR FLOWING OF SEDIMENT ONTO THE SURROUNDING ROADWAYS. ENTRANCES SHALL BE MAINTAINED IN A CONDITION THAT WILL PREVENT TRACKING OR FLOWING OF SEDIMENT ONTO THE SURROUNDING ROADWAYS. THIS WILL REQUIRE PERIODIC TOP DRESSING WITH ADDITIONAL STONE OR ADDITIONAL LENGTH AS CONDITIONS DEMAND AND REPAIR AND/OR CLEANOUT OF ANY MEASURES USED TO TRAP SEDIMENT. ALL SEDIMENT SPILLED, DROPPED, WASHED, OR TRACKED ONTO THE SURROUNDING ROADWAYS AND PARKING AREAS MUST BE REMOVED IMMEDIATELY. ADDITIONAL ENTRANCES FOR CONSTRUCTION PHASING SHALL BE INSTALLED AS REQUIRED TO PREVENT TRACKING OR FLOWING OF SEDIMENT ONTO ROADWAYS.
9. THE CONTRACTOR SHALL INSTALL ALL PERIMETER SEDIMENT CONTROL BARRIERS (I.E. SILT FENCE) AS SHOWN ON THE PLANS. A SILT FENCE SHALL ALSO BE INSTALLED AROUND ANY SOIL STOCKPILE AREAS.
10. TEMPORARY VEGETATIVE COVER SHALL BE ESTABLISHED IMMEDIATELY IN ANY DISTURBED AREAS THAT HAVE NOT YET REACHED FINISHED GRADE AND CONSTRUCTION IS NOT EXPECTED TO RESUME FOR MORE THAN 14 DAYS. TEMPORARY VEGETATIVE COVER SHALL CONSIST OF SHORT-TERM EROSION CONTROL SEED (SUBSECTION M6.03.1 OF THE MASSDOT STANDARD SPECIFICATIONS) FROM APRIL 1 TO JUNE 1 AND AUGUST 15 TO OCTOBER 15. MAY ALSO BE INSTALLED BETWEEN OCTOBER 15 TO MARCH 31 IF COVERED WITH TEMPORARY MULCHING. SEED AT A RATE OF 75 LBS/ACRE BY HAND.
11. PERMANENT VEGETATIVE COVER SHALL BE ESTABLISHED TO ALL DISTURBED AREAS THAT HAVE REACHED FINISHED GRADE AS SOON AS POSSIBLE, BUT NOT MORE THAN 14 DAYS AFTER THE CONSTRUCTION ACTIVITY IN THAT AREA HAS PERMANENTLY CEASED. SEEDING OF PERMANENT SEED MIXES DATED APRIL 1 TO JUNE 1 AND SEPTEMBER 15 TO OCTOBER 15. REFER TO RESTORATION PLANS FOR PERMANENT VEGETATIVE COVER SEED MIXTURES AND APPLICATION RATES. ALL PLANTINGS AND SEED MIXES SHALL BE CONSTRUCTED BY A ONE-YEAR WARRANTY PERIOD. REWEEDING/RE-PLANTING SHALL BE COMPLETED TO ENSURE STABLE VEGETATIVE COVER IS ESTABLISHED OVER ALL DISTURBED AREAS.
12. IF PERMANENT SEEDING CANNOT BE COMPLETED WITHIN 14 DAYS OF THE COMPLETION OF CONSTRUCTION OR WITHIN THE RECOMMENDED SEEDING DATES, TEMPORARY BIODEGRADABLE EROSION CONTROL BLANKETING (CONTAINING NO PLASTIC COMPONENTS) OR MULCHING SHALL BE SPREAD/INSTALLED OVER ALL DISTURBED AREAS TO PROTECT THE SITE UNTIL ARRIVAL OF THE NEXT RECOMMENDED SEEDING PERIOD. MULCHING OR BLANKETING SHOULD BE INSTALLED AS SOON AS POSSIBLE IF SEEDING IS INSTALLED BETWEEN OCTOBER 15 AND MARCH 31, BUT NOT MORE THAN 14 DAYS AFTER THE CONSTRUCTION ACTIVITY IN THAT AREA HAS TEMPORARILY CEASED. IF PERMANENT SEEDING IS INSTALLED IN JULY AND AUGUST, APPLY WATER TO SEEDED AREAS ON A DAILY BASIS.
13. BLANKETING OR MULCHING MUST BE INSPECTED PERIODICALLY, IN PARTICULAR AFTER RAINSTORMS, TO CHECK FOR RILL EROSION. WHERE EROSION IS OBSERVED, ADDITIONAL MULCH MUST BE APPLIED OR BLANKETING REPAIRED OR REPLACED. INSPECTIONS SHALL TAKE PLACE UNTIL VEGETATION IS THOROUGHLY ESTABLISHED.
14. INSPECT PERMANENT TURF REINFORCEMENT MATTING AT LEAST ONCE A WEEK AND WITHIN 24 HOURS OF THE END OF A STORM WITH A RAINFALL AMOUNT OF 0.5 INCH OR GREATER FOR FAILURES UNTIL THE TURF HAS BECOME ESTABLISHED. MAT FAILURE HAS OCCURRED WHEN SOIL AND/OR SEED HAVE WASHED AWAY FROM BENEATH OR WITHIN THE MAT RESULTING IN A SOIL SURFACE THAT CAN BE EXPECTED TO CONTINUE TO ERODE OR WHEN THE MAT HAS BECOME DISLODGED FROM THE SOIL SURFACE. WHEN REPETITIVE FAILURES OCCUR AT THE SAME LOCATION, REVIEW CONDITIONS AND LIMITATIONS OF T



COMMONWEALTH OF MASSACHUSETTS
DEANE AUBERT
CIVIL
No. 45317
REGISTERED PROFESSIONAL ENGINEER

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER

SCALE:
HORZ.: 1" = 300'
VERT.:
DATUM:
HORZ.: NAD83
VERT.: NAVD88
0 150 300
GRAPHIC SCALE

FUSS & O'NEILL
1550 MAIN STREET, SUITE 400
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CITY OF HAVERHILL

INDEX PLAN

LITTLE RIVER DAM REMOVAL AND RESTORATION

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

GI-003

File: J:\DWG\P2017\0390\U30\Civil\Plan\20170390U30_IND01.dwg Layout: 11X17-GI-003 Plotted: 2022-12-08 3:13 PM Saved: 2022-12-06 1:46 PM User: CNauman
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STEVENS STREET

MBTA RAILROAD

WINTER STREET

LITTLE RIVER

LITTLE RIVER DAM
SPILLWAY CREST EL.=18.6±

FORMER/ABANDONED
12' WIDE MILL
RACEWAY CHANNEL

16'Wx8'H STONE
MASONRY ARCH CULVERT

54" RCP OUTFALL
(NPDES 021H)

PROPERTY CONTAINS
UST ID No. 5252

BENCHMARK 302

BENCHMARK 301

SCOUR HOLE

42" RCP OUTFALL (NPDES 038)
INV. 11.39

21" OVERFLOW
(LR0934)

30'Wx14'H STONE
MASONRY ARCH CULVERT

BIT. SIDEWALK AND
GRANITE CURB

AUL PROPERTY WITH
CLASS B2 RAO

200' RIVERFRONT AREA

100' BUFFER ZONE

50' NO BUILD ZONE

25' NO DISTURBANCE ZONE

FLOODWAY

100YR

500YR

LAFAYETTE SQUARE

ESSEX STREET

LEGEND:

FLOODWAY	FEMA FLOODWAY
100YR	100-YEAR FLOOD ELEVATION
500YR	500-YEAR FLOOD ELEVATION
AA100	WETLAND DELINEATION FLAG
	BANK/MEAN ANNUAL HIGH WATER
	BORDERING VEGETATED WETLANDS
	25' NO DISTURBANCE ZONE
	50' NO BUILD ZONE
	100' BUFFER ZONE
	200' RIVERFRONT AREA
	BASE CONDITION FLOW LIMITS / MEAN ANNUAL LOW WATER
	PARCEL BOUNDARY
D	DRAIN/CSO LINE
W	WATER LINE
G	GAS LINE
E/T	ELECTRIC/TELEPHONE LINE
	CATCH BASIN
	EXISTING GROUND OR BOTTOM OF RIVER CHANNEL CONTOUR
100	WATER GATE / GAS GATE
	TREE LINE

COMMONWEALTH OF MASSACHUSETTS
DEAN E. AUDET
CIVIL
NO. 45977
REGISTERED
PROFESSIONAL ENGINEER

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER

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VERT.:
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VERT.: NAVD88
0 35 70
GRAPHIC SCALE

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CITY OF HAVERHILL

EXISTING CONDITIONS PLAN NO. 1

LITTLE RIVER DAM REMOVAL AND RESTORATION

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

CS-101

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MATCH LINE SEE SHEET CS-101

MBTA RAILROAD

LITTLE RIVER

LITTLE RIVER STREET

APPLE STREET

STEVENS STREET

BENJAMIN STREET

CLIFF STREET

FLOODWAY

100YR

500YR

50' NO BUILD ZONE

25' NO DISTURBANCE ZONE

100' BUFFER ZONE

200' RIVERFRONT AREA

LEGEND:

FLOODWAY	FEMA FLOODWAY
100YR	100-YEAR FLOOD ELEVATION
500YR	500-YEAR FLOOD ELEVATION
AA100	WETLAND DELINEATION FLAG
	BANK/MEAN ANNUAL HIGH WATER
	BORDERING VEGETATED WETLANDS
	25' NO DISTURBANCE ZONE
	50' NO BUILD ZONE
	100' BUFFER ZONE
	200' RIVERFRONT AREA
	BASE CONDITION FLOW LIMITS / MEAN ANNUAL LOW WATER
	PARCEL BOUNDARY
D	DRAIN/CSO LINE
W	WATER LINE
G	GAS LINE
E/T	ELECTRIC/TELEPHONE LINE
	CATCH BASIN
	EXISTING GROUND OR BOTTOM OF RIVER CHANNEL CONTOUR
WG	WATER GATE / GAS GATE
	TREE LINE

COMMONWEALTH OF MASSACHUSETTS
DEAN E. AUDET
CIVIL
No. 45907
REGISTERED PROFESSIONAL ENGINEER

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER

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CITY OF HAVERHILL

EXISTING CONDITIONS PLAN NO. 2

LITTLE RIVER DAM REMOVAL AND RESTORATION

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

CS-102

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MS VIEW:

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MATCH LINE SEE SHEET CS-102

MBTA RAILROAD

LITTLE RIVER

CASHMAN'S FIELD

SKATE PARK

LEBLANC STREET

100' BUFFER ZONE

50' NO BUILD ZONE

25' NO DISTURBANCE ZONE

200' RIVERFRONT AREA

BUILDING NOT PRESENT DURING WETLAND DELINEATION ON 9/27/21

LEGEND:

FLOODWAY	FEMA FLOODWAY
100YR	100-YEAR FLOOD ELEVATION
500YR	500-YEAR FLOOD ELEVATION
AA100	WETLAND DELINEATION FLAG
	BANK/MEAN ANNUAL HIGH WATER
	BORDERING VEGETATED WETLANDS
	25' NO DISTURBANCE ZONE
	50' NO BUILD ZONE
	100' BUFFER ZONE
	200' RIVERFRONT AREA
	BASE CONDITION FLOW LIMITS / MEAN ANNUAL LOW WATER
	PARCEL BOUNDARY
D	DRAIN/CSO LINE
W	WATER LINE
G	GAS LINE
E/T	ELECTRIC/TELEPHONE LINE
	CATCH BASIN
	EXISTING GROUND OR BOTTOM OF RIVER CHANNEL CONTOUR
	WATER GATE / GAS GATE
	TREE LINE

COMMONWEALTH OF MASSACHUSETTS
DEAN E. AUDET
CIVIL
No. 45977
REGISTERED
PROFESSIONAL ENGINEER

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER

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CITY OF HAVERHILL

EXISTING CONDITIONS PLAN NO. 3

LITTLE RIVER DAM REMOVAL AND RESTORATION

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

CS-103

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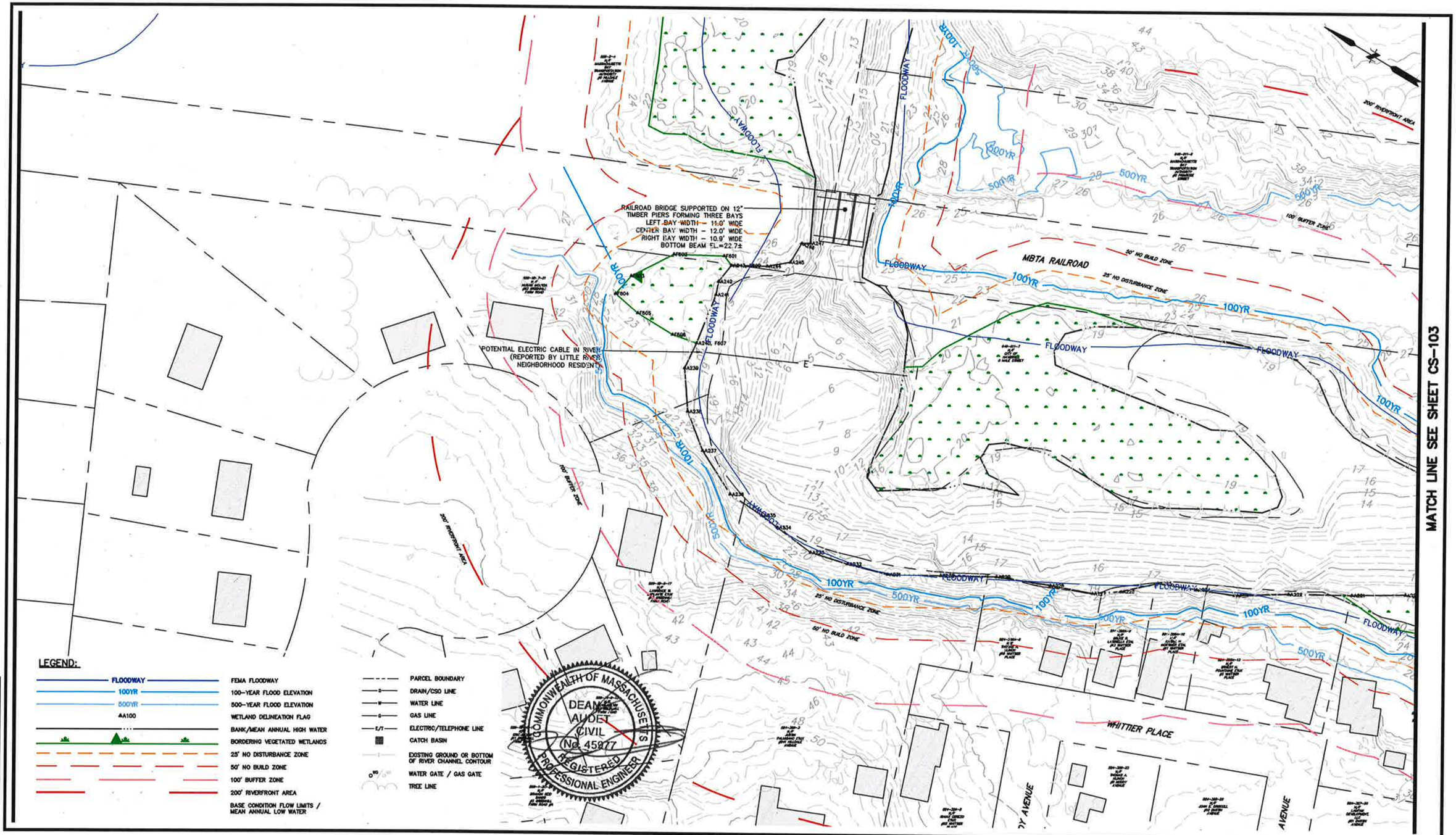

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CITY OF HAVERHILL

EXISTING CONDITIONS PLAN NO. 4

LITTLE RIVER DAM REMOVAL AND RESTORATION

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

CS-104

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LIMIT OF DISTURBANCE (TYP.)
TEMPORARY COFFERDAM (TYP.)
CLEARING LIMIT (TYP.)
UPPER RIVERBANK STABILIZATION AND FLOODPLAIN RESTORATION AREA (TYP.)
12" DIA. BIODEGRADABLE FIBER ROLL/VEGETATED COIR FASCINE (TYP.)
LOWER RIVER SLOPE STABILIZATION (TYP.)
TEMPORARY HAUL ROAD (TYP.)
TEMPORARY RIVER CROSSING (TYP.)
STEVENS STREET
MBTA RAILROAD
WINTER STREET
PROPERTY CONTAINS UST ID No. 5252
REMOVE AND DISPOSE OF DAM
FORMER/ABANDONED 12' WIDE MILL RACEWAY CHANNEL
16'W x 8'H STONE MASONRY ARCH CULVERT
54" RCP OUTFALL (NPDES 021H)
BENCHMARK 302
42" RCP OUTFALL (NPDES 038) INV. 11.39
FLOATING TYPE 3 PERMEABLE TURBIDITY BARRIER
RESTORE SIDEWALK AND GRANITE CURB TO PREVIOUS CONDITION OR BETTER. RE-USE GRANITE CURB IF POSSIBLE.
CONSTRUCTION EQUIPMENT AND STAGING AREA
AUL PROPERTY WITH CLASS B2 RAO
SILT FENCE FOR TEMPORARY STONE CONSTRUCTION ACCESS ROUTE AND STAGING AREA. RESTORE EXISTING FENCE TO PREVIOUS CONDITION OF BETTER.
GRANVILLE STREET
LAFAYETTE SQUARE
ESSEX STREET
PROPERTY CONTAINED USTs ID No. 5235 (REMOVED AS OF 7/30/20); FORMER AUL

NOTES:

1. IMPLEMENT AND MAINTAIN CONSTRUCTION ACCESS STABILIZATION MEASURES THROUGHOUT CONSTRUCTION. REMOVE ALL SUCH MEASURES AND STABILIZE/RESTORE ALL DISTURBED AREAS FOLLOWING CONSTRUCTION.
2. SUCH MEASURES SHALL BE COMPLETED BY THE CONTRACTOR AND ACCEPTED BY THE ENGINEER PRIOR TO INITIATION OF CONSTRUCTION ACTIVITIES.
3. REFER TO RIVER RESTORATION PLAN AND LANDSCAPE AND PLANTING PLAN FOR POST-CONSTRUCTION RESTORATION MEASURES (SEEDING AND PLANTING).
4. REFER TO WATER CONTROL AND CONSTRUCTION SEQUENCING PLAN FOR INSTALLATION OF HAUL ROADS, TEMPORARY COFFERDAMS AND FLOATING TURBIDITY CURTAIN(S).

COMMONWEALTH OF MASSACHUSETTS
DEAN E. AUDET
CIVIL
NO. 45977
REGISTERED PROFESSIONAL ENGINEER

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER

SCALE:
HORZ.: 1" = 70'
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0 35 70
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CITY OF HAVERHILL

SITE PREPARATION AND EROSION CONTROL PLAN NO. 1

LITTLE RIVER DAM REMOVAL AND RESTORATION

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

CP-101

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MBTA RAILROAD

AREA OF CONTAMINATED SEDIMENT TO BE REMOVED

TEMPORARY HAUL ROAD (TYP.)

TEMPORARY HAUL ROAD BUMP OUTS (TYP.)

TEMPORARY RIVER CROSSING (TYP.)

UPPER RIVERBANK STABILIZATION AND FLOODPLAIN RESTORATION AREA (TYP.)

12" DIA. BIODEGRADABLE FIBER ROLL/VEGETATED COIR FASCINE (TYP.)

LOWER RIVER SLOPE STABILIZATION (TYP.)

TEMPORARY COFFERDAM (TYP.)

CLEARING LIMIT (TYP.)

LIMIT OF DISTURBANCE (TYP.)

STONE PROTECTION AT EXISTING OUTFALL

LOD

STEVENS STREET

LITTLE RIVER STREET

APPLE STREET

BENJAMIN STREET

CLIFF ST...ET

COMMONWEALTH OF MASSACHUSETTS
DEAN E. AUDET
CIVIL
No. 45077
REGISTERED
PROFESSIONAL ENGINEER

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER

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CITY OF HAVERHILL

SITE PREPARATION AND EROSION CONTROL PLAN NO. 2

LITTLE RIVER DAM REMOVAL AND RESTORATION

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

CP-102

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COMMONWEALTH OF MASSACHUSETTS
DEAN E. AUDET
CIVIL
No. 45977
REGISTERED
PROFESSIONAL ENGINEER

TEMPORARY COFFERDAM (TYP.)

TEMPORARY HAUL ROAD (TYP.)

TEMPORARY HAUL ROAD BUMP OUTS (TYP.)

MBTA RAILROAD

TEMPORARY RIVER CROSSING (TYP.)

UPPER RIVERBANK STABILIZATION AND FLOODPLAIN RESTORATION AREA (TYP.)

12" DIA. BIODEGRADABLE FIBER ROLL/VEGETATED COIR FASCINE (TYP.)

LOWER RIVER SLOPE STABILIZATION (TYP.)

MBTA RAILROAD

CLEARING LIMIT (TYP.)

LIMIT OF DISTURBANCE (TYP.)

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SKATE PARK

LEBLANC STREET

LOD

CSF

SILT FENCE AND 6' HIGH TEMPORARY CHAINLINK CONSTRUCTION FENCE TO ENCOMPASS TEMPORARY STONE CONSTRUCTION ACCESS ROUTE AND STAGING AREA (TYP.)

CASHMAN'S FIELD

PLACE SILT FENCE AND CONSTRUCTION FENCE AROUND KAYAK/CANOE LAUNCH PATH ONLY DURING THAT PHASE OF WORK TO PRESERVE PEDESTRIAN ACCESS TO PLAYGROUNG

TEMPORARY 5' WIDE COMPACTED GRAVEL PEDESTRIAN WALKWAY (FOR SKATE PARK ACCESS)

RESTORE CHAIN LINK FENCE TO PREVIOUS CONDITION OR BETTER

CONSTRUCTION EQUIPMENT, STAGING, AND SOIL STORAGE AREAS (TYP.)

TEMPORARY 5' WIDE COMPACTED GRAVEL PEDESTRIAN WALKWAY (FOR SKATE PARK ACCESS)

REMOVE SECTION OF WOOD GUARDRAIL AND CONNECT TEMPORARY GRAVEL PEDESTRIAN WALKWAY TO EXIST. BITUMINOUS SIDEWALK; FOLLOWING CONSTRUCTION, REMOVE WALKWAY AND RESTORE DISTURBED LAWN AREAS

INSET 2

MATCH LINE SEE INSET 2

MATCH LINE SEE INSET 1

SILT FENCE AND 6' HIGH TEMPORARY CHAINLINK CONSTRUCTION FENCING TO SURROUND TEMPORARY STONE CONSTRUCTION ACCESS ROUTE (TYP.)

TEMPORARY 5' WIDE COMPACTED GRAVEL PEDESTRIAN WALKWAY (FOR PLAYGROUND ACCESS)

GATED ENTRANCE TO CONSTRUCTION ACCESS ROUTE; SECURE/LOCK GATES AT END OF WORK DAY

FOLLOWING CONSTRUCTION: RESTORE SIDEWALK, CURBING, GATE, WOODEN GUARDRAIL, GRAVEL WALKWAY AND DRIVEWAY TO PREVIOUS CONDITION OR BETTER

TEMPORARY STONE CONSTRUCTION ACCESS

HILLDALE AVENUE

INSET 1

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER

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CITY OF HAVERHILL

SITE PREPARATION AND EROSION CONTROL PLAN NO. 3

LITTLE RIVER DAM REMOVAL AND RESTORATION

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

CP-103

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COMMONWEALTH OF MASSACHUSETTS
DEAN E. AUDET
CIVIL
No. 45977
REGISTERED PROFESSIONAL ENGINEER

RAILROAD BRIDGE SUPPORTED ON 12" TIMBER PIERS FORMING THREE BAYS
LEFT BAY WIDTH – 11.0' WIDE
CENTER BAY WIDTH – 12.0' WIDE
RIGHT BAY WIDTH – 10.9' WIDE
BOTTOM BEAM EL.=22.74

POTENTIAL ELECTRIC CABLE IN RIVER (REPORTED BY LITTLE RIVER NEIGHBORHOOD RESIDENT)

TEMPORARY RIVER CROSSING (TYP.)
TEMPORARY COFFERDAM (TYP.)
TEMPORARY HAUL ROAD (TYP.)
TEMPORARY HAUL ROAD BUMP OUTS (TYP.)
MBTA RAILROAD
CLEARING LIMIT (TYP.)
LIMIT OF DISTURBANCE (TYP.)
UPPER RIVERBANK STABILIZATION AND FLOODPLAIN RESTORATION AREA (TYP.)
12" DIA. BIODEGRADABLE FIBER ROLL/VEGETATED COIR FASCINE (TYP.)
LOWER RIVER SLOPE STABILIZATION (TYP.)
LOD
WHITTIER PLACE

MATCH LINE SEE SHEET CP-103

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER

SCALE:
HORZ.: 1" = 70'
VERT.:
DATUM:
HORZ.: NAD83
VERT.: NAVD88
0 35 70
GRAPHIC SCALE

FUSS & O'NEILL
1550 MAIN STREET, SUITE 400
SPRINGFIELD, MA 01103
413.452.0445
www.fando.com

CITY OF HAVERHILL

SITE PREPARATION AND EROSION CONTROL PLAN NO. 4

LITTLE RIVER DAM REMOVAL AND RESTORATION

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

CP-104

File: J:\DWG\P2017\03390\U30\Civil\Plan\20170390U30_ERO01.dwg Layout: 11X17-CP-104 Plotted: 2022-12-08 3:16 PM Saved: 2022-12-07 1:56 PM User: CNauman
PC3: AUTOCAD PDF (GENERAL DOCUMENTATION).PC3 STB\CTB: FO HALF.STB
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MATCH LINE SEE SHEET CG-102

COMPACTED GRAVEL WALKING TRAIL EL. 23.0±

UPPER RIVERBANK STABILIZATION AND FLOODPLAIN RESTORATION AREA (TYP.)

PROPOSED 100 YEAR WATER SURFACE ELEVATION (TYP.)

12" DIA. BIODEGRADABLE FIBER ROLL/VEGETATED COIR FASCINE (TYP.)

APPROXIMATE LOCATION OF PORTAGE ACCESS FOR KAYAK/CANOE

LOWER RIVER SLOPE STABILIZATION (TYP.) CHOICE OF NATURAL OR STONE TO BE DETERMINED IN THE FIELD BY THE ENGINEER, SEE CONSTRUCTION DETAILS SHEET CD-502

SIGNAGE TO PROTECT PUBLIC FROM PADDLING FURTHER DOWNSTREAM

POOL BOTTOMS AND BANKS FORMED WITH NATIVE STABLE STONE/COBBLES INFILLED WITH NATIVE SEDIMENT AND INTERSPERSED SMALL/MEDIUM BOULDERS (TYP.)

SLOPE PROTECTION RETAINING WALL (SEE STRUCTURAL PLANS AND DETAILS)
TOP EL. VARIES BETWEEN EL. 18.5 TO EL 15.0
BOTTOM EL. VARIES BETWEEN EL. 14.0 TO EL 9.0

SLOPE PROTECTION RETAINING WALL (SEE STRUCTURAL PLANS AND DETAILS)
TOP EL. VARIES BETWEEN EL. 25.0 TO EL 22.0
BOTTOM EL. VARIES BETWEEN EL. 17.0 TO EL. 11.5

STEVENS STREET

MBTA RAILROAD

WINTER STREET

GRANVILLE STREET

LAFAYETTE SQUARE

ESSEX STREET

PROPERTY CONTAINS UST ID No. 5252

PROPERTY CONTAINED USTs ID No. 5235 (REMOVED AS OF 7/30/20); FORMER AUL

54" RCP OUTFALL (NPDES 021H)

42" RCP OUTFALL (NPDES 038) INV. 11.39

BENCHMARK 302

BENCHMARK 301

FORMER RACEWAY CHANNEL

BIT. SIDEWALK AND GRANITE CURB

100YR

LOD

COMMONWEALTH OF MASSACHUSETTS
DEAN E. AUDET
CIVIL
No. 43977
REGISTERED PROFESSIONAL ENGINEER

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER

SCALE:
HORZ.: 1" = 70'
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HORZ.: NAD83
VERT.: NAVD88
0 35 70
GRAPHIC SCALE

CITY OF HAVERHILL

SITE LAYOUT AND GRADING PLAN NO. 1

LITTLE RIVER DAM REMOVAL AND RESTORATION

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

CG-101

MS VIEW:
LAYER STATE:

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MS VIEW:

MATCH LINE SEE SHEET CG-103

MATCH LINE SEE SHEET CG-101

PROPOSED 100 YEAR WATER SURFACE ELEVATION (TYP.)

SCOUR POOL #5
POOL BOTTOM EL.=8.70
POOL BOTTOM FORMED WITH NATIVE STABLE STONE/COBBLES INFILLED WITH NATIVE SEDIMENT (TYP.)

GRADE CONTROL BOULDER WEIR #5
TOP OF WEIR EL.= 11.22
3.5' WIDE NOTCH INV. EL.=10.22

COMPACTED GRAVEL WALKING TRAIL
EL. 23.0±

UPPER RIVERBANK STABILIZATION AND FLOODPLAIN RESTORATION AREA (TYP.)

12" DIA. BIODEGRADABLE FIBER ROLL/VEGETATED COIR FASCINE (TYP.)

LOWER RIVER SLOPE STABILIZATION (TYP.)
CHOICE OF NATURAL OR STONE TO BE DETERMINED IN THE FIELD BY THE ENGINEER, SEE CONSTRUCTION DETAILS SHEET CD-502

MBTA RAILROAD

GRADE CONTROL BOULDER WEIR #6
TOP OF WEIR EL.= 11.22
3.5' WIDE NOTCH INV. EL.=10.22

STEVENS STREET

SCOUR POOL #6
POOL BOTTOM EL.=8.00
POOL BOTTOM FORMED WITH NATIVE STABLE STONE/COBBLES INFILLED WITH NATIVE SEDIMENT (TYP.)

LITTLE RIVER STREET

APPLE STREET

BENJAMIN STREET

CLIFF STREET

100YR

LOD

COMMONWEALTH OF MASSACHUSETTS
DEAN R. AUDET
CIVIL
No. 45977
REGISTERED
PROFESSIONAL ENGINEER

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER

SCALE:
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DATUM:
HORZ.: NAD83
VERT.: NAVD88
0 35 70
GRAPHIC SCALE

CITY OF HAVERHILL

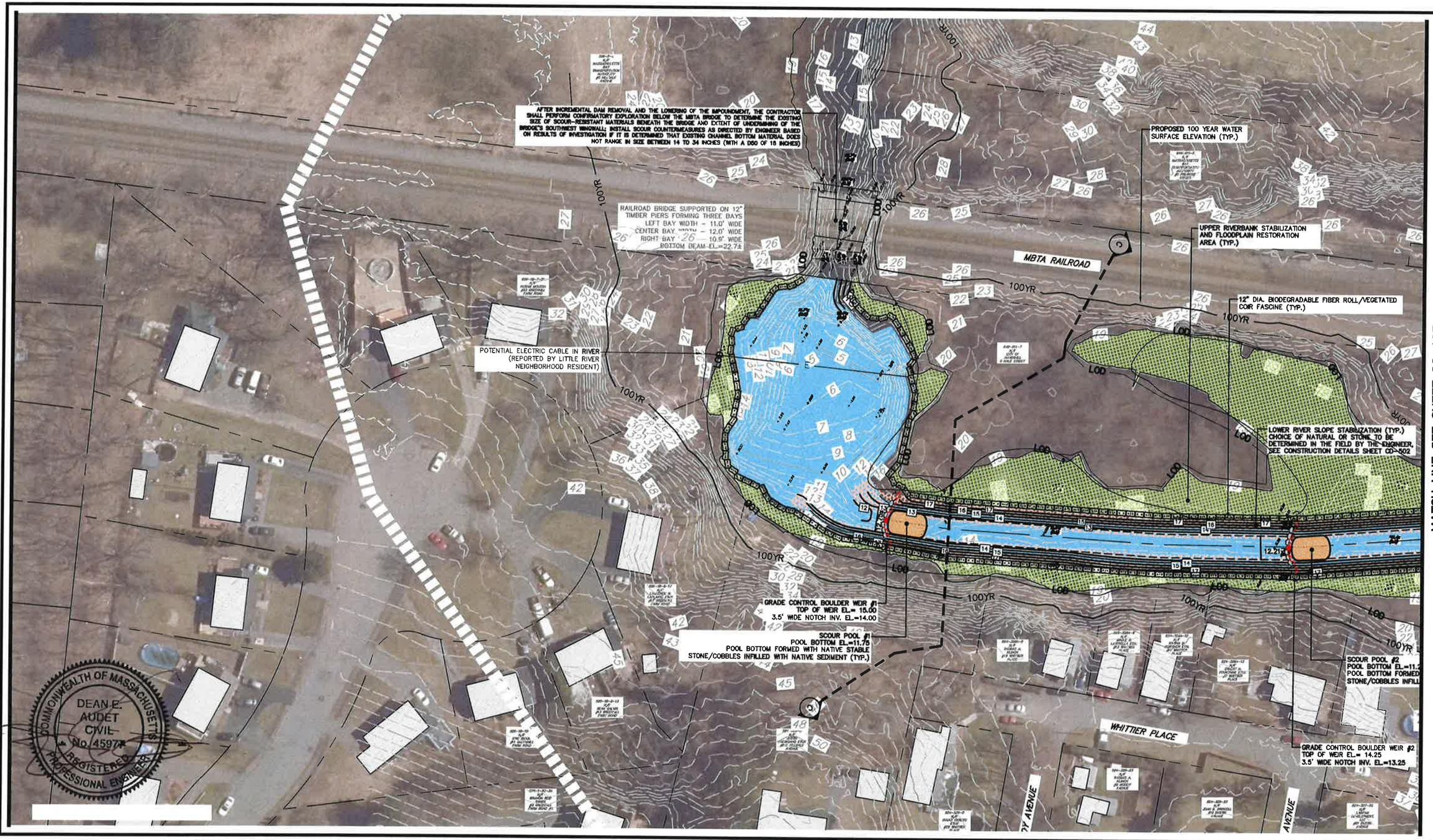
SITE LAYOUT AND GRADING PLAN NO. 2

LITTLE RIVER DAM REMOVAL AND RESTORATION

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

CG-102



MATCH LINE SEE SHEET CG-103

COMMONWEALTH OF MASSACHUSETTS
DEAN E. AUDET
CIVIL
No. 45974
REGISTERED PROFESSIONAL ENGINEER

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER

SCALE:
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0 35 70
GRAPHIC SCALE

CITY OF HAVERHILL

SITE LAYOUT AND GRADING PLAN NO. 4

LITTLE RIVER DAM REMOVAL AND RESTORATION

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

CG-104

File: J:\DWG\P2017\0390\U30\Civil\Plan\20170390U30_STP01.dwg Layout: 11X17-CG-104 Plotted: 2022-12-08 3:17 PM Saved: 2022-12-08 3:11 PM User: CNauman
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LAYER STATE:
MS VIEW:

MATCH LINE SEE SHEET CG-104

MATCH LINE SEE SHEET CG-102

PROPOSED 100 YEAR WATER SURFACE ELEVATION (TYP.)

PEDESTRIAN BRIDGE
TOP OF BRIDGE EL.=26.5±
BOTTOM OF BRIDGE EL.=25.0±(MIN.)

MBTA RAILROAD

GRADE CONTROL BOULDER WEIR #3
TOP OF WEIR EL.= 13.59
3.5' WIDE NOTCH INV. EL.=12.59

FISHING AREA AND ACCESS WITH STEPS/TERRACES TO PROVIDE ACCESS TO RIVER AT VARYING WATER LEVELS (SEE LANDSCAPE PLAN FOR DETAILS); TOP OF PLATFORM EL.= 19.00

GRADE CONTROL BOULDER WEIR #4
TOP OF WEIR EL.= 12.80
3.5' WIDE NOTCH INV. EL.=11.80

SCOUR POOL #4
POOL BOTTOM EL.=9.70
POOL BOTTOM FORMED WITH NATIVE STABLE STONE/COBBLES INFILLED WITH NATIVE SEDIMENT (TYP.)

MBTA RAILROAD

COMPACTED GRAVEL WALKING TRAIL EL. 23.0±

WITH NATIVE STABLE
D WITH NATIVE SEDIMENT (TYP.)

REINFORCED GRAVEL ACCESS/WALKWAY TO FISHING AREA ACCESS

SKATE PARK

CASHMAN'S FIELD

REINFORCED GRAVEL KAYAK/CANOE LAUNCH ACCESS (MAX. SLOPE 15%) WITH

LEBLANC STREET

CASHMAN'S FIELD

100YR

LOD

WET

COMMONWEALTH OF MASSACHUSETTS
DEAN E. ADDET
CIVIL
No. 45077
REGISTERED
PROFESSIONAL ENGINEER

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER

SCALE:
HORZ.: 1" = 70'
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DATUM:
HORZ.: NAD83
VERT.: NAVD88
0 35 70
GRAPHIC SCALE

CITY OF HAVERHILL

SITE LAYOUT AND GRADING PLAN NO. 3

LITTLE RIVER DAM REMOVAL AND RESTORATION

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

CG-103

File: J:\DWG\P2017\0390\U30\Civil\Plan\20170390U30_STP01.dwg Layout: 11X17-CG-103 Plotted: 2022-12-08 3:18 PM Saved: 2022-12-08 3:11 PM User: CNauman
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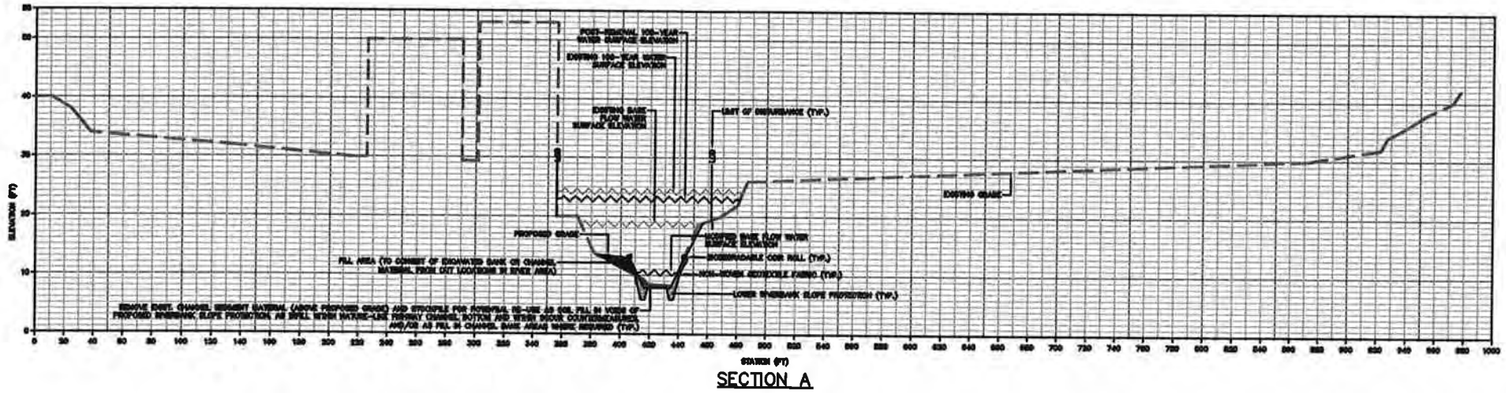

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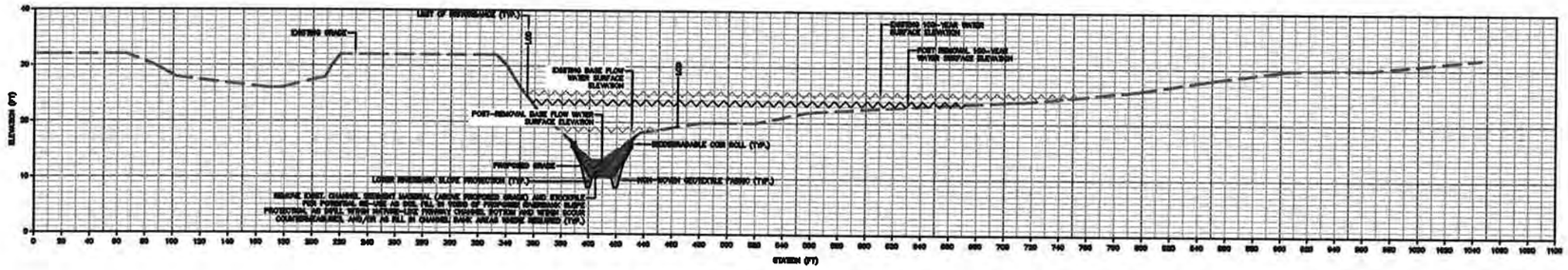

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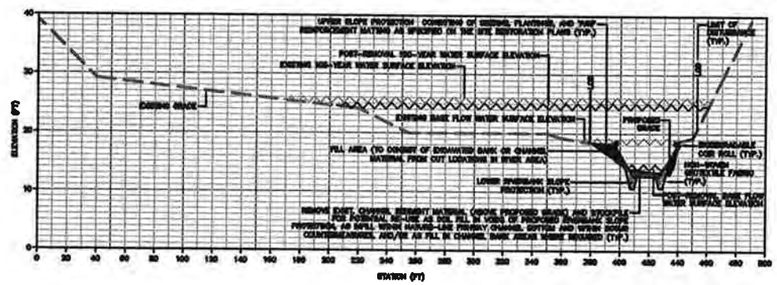

SECTION C

COMMONWEALTH OF MASSACHUSETTS
DEAN E. AUDET
CIVIL
No. 45977
REGISTERED PROFESSIONAL ENGINEER

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER

SCALE:
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VERT.: 1" = 25'
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HORZ.: NAD83
VERT.: NAVD88
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GRAPHIC SCALE

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CITY OF HAVERHILL

TYPICAL CHANNEL CROSS SECTIONS

LITTLE RIVER DAM REMOVAL AND RESTORATION

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

CX-301

File: J:\DWG\P\20170390\U30\Civil\Plan\20170390U30_XCS01.dwg Layout: 11X17-CX-301 Plotted: 2022-12-08 3:18 PM Saved: 2022-11-29 5:07 PM User: CNauman
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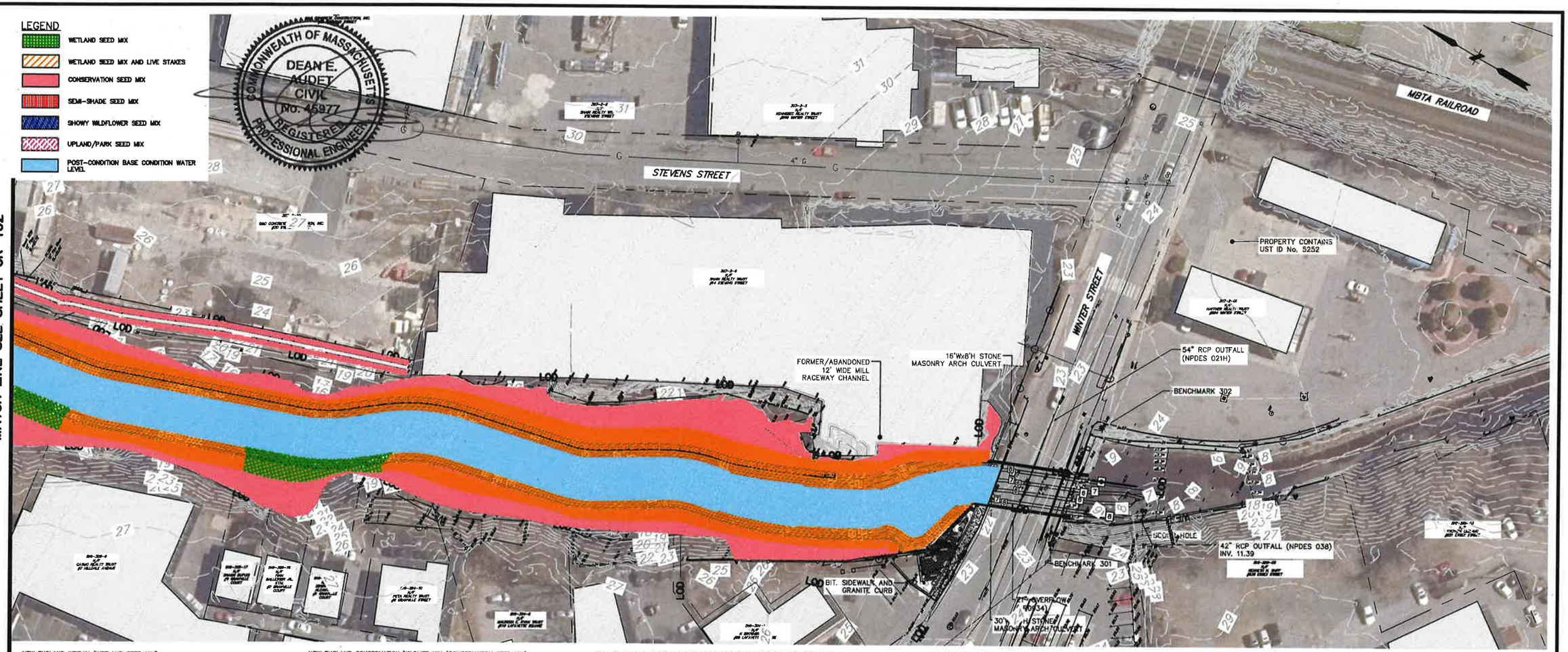

NEW ENGLAND WETMIX (WETLAND SEED MIX)

BOTANICAL NAME	COMMON NAME	IND.
CAREX VULPINOIDEA	FOX SEDGE	OBL
CAREX LURIDA	LURID SEDGE	OBL
CAREX SCOPARIA	BLUNT BROOM SEDGE	FACW
SCIRPUS ATROVIRENS	GREEN BULRUSH	OBL
POA PALUSTRIS	FOWL BLUEGRASS	FACW
CAREX LUPULINA	HOP SEDGE	OBL
BIDENS FRONDOSA	BEGGAR TICKS	FACW
VERNONIA NOVEBORACENSIS	NEW YORK IRONWEED	FACW
CAREX CRINITA	FRINGED SEDGE	OBL
JUNCUS EFFUSUS	SOFT RUSH	FACW
LYCOPUS VIRGINICUS	AMERICAN BUGLEWEED	OBL
EUPATORIUM MACULATUM	SPOTTED JOE PYE WEED	FACW
ASTER LATERIFLORUS	STARRED/CALICO ASTER	FACW
ASCLEPIAS INCARNATA	SWAMP MILKWEED	OBL
MIMULUS RINGENS	SQUARE STEMMED MONKEY FLOWER	OBL
IRIS VERSICOLOR	BLUE FLAG	OBL

WETLAND SEED MIX
MIXTURE: WETLAND SEED MIX
ANNUAL RYEGRASS (TEMPORARY COVER)
APPLICATION RATE: ANNUAL RYEGRASS = 25 LBS/ACRE
WETLAND SEED MIX = 18 LBS/ACRE

NEW ENGLAND CONSERVATION/WILDLIFE MIX (CONSERVATION SEED MIX)

BOTANICAL NAME	COMMON NAME	IND.
ELYMUS VIRGINICUS	VIRGINIA WILD RYE	FACW
SCHIZACHYRIUM SCOPARIUM	LITTLE BLUESTEM	FACU
ANDROPOGON GERARDII	BIG BLUESTEM	FAC
FESTUCA RUBRA	RED FESCUE	FACU
PANICUM VIRGATUM	SWITCH GRASS	FAC
CHAMAECRISTA FASCICULATA	PARTRIDGE PEA	FACU
DESMODIUM CANADENSE	SHOWY TICK TREFOIL	FAC
SORGHASTRUM NUTANS	INDIAN GRASS	UPL
ASCLEPIAS TUBEROSA	BUTTERFLY MILKWEED	NI
BIDENS FRONDOSA	BEGGAR TICKS	FACW
RUDBECKIA HIRTA	BLACK EYED SUSAN	FACU
EUPATORIUM PURPUREUM	PURPLE JOE PYE WEED	FAC
ASTER PILOSUS	HEATH OR HAIRY ASTER	UPL
SOLIDAGO JUNCEA	EARLY GOLDENROD	NI

CONSERVATION SEED MIX
MIXTURE: CONSERVATION MIX
ANNUAL RYEGRASS (TEMPORARY COVER)
APPLICATION RATE: ANNUAL RYEGRASS = 25 LBS/ACRE
CONSERVATION SEED MIX = 25 LBS/ACRE

NEW ENGLAND SEMI-SHADE GRASS AND FORBS MIX (SEMI-SHADE SEED MIX)

BOTANICAL NAME	COMMON NAME	IND.
ELYMUS VIRGINICUS	VIRGINIA WILD RYE	FACW
ELYMUS CANADENSIS	CANADA WILD RYE	FACU
FESTUCA RUBRA	RED FESCUE	FACU
CHAMAECRISTA FASCICULATA	PARTRIDGE PEA	FACU
HATIERA SERRATA	SPINED GAYFEATHER/MARSH BLAZING STAR	FAC
CHELONE GLABRA	SNAKEHEAD	FACW
ASTER PRENANTHOIDES	ZIGZAG ASTER	FAC
EUPATORIUM FISTULOSUM	HOLLOW-STEM JOE PYE WEED	FACW
EUPATORIUM PERFOLIATUM	BONESET	FACW
JUNCUS TENUIS	PATH RUSH	FAC

SEMI-SHADE SEED MIX
APPLICATION RATE: SEMI-SHADE SEED MIX = 30 LBS/ACRE

NEW ENGLAND SHOWY WILDFLOWER MIX (SHOWY WILDFLOWER SEED MIX)

BOTANICAL NAME	COMMON NAME	IND.
ECHINACEA PURPUREA	PURPLE CONEFLOWER	NI
SCHIZACHYRIUM SCOPARIUM	LITTLE BLUESTEM	FACU
CHAMAECRISTA FASCICULATA	PARTRIDGE PEA	FACU
SORGHASTRUM NUTANS	INDIAN GRASS	UPL
FESTUCA RUBRA	RED FESCUE	FACU
ELYMUS CANADENSIS	CANADA WILD RYE	FACU
ELYMUS RIPARIUS	RIVERBANK WILD RYE	FACW
HELIOPSIS HELIANTHOIDES	OX EYE SUNFLOWER	UPL
COREOPSIS LANCEOLATA	LANCE LEAVED COREOPSIS	FACU
RUDBEKIA HIRTA	BLACK EYED SUSAN	FACU
LIATRIS SPICATA	SPIKED GAYFEATHER/MARSH BLAZING STAR	FAC
ASCLEPIAS SYRIACA	COMMON MILKWEED	FACU
VERONIA NOVEBORACENSIS	NEW YORK IRONWEED	FACW
ASTER NOVAE-ANGLIAE	NEW ENGLAND ASTER	FACW
EUPATORIUM PURPUREUM	PURPLE JOE PYE WEED	FAC
ASCLEPIAS TUBEROSA	BUTTERFLY MILKWEED	NI
SOLIDAGO JUNCEA	EARLY GOLDENROD	NI
EUPATORIUM PERFOLIATUM	BONESET	FACW

SHOW WILDFLOWER SEED MIX
APPLICATION RATE: SHOWY WILDFLOWER SEED MIX = 23 LBS/ACRE

UPLAND/PARK SEED MIX
MIXTURE: SHALL BE IN ACCORDANCE WITH SECTION M.6.03.0-1 OF THE MASSDOT STANDARD SPECIFICATIONS FOR FLAT LAWN GRASS AREAS AND M6.03.0-2 FOR SLOPED LAWN GRASS AREAS.
APPLICATION RATE: 25 LBS/ACRE

RESTORATION NOTES:

1. CONSTRUCTION ACCESS ROUTES AND STAGING AREAS WITHIN CASHMAN'S PARK AREA THAT WERE PREVIOUSLY MAINTAINED AS LAWN AREA SHALL BE COVERED WITH TOPSOIL PRIOR TO SEEDING. ALL SEED MIXES SHALL BE FREE OF INVASIVE NON-NATIVE PLANT SPECIES.
2. AREAS TO BE STABILIZED BETWEEN SEPTEMBER THROUGH NOVEMBER SHALL BE OVERSEEDED WITH WINTER RYE (SECALE CEREALE).
3. STABILIZATION OF DISTURBED AREAS SHALL BE IMPLEMENTED WITHIN 14 DAYS AFTER GRADING OR CONSTRUCTION ACTIVITIES HAVE TEMPORARILY OR PERMANENTLY CEASED.
4. RESTORATION AREAS SHALL BE MULCHED WITH STRAW FOLLOWING SEEDING.

LIVE STAKE SPECIES

Select at least 4 of the following species in equal quantities

Black Willow (Salix nigra; OBL)
Silky Willow (Salix sericea; OBL)
Bebb's Willow (Salix bebbiana; FACW)
Peachy Willow (Salix amygdaloides; FACW)
Speckled Alder (Alnus incana; FACW)
Silky Dogwood (Cornus amomum; FACW)
Red-osier Dogwood (Cornus sericea; NI)

Staking Density: 1 live stake every 3' on center.

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GRAPHIC SCALE

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CITY OF HAVERHILL

RIVER RESTORATION PLAN NO. 1

LITTLE RIVER DAM REMOVAL AND RESTORATION

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

CR-101

File: J:\DWG\P2017\0390\U30\Civil\Plan\20170390U30_RES01.dwg Layout: 11X17-CR-101 Plotted: 2022-12-08 3:19 PM Saved: 2022-12-07 4:02 PM User: CNauman
PC3 AUTOCAD PDF (GENERAL DOCUMENTATION).PC3 STB\CTB: FO HALF.STB
LAYER STATE:
MS VIEW:

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MATCH LINE SEE SHEET CR-101

COMMONWEALTH OF MASSACHUSETTS
DEAN E. AUDET
CIVIL
No. 45677
REGISTERED PROFESSIONAL ENGINEER

MBTA RAILROAD

STEVENS STREET

LITTLE RIVER STREET

APPLE STREET

BENJAMIN STREET

CLIFF STREET

LOD

FLOODWAY

AA100

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CITY OF HAVERHILL

RIVER RESTORATION PLAN NO. 2

LITTLE RIVER DAM REMOVAL AND RESTORATION

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

CR-102

File: J:\DWG\P20\7\03900\U30\Civil\Plan\20170390U30_RES01.dwg Layout: 11X17-CR-102 Plotted: 2022-12-08 3:19 PM Saved: 2022-12-07 4:02 PM User: CNauman
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COMMONWEALTH OF MASSACHUSETTS
DEAN E AUDET
CIVIL
NO. 45977
REGISTERED PROFESSIONAL ENGINEER

MATCH LINE SEE SHEET CR-104

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MBTA RAILROAD

MBTA RAILROAD

SKATE PARK

CASHMAN'S FIELD

CASHMAN'S FIELD

LEBLANC STREET

LOD

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CITY OF HAVERHILL

RIVER RESTORATION PLAN NO. 3

LITTLE RIVER DAM REMOVAL AND RESTORATION

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

CR-103

RAILROAD BRIDGE SUPPORTED ON 12" TIMBER PIERS FORMING THREE BAYS
LEFT BAY WIDTH – 11.0' WIDE
CENTER BAY WIDTH – 12.0' WIDE
RIGHT BAY WIDTH – 10.9' WIDE
BOTTOM BEAM EL.=22.7±

POTENTIAL ELECTRIC CABLE IN RIVER (REPORTED BY LITTLE RIVER NEIGHBORHOOD RESIDENT)

MBTA RAILROAD

WHITTIER PLACE

MATCH LINE SEE SHEET CR-103

COMMONWEALTH OF MASSACHUSETTS
DEAN E. AVDET
CIVIL
No. 45077
REGISTERED PROFESSIONAL ENGINEER

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CITY OF HAVERHILL

RIVER RESTORATION PLAN NO. 4

LITTLE RIVER DAM REMOVAL AND RESTORATION

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

CR-104

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PC3: AUTOCAD PDF (GENERAL DOCUMENTATION).PC3 STB/CTB: FO HALF.STB
LAYER STATE:
MS VIEW:

GENERAL WATER CONTROL SYSTEM NOTES:

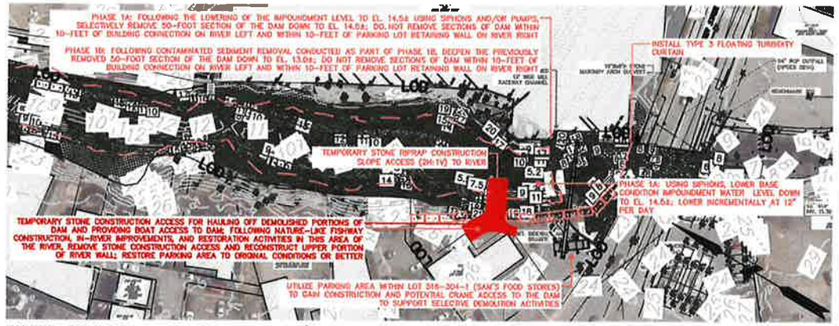
1. PRIOR TO ANY LAND DISTURBANCE ACTIVITIES, THE CONTRACTOR MUST PHYSICALLY MARK THE LIMITS OF DISTURBANCE IN ACCORDANCE WITH THE APPROVED PLANS.
2. THE TEMPORARY COFFERDAMS, RIVER CROSSINGS, AND HAUL ROADS MUST BE INSTALLED DURING THE LOW FLOW PERIOD (I.E., THE PERIOD BETWEEN JULY 1 THROUGH OCTOBER 31). COFFERDAMMED AREAS, WHERE APPLICABLE, SHALL BE MAINTAINED TO ALLOW A DRY WORKING CONDITION (NO SEDIMENT PLUME) IN THE WATERCOURSE. SOIL DISTURBANCE IN COFFERDAMMED AREAS OR THE WATERCOURSE MUST TEMPORARILY CEASE IN THE EVENT OF ANY ABNORMALLY HIGH STORMWATER RUNOFF EVENT THAT OVERTOPS THE COFFERDAMS OR TEMPORARY RIVER CROSSINGS.
3. SELECTIVE DEMOLITION/REMOVAL OF THE DAM MUST BE CONDUCTED SEQUENTIALLY TO CONTROL UPSTREAM DRAWDOWN TO NO MORE THAN TWELVE (12) INCHES PER DAY.
4. OBTAIN CONFIRMATORY ELEVATIONS OF THE RIVER CHANNEL BOTTOM ALONG THE PROPOSED ALIGNMENTS OF THE TEMPORARY COFFERDAMS AND RIVER CROSSINGS TO VERIFY EXISTING CONDITIONS AND ACTUAL COFFERDAM HEIGHTS PRIOR TO INSTALLATION.
5. THIS PLAN ILLUSTRATES ONE CONCEPTUAL APPROACH TO WATER CONTROL FOR THE PROJECT. THE CONTRACTOR SHALL SUBMIT A FINAL WATER CONTROL PLAN TO FUSS & O'NEILL AND THE MASSDEP FOR REVIEW WITH ADEQUATE TIME FOR THEIR REVIEW AND ACCEPTANCE PRIOR TO THE INITIATION OF CONSTRUCTION.
6. TEMPORARY HAUL ROADS, COFFERDAMS, TEMPORARY RIVER CROSSINGS, AND BYPASS PROVISIONS SHALL BE MAINTAINED THROUGHOUT THE CONSTRUCTION PERIOD TO ENSURE RESPECTIVE COMPONENTS FUNCTION AS INTENDED TO PROTECT ADJACENT PROPERTIES, WETLAND RESOURCES AND DOWNSTREAM WORK AREAS.

PHASE 1A:

1. AFTER MOBILIZING AT CASHMAN PARK AND INSTALLING TEMPORARY EROSION CONTROL MEASURES AT THE PORTION OF THE PARKING LOT OF PARCEL 518-304-1 (SAM'S FOOD STORE PROPERTY) AND CASHMAN PARK AREA WITHIN THE LIMIT OF DISTURBANCE, THE CONTRACTOR SHALL INSTALL FLOATING TURBIDITY BARRIER JUST UPSTREAM OF THE WINTER STREET BRIDGE OPENING. THE FLOATING TURBIDITY BARRIER MUST BE A TYPE III BARRIER CAPABLE OF PASSING FLOW VELOCITIES UP TO 3 FEET PER SECOND.
2. THE CONTRACTOR SHALL THEN INSTALL THE TEMPORARY CONSTRUCTION ACCESS TO THE RIVER AT PARCEL 518-304-1, REMOVE 20-FOOT SECTION OF THE FREESTANDING PORTION OF THE PARKING LOT RETAINING WALL BEHIND THE SAM'S STORE BUILDING STRUCTURE (OR AS REQUIRED AND APPROVED BY OWNER TO FACILITATE ACCESS), AND CONSTRUCT TEMPORARY STONE RIPRAP ACCESS DOWN THE SLOPE (AT NO STEEPER THAN 2H:1V) IN ORDER TO GAIN ACCESS TO THE IMPOUNDMENT JUST UPSTREAM OF THE DAM FROM PARCEL 518-304-1 FOR CONSTRUCTION EQUIPMENT AND/OR BARGE ACCESS TO DAM. THE STONE RIPRAP USED TO CONSTRUCT THE TEMPORARY STONE RIPRAP ACCESS SHALL BE CONSTRUCTED OF SAME STONE MATERIAL USED TO PERMANENTLY STABILIZE THE LOWER SLOPE OF THE PROPOSED RIVER CHANNEL SIDESLOPES. THIS STONE IS TO REMAIN STABLE DURING FLOOD FLOWS.
3. USING SIPHONS AND/OR PUMPS, INCREMENTALLY LOWER THE IMPOUNDMENT BY 12-INCHES PER DAY TO DOWN TO EL. 14.5 FEET. THIS SHOULD TAKE APPROXIMATELY 4 WORK DAYS ASSUMING NO SUBSTANTIAL RAINFALL EVENTS OCCUR. THIS WILL ALSO ALLOW THE NEWLY EXPOSED AREAS ALONG THE RIVER BANK TIME TO BEGIN TO DRAIN AND STABILIZE.
4. ONCE THE BASE CONDITION WATER SURFACE WITHIN THE IMPOUNDMENT HAS BEEN LOWERED TO EL. 14.5 FEET, REMOVE A 50-FOOT SECTION OF THE UPPER PORTION OF THE DAM USING BARGE MOUNTED EQUIPMENT OR BY CRANE FROM ADJACENT PARKING LOT (ON PARCEL 518-304-1) DOWN TO EL. 14.50 FEET, DO NOT DISTURB SECTION OF DAM WITHIN 10-FEET OF ITS CONNECTION TO BUILDING ON RIVER LEFT AND WITHIN 10-FEET OF ITS CONNECTION TO RIVER WALL ON RIVER RIGHT. THIS WILL BE CONSIDERED THE FIRST PHASE OF THE INCREMENTAL REMOVAL OF THE DAM. REMOVING THE DAM INCREMENTALLY WILL MINIMIZE THE POTENTIAL FOR SEDIMENT TO MOBILIZE DOWNSTREAM, ALLOW THE BED AND NEWLY EXPOSED BANKS OF THE IMPOUNDMENT AND STREAM TO DRAIN AND STABILIZE, AND PREVENT A SUDDEN RELEASE OF WATER WHICH COULD UNNECESSARILY DAMAGE DOWNSTREAM INFRASTRUCTURE AND/OR HABITAT.

PHASE 1B:

1. ONCE THE BASE FLOW CONDITION WATER SURFACE ELEVATION IS LOWERED TO APPROXIMATELY EL. 15.0 WITHIN THE ENTIRE IMPOUNDMENT FROM THE DAM UP TO THE MBTA BRIDGE, CONSTRUCT TEMPORARY RIVER CROSSING AT CASHMAN'S PARK (WITH A TOP WIDTH OF 12 FEET). THIS RIVER CROSSING WILL BE CONSTRUCTED OF STONE RIPRAP EQUIVALENT IN SIZE TO THAT USED TO STABILIZE THE LOWER SIDESLOPES OF THE PROPOSED RIVER CHANNEL. THE CROSSING WILL BE CONSTRUCTED WITH (4) 48-INCH CULVERTS THAT WILL PASS APPROXIMATELY 380 CFS AT FULL CAPACITY. THIS FLOW IS EQUIVALENT TO THE BANKFULL FLOW. BANKFULL FLOW CONDITIONS ARE APPROXIMATELY EQUIVALENT TO THE 1.5-YEAR RECURRENCE INTERVAL FLOOD EVENT. INLET CONTROL DEVICES SHALL BE INSTALLED ON UPSTREAM ENDS OF CULVERTS TO ALLOW FOR THE REGULATION OF FLOW THROUGH CULVERTS.
2. ONCE CONSTRUCTION OF THE TEMPORARY RIVER CROSSING IS COMPLETE, CONTINUE CONSTRUCTION OF A STONE ACCESS/HAUL ROAD (WITH A 10-FOOT MINIMUM TOP WIDTH) BETWEEN THE TEMPORARY RIVER CROSSING AND THE AREA OF SEDIMENT CONTAMINATION. THE TEMPORARY HAUL ROAD WILL FOLLOW THE ALIGNMENT OF THE TOP OF LEFT BANK OF THE PROPOSED RIVER CHANNEL. AS A RESULT, CONSTRUCTING THIS HAUL ROAD WILL ALSO ASSIST IN FORMING A STABLE LEFT BANK FOR THE PROPOSED RIVER CHANNEL.
3. ONCE THE HAUL ROAD HAS BEEN BUILT TO THE APPROXIMATE AREA OF SEDIMENT CONTAMINATION, CONSTRUCT A TEMPORARY RIVER CROSSING (WITH A 12-FOOT TOP WIDTH) JUST UPSTREAM OF THE AREA NEAR LITTLE RIVER STREET. THE ROAD SHALL BE CONSTRUCTED FROM THE TEMPORARY HAUL ROAD AS OPPOSED TO CONSTRUCTING FROM LITTLE RIVER STREET. THIS TEMPORARY RIVER CROSSING WILL BE CONSTRUCTED OF STONE RIPRAP EQUIVALENT IN SIZE TO THAT USED TO STABILIZE THE LOWER SIDESLOPES OF THE PROPOSED RIVER CHANNEL. THE CROSSING WILL BE CONSTRUCTED WITH (4) 48-INCH CULVERTS THAT WILL PASS APPROXIMATELY 380 CFS AT FULL CAPACITY. THE PURPOSE OF THIS CROSSING WILL BE TO GAIN ACCESS TO BOTH SIDES OF THE RIVER CHANNEL FOR SEDIMENT REMOVAL AND TO CONSTRUCT IN-CHANNEL RIVER IMPROVEMENTS.
4. USING LARGE SANDBAGS OR EQUAL, CONSTRUCT A TEMPORARY COFFERDAM DOWN THE APPROXIMATE CENTER OF THE RIVER CHANNEL BETWEEN THE TEMPORARY RIVER CROSSING AND DOWNSTREAM LIMIT OF CONTAMINATED SEDIMENT AREA. CAP/BLOCK THE INLET TO THE EASTERN CULVERTS AND ISOLATE THE EASTERN HALF OF THE RIVER USING COFFERDAM SYSTEM. ONLY ALLOW FLOW THROUGH THE WESTERN CULVERTS. INSTALL TEMPORARY DEWATERING AREA ATOP THE WESTERN HALF OF THE TEMPORARY RIVER CROSSING AND UTILIZE CONSTRUCTION DEWATERING PUMPS TO CREATE A DRY WORKING AREA WITHIN THE LIMITS OF THE COFFERDAM. PERFORM SEDIMENT REMOVAL OPERATIONS. HAUL SEDIMENT TO CASHMAN PARK TEMPORARY SOIL STORAGE AREA FOR DEWATERING AND ULTIMATE TRANSPORT OFF-SITE. THE TOP OF THE COFFERDAM SYSTEM SHALL BE SET TO PROTECT WORK AREA FOR MAXIMUM RIVER FLOWS OF UP TO APPROXIMATELY 100 CFS (OR 3-FEET FLOW DEPTH THROUGH DIVERTED HALF OF RIVER CHANNEL) AT MINIMUM WITHOUT OVERTOPPING.
5. ONCE CONTAMINATED SEDIMENT HAS BEEN REMOVED IN THE EASTERN HALF OF THE RIVER, ROUGH GRADE LEFT BANK AND CHANNEL BOTTOM IN THIS LOCATION TO PROPOSED GRADE AND STABILIZE WITH LOWER SLOPE PROTECTION AND CHANNEL BOTTOM STABILIZATION MEASURES.
6. REMOVE TEMPORARY DEWATERING AREA ON THE RIVER CROSSING AND SHIFT TO THE UPPER LEFT BANK OF RIVER AT EL. 17.5± FEET OR ABOVE. ADJUST TEMPORARY COFFERDAM SYSTEM TO ISOLATE THE WESTERN SIDE OF RIVER. SLOWLY ALLOW FLOW THROUGH THE EASTERN CULVERTS AND CAP/BLOCK WESTERN CULVERTS. UTILIZE CONSTRUCTION DEWATERING PUMPS TO CREATE A DRY WORKING AREA WITHIN WESTERN COFFERDAMMED AREA. PERFORM SEDIMENT REMOVAL OPERATIONS IN WESTERN HALF OF RIVER. HAUL SEDIMENT TO CASHMAN PARK TEMPORARY SOIL STORAGE AREA FOR DEWATERING AND ULTIMATE TRANSPORT OFF-SITE. ONCE CONTAMINATED SEDIMENT HAS BEEN REMOVED, ROUGH GRADE RIGHT BANK AND CHANNEL BOTTOM TO PROPOSED GRADE AND STABILIZE WITH LOWER SLOPE PROTECTION AND CHANNEL BOTTOM STABILIZATION MEASURES.
7. ONCE IN-RIVER IMPROVEMENTS ARE COMPLETE IN THIS LOCATION, REMOVE TEMPORARY COFFERDAM SYSTEM AND TEMPORARY RIVER CROSSING (WITH CULVERTS) AT LITTLE RIVER STREET AREA. STONE RIPRAP USED TO CONSTRUCT TEMPORARY RIVER CROSSING CAN BE USED ELSEWHERE AS STABILIZATION FOR LOWER RIVER CHANNEL SLOPE AND CHANNEL BOTTOM PROTECTION OF RIVER CHANNEL.

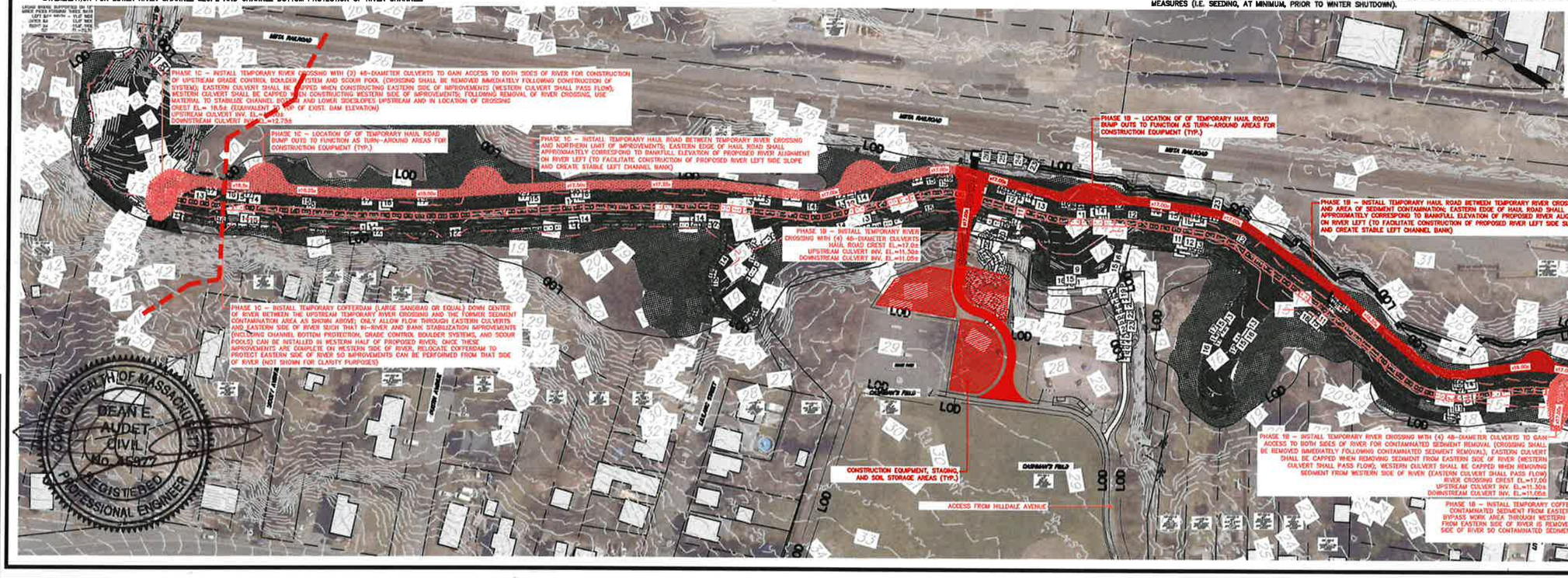


WATER CONTROL – PHASE 1A & 1B (INCREMENTAL REMOVAL OF DAM AND LOWERING OF HEADPOND)

SCALE: 1"= 140'

PHASE 1C:

1. ONCE CONTAMINATED SEDIMENT HAS BEEN FULLY REMOVED, CONTINUE CONSTRUCTION OF STONE ACCESS/HAUL ROAD (WITH A 10-FOOT TOP WIDTH) BETWEEN THE TEMPORARY RIVER CROSSING AT CASHMAN PARK AND THE UPSTREAM LIMIT OF PROPOSED CONSTRUCTION. THIS PORTION OF THE TEMPORARY HAUL ROAD WILL ALSO FOLLOW THE ALIGNMENT OF THE TOP OF LEFT BANK OF THE PROPOSED RIVER CHANNEL. AS A RESULT, CONSTRUCTING THIS HAUL ROAD WILL ALSO ASSIST IN FORMING A STABLE LEFT BANK FOR THE PROPOSED RIVER CHANNEL. CONSTRUCT TEMPORARY RIVER CROSSING WITH A 12-FOOT TOP WIDTH AND WITH (4) 48-INCH CULVERTS JUST UPSTREAM OF PROPOSED UPSTREAM GRADE CONTROL BOULDER SYSTEM AND SCOUR POOL. INSTALL CULVERTS WITH INLET AND/OR OUTLET CONTROL DEVICES THAT WILL ALLOW FLOW TO BE REGULATED. CONSTRUCTING THIS SYSTEM WILL ASSIST IN MINIMIZING UPSTREAM IMPACTS DURING THIS PHASE OF CONSTRUCTION.
2. FOLLOWING CONSTRUCTION OF THE UPSTREAM TEMPORARY RIVER CROSSING, PERFORM THE SECOND PHASE OF INCREMENTAL DAM REMOVAL. LOWER THE DAM CREST FROM EL. 14.5± FEET DOWN TO EL. 12.0±. THIS WILL LOWER THE BASE FLOW CONDITION WATER SURFACE ELEVATION TO BETWEEN APPROXIMATELY EL. 12.0± AND EL. 13.5± WITHIN THE ENTIRE IMPOUNDMENT FROM THE DAM UP TO THE UPSTREAM RIVER CROSSING.
3. CONSTRUCT LARGE SANDBAG OR SIMILAR COFFERDAM SYSTEM DOWN THE APPROXIMATE CENTER OF THE RIVER CHANNEL BETWEEN THE UPSTREAM TEMPORARY RIVER CROSSING AND THE TEMPOORARY RIVER CROSSING AT CASHMAN PARK. CAP/BLOCK THE INLET TO THE EASTERN CULVERTS AND ISOLATE THE EASTERN HALF OF THE RIVER USING COFFERDAM SYSTEM. ONLY ALLOW FLOW THROUGH THE WESTERN CULVERTS. CONSTRUCT IN-RIVER IMPROVEMENTS AND LOWER BANK STABILIZATION MEASURES. CONSTRUCTING THIS SYSTEM WILL ASSIST IN MINIMIZING TEMPORARY UPSTREAM IMPACTS THROUGHOUT THE REMAINDER OF CONSTRUCTION. THE TOP OF THE COFFERDAM SYSTEM SHALL BE SET TO PROTECT WORK AREA FOR MAXIMUM RIVER FLOWS OF UP TO APPROXIMATELY 100 CFS (OR 3-FEET FLOW DEPTH THROUGH DIVERTED HALF OF RIVER CHANNEL) AT MINIMUM WITHOUT OVERTOPPING.
4. PERFORM RIVER CHANNEL IMPROVEMENTS BETWEEN THE UPSTREAM RIVER CROSSING AND THE FORMER AREA OF SEDIMENT CONTAMINATION AS INDICATED IN THE CONTRACT DOCUMENTS INCLUDING CHANNEL REALIGNMENT (INCLUDING SEDIMENT EXCAVATION AND RELOCATION), INSTALL GRADE CONTROL BOULDER WEIR NOS. 1 THRU 5, SCOUR POOL NOS. 1 THRU 5, LOWER AND UPPER SLOPE STABILIZATION MEASURES, FISHING PLATFORM AT CASHMAN PARK BELOW THE BANKFULL ELEVATION, AND VEGETATIVE RESTORATION MEASURES (I.E. SEEDING, AT MINIMUM, PRIOR TO WINTER SHUTDOWN).



WATER CONTROL SYSTEM CONSTRUCTION SEQUENCE NOTES:

NOTES ON THIS SHEET AND CW-102 ARE INTENDED TO SUPPORT THE WATER CONTROL CONSTRUCTION SEQUENCE AND CONCEPT AS DEPICTED ON THESE PLANS. THE CONTRACTOR SHALL SUBMIT A FINAL WATER CONTROL PLAN TO FUSS & O'NEILL AND THE MASSDEP FOR REVIEW WITH ADEQUATE TIME FOR THEIR REVIEW AND ACCEPTANCE PRIOR TO THE INITIATION OF CONSTRUCTION.

DEAN E. AUDET, CIVIL, No. 45977, REGISTERED PROFESSIONAL ENGINEER, COMMONWEALTH OF MASSACHUSETTS

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER

SCALE:
HORZ.: 1" = 140'
VERT.:
DATUM:
HORZ.: NAD83
VERT.: NAVD88
0 70 140
GRAPHIC SCALE

CITY OF HAVERHILL

WATER CONTROL & CONSTRUCTION SEQUENCING PLAN NO. 1

LITTLE RIVER DAM REMOVAL AND RESTORATION

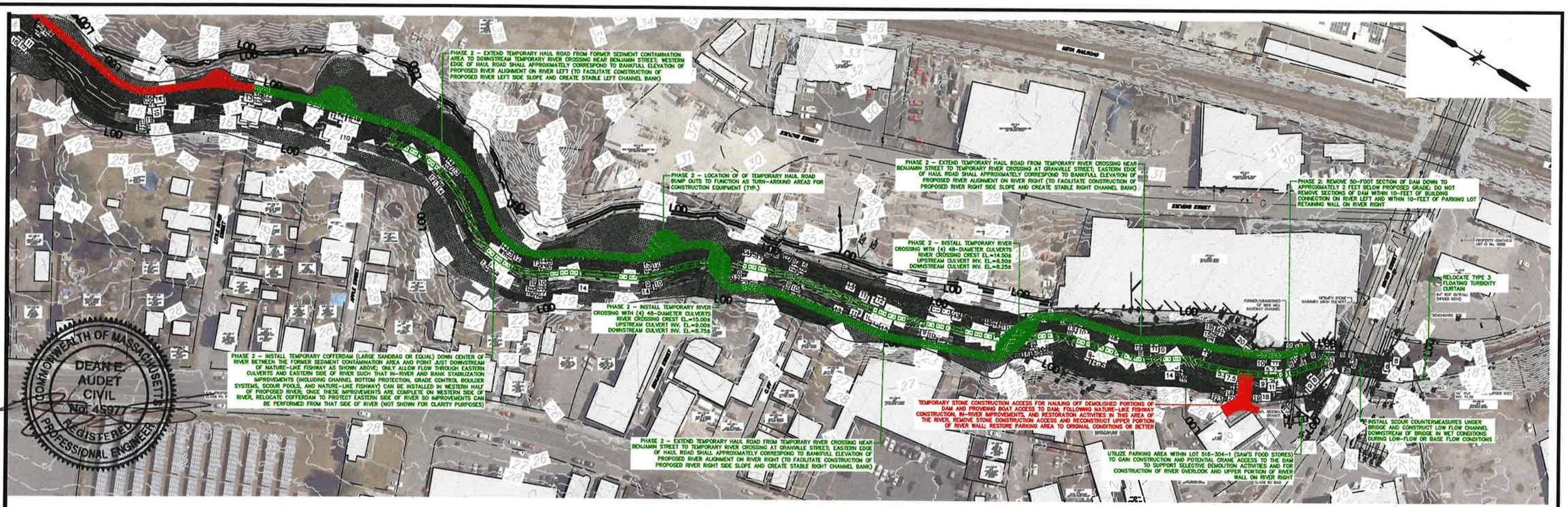
HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

CW-101

LAYER STATE:
MS VIEW:

MATCH LINE SEE SHEET CW-101



WATER CONTROL – PHASE 2
SCALE: 1"= 140'

NOTE:
PROPOSED LAYOUT SHOWN HEREON IS APPROXIMATE ONLY AND IS INTENDED TO ONLY DEPICT RELATIVE PHASES OF WORK AND GENERAL WORK AREAS. REFER TO OTHER DRAWINGS FOR SPECIFIC WORK ACTIVITIES AND LIMITS.

OUT OF RIVER CONSTRUCTION ACTIVITIES (TO BE PERFORMED OUTSIDE OF LOW-FLOW SEASONS):

1. AT THE END OF THE LOW FLOW SEASON, THE CONTRACTOR SHALL CEASE PHASE I IN-RIVER CONSTRUCTION ACTIVITIES.
2. WORK OUTSIDE OF THE RIVER, HOWEVER, SHALL CONTINUE SUCH AS THE CONSTRUCTION OF THE UPPER PORTION OF THE RIVER WALL ALONG PARCEL 516-304-1. PEDESTRIAN BRIDGE AT CASHMAN PARK, THE GRAVEL WALKING TRAIL ON EASTERN SIDE OF RIVER, AND THE FISHING PLATFORM AT CASHMAN PARK.

PHASE 2:

1. AT THE START OF THE SECOND LOW-FLOW SEASON, EXTEND TEMPORARY STONE ACCESS/HAUL ROAD (WITH A 12-FOOT TOP WIDTH) FROM THE SOUTHERN LIMIT OF THE PREVIOUSLY CONSTRUCTED HAUL ROAD ON RIVER LEFT TO THE LOCATION OF PROPOSED TEMPORARY RIVER CROSSING NEAR BENJAMIN ROAD AS SHOWN ABOVE. THE TEMPORARY HAUL ROAD WILL FOLLOW THE ALIGNMENT OF THE TOP OF LEFT BANK OF THE PROPOSED RIVER CHANNEL. AS A RESULT, CONSTRUCTING THIS HAUL ROAD WILL ALSO ASSIST IN FORMING A STABLE LEFT BANK FOR THE PROPOSED RIVER CHANNEL.
2. CONSTRUCT TEMPORARY RIVER CROSSING NEAR BENJAMIN STREET TO FACILITATE ACCESS TO RIVER RIGHT. THIS RIVER CROSSING WILL BE CONSTRUCTED OF STONE RIPRAP EQUIVALENT IN SIZE TO THAT USED TO STABILIZE THE LOWER SIDESLOPES OF THE PROPOSED RIVER CHANNEL. THE CROSSING WILL BE CONSTRUCTED WITH (4) 48-INCH CULVERTS THAT WILL PASS APPROXIMATELY 380 CFS AT FULL CAPACITY. THIS FLOW IS EQUIVALENT TO THE BASE FLOW CONDITION AND THE BANKFULL FLOW, RESPECTIVELY.
3. ONCE CONSTRUCTION OF THE TEMPORARY RIVER CROSSING IS COMPLETE, CONTINUE CONSTRUCTION OF A STONE ACCESS/HAUL ROAD (WITH A 12-FOOT TOP WIDTH) ON RIVER RIGHT BETWEEN TO THE VICINITY OF GRANVILLE STREET. THE TEMPORARY HAUL ROAD WILL FOLLOW THE ALIGNMENT OF THE TOP OF RIGHT BANK OF THE PROPOSED RIVER CHANNEL. AS A RESULT, CONSTRUCTING THIS HAUL ROAD WILL ALSO ASSIST IN FORMING A STABLE RIGHT BANK FOR THE PROPOSED RIVER CHANNEL.
3. CONSTRUCT SECOND TEMPORARY RIVER CROSSING IN THE VICINITY OF GRANVILLE STREET THAT WILL THEN PROVIDE ACCESS BACK TO RIVER LEFT. THIS RIVER CROSSING WILL ALSO BE CONSTRUCTED OF STONE RIPRAP EQUIVALENT IN SIZE TO THAT USED TO STABILIZE THE LOWER SIDESLOPES OF THE PROPOSED RIVER CHANNEL. THE CROSSING WILL BE CONSTRUCTED WITH (4) 48-INCH CULVERTS THAT WILL PASS APPROXIMATELY 380 CFS AT FULL CAPACITY. ONCE CONSTRUCTION OF THE TEMPORARY RIVER CROSSING IS COMPLETE, CONTINUE CONSTRUCTION OF STONE ACCESS/HAUL ROAD (WITH A 12-FOOT TOP WIDTH) ON RIVER LEFT DOWN TO THE DAM. THE TEMPORARY HAUL ROAD WILL FOLLOW THE ALIGNMENT OF THE TOP OF LEFT BANK OF THE PROPOSED RIVER CHANNEL. AS A RESULT, CONSTRUCTING THIS HAUL ROAD WILL ALSO ASSIST IN FORMING A STABLE LEFT BANK FOR THE PROPOSED RIVER CHANNEL.
4. REMOVE THE REMAINING SECTION OF THE DAM DOWN TO APPROXIMATELY 2 FEET BELOW PROPOSED GRADE. TAKE CARE NOT TO REMOVE SECTIONS OF THE DAM WITHIN 10-FEET OF EXISTING BUILDING CONNECTION (ON RIVER LEFT) AND RETAINING WALL CONNECTION (ON RIVER RIGHT).
5. RELOCATE FLOATING TURBIDITY CURTAIN TO SPAN ACROSS RIVER AT DOWNSTREAM LIMIT OF PROJECT DISTURBANCE.
6. INSTALL SCOUR COUNTERMEASURES BELOW THE WINTER STREET BRIDGE BY PLACING STONE RIPRAP IN THE WET DURING NORMAL (NON-FLOOD) LOW FLOW CONDITIONS.
7. ONCE SCOUR COUNTERMEASURES ARE INSTALLED, ACCESS DOWNSTREAM SIDE OF BRIDGE BY DRIVING LOW-HEIGHT EQUIPMENT (E.G. MINI-EXCAVATOR) BENEATH BRIDGE. SHAPE LOW-FLOW CHANNEL ON DOWNSTREAM SIDE OF BRIDGE AND STABILIZE WITH STONE RIPRAP.
8. REMOVE FLOATING TURBIDITY CURTAIN AND RELOCATE BACK TO LOCATION JUST UPSTREAM OF WINTER STREET BRIDGE OPENING.
9. BEGIN CONSTRUCTION OF NATURE-LIKE FISHWAY AND RIVER WALLS ON BOTH SIDES OF THE RIVER. UTILIZE TEMPORARY COFFERDAMS (LARGE SANDBAGS OR EQUAL) AND CONSTRUCTION DEWATERING PUMPS (WITH CRUSHED STONE SUMPS) TO ISOLATE SECTIONS OF THE RIVER TO FACILITATE THE CONSTRUCTION OF IMPROVEMENTS UNDER DRY-CONDITIONS AS SHOWN ABOVE. INSTALL TEMPORARY DEWATERING AREA ON TEMPORARY HAUL ROAD IF NECESSARY (I.E. IF IT IS DETERMINED THAT TURBID WATER IS BEING DISCHARGED FROM PUMPS AND CRUSHED STONE SUMPS). NOTE THAT COFFERDAM ISOLATING THE RIVER LEFT, WHERE FLOW WOULD BE DIVERTED THROUGH RIGHT SIDE OF RIVER ONLY, IS SHOWN FOR GRAPHICAL PURPOSES ONLY TO MINIMIZE VISUAL CLUTTER. HOWEVER, THE SAME APPROACH WOULD BE APPLIED TO CONSTRUCT IN-RIVER IMPROVEMENTS ON RIVER RIGHT. FLOW WOULD THEN BYPASS THE WORK AREA ON RIVER LEFT.THE TOP OF THE COFFERDAM SYSTEM SHALL BE SET TO PROTECT WORK AREA FOR MAXIMUM RIVER FLOWS OF UP TO APPROXIMATELY 100 CFS (OR 3-FEET FLOW DEPTH THROUGH DIVERTED HALF OF RIVER CHANNEL) AT MINIMUM WITHOUT OVERTOPPING.
10. ONCE CONSTRUCTION OF THE NATURE-LIKE FISHWAY, RIVER WALL ON RIVER LEFT, LOWER PORTION OF THE RIVER WALL ON RIVER RIGHT (TO AN ELEVATION ABOVE THE BANKFULL ELEVATION), AND BANK STABILIZATION MEASURES ARE COMPLETE WITHIN THIS SECTION OF RIVER; FINISH GRADE, STABILIZE, AND RESTORE TEMPORARY HAUL ROAD AREA IN THIS LOCATION AND BEGIN CONSTRUCTION OF IN-RIVER IMPROVEMENTS AND BANK STABILIZATION MEASURES BETWEEN THE GRANVILLE TEMPORARY CROSSING AND THE NATURE-LIKE FISHWAY. UTILIZE TEMPORARY COFFERDAMS AND CONSTRUCTION DEWATERING PUMPS (WITH CRUSHED STONE SUMPS) AS REQUIRED TO ISOLATE SECTIONS OF THE RIVER BETWEEN THE GRANVILLE TEMPORARY CROSSING AND THE NATURE-LIKE FISHWAY TO FACILITATE CONSTRUCTION OF IN-RIVER IMPROVEMENTS UNDER DRY WORKING CONDITIONS. AS SHOWN IN GRAPHIC, A TEMPORARY COFFERDAM COULD BE CONSTRUCTED DOWN THE APPROXIMATE CENTER OF THE RIVER CHANNEL SO THAT IMPROVEMENTS COULD BE CONSTRUCTED ON ONE SIDE OF RIVER WHILE FLOW IS BEING DIVERTED TO OTHER SIDE OF RIVER. THE CULVERTS AT THE UPSTREAM RIVER CROSSING WOULD BE CAPPED/BLOCKED ACCORDINGLY.
11. ONCE CONSTRUCTION OF THE IN-RIVER IMPROVEMENTS AND BANK STABILIZATION MEASURES ARE COMPLETE WITHIN THIS SECTION OF RIVER; REMOVE TEMPORARY RIVER CROSSING NEAR GRANVILLE STREET; FINISH GRADE, STABILIZE, AND RESTORE TEMPORARY HAUL ROAD AREA IN THIS SECTION; AND BEGIN CONSTRUCTION OF IN-RIVER IMPROVEMENTS AND BANK STABILIZATION MEASURES BETWEEN THE FORMER GRANVILLE TEMPORARY CROSSING AND THE TEMPORARY RIVER CROSSING NEAR BENJAMIN STREET. UTILIZE TEMPORARY COFFERDAMS AND CONSTRUCTION DEWATERING PUMPS (WITH CRUSHED STONE SUMPS) AS REQUIRED TO ISOLATE SECTIONS OF THE RIVER BETWEEN THE BENJAMIN TEMPORARY CROSSING AND FORMER GRANVILLE TEMPORARY CROSSING TO FACILITATE CONSTRUCTION OF IN-RIVER IMPROVEMENTS UNDER DRY WORKING CONDITIONS. AS SHOWN IN GRAPHIC, A TEMPORARY COFFERDAM COULD BE CONSTRUCTED DOWN THE APPROXIMATE CENTER OF THE RIVER CHANNEL SO THAT IMPROVEMENTS COULD BE CONSTRUCTED ON ONE SIDE OF RIVER WHILE FLOW IS BEING DIVERTED TO OTHER SIDE OF RIVER. THE CULVERTS AT THE UPSTREAM RIVER CROSSING WOULD BE CAPPED/BLOCKED ACCORDINGLY.
11. ONCE CONSTRUCTION OF THE IN-RIVER IMPROVEMENTS AND BANK STABILIZATION MEASURES ARE COMPLETE WITHIN THIS SECTION OF RIVER; REMOVE TEMPORARY RIVER CROSSING NEAR BENJAMIN STREET; FINISH GRADE, STABILIZE, AND RESTORE TEMPORARY HAUL ROAD AREA IN THIS SECTION; AND BEGIN CONSTRUCTION OF IN-RIVER IMPROVEMENTS AND BANK STABILIZATION MEASURES BETWEEN THE FORMER BENJAMIN TEMPORARY CROSSING AND THE FORMER SEDIMENT CONTAMINATION AREA. CONNECT IMPROVEMENTS INTO PREVIOUSLY CONSTRUCTED IMPROVEMENTS AS PART OF PHASE 1. UTILIZE TEMPORARY COFFERDAMS (LARGE SANDBAGS OR EQUAL) AND CONSTRUCTION DEWATERING PUMPS AS REQUIRED TO ISOLATE SECTIONS OF THE RIVER BETWEEN THE GRANVILLE TEMPORARY CROSSING AND THE NATURE-LIKE FISHWAY TO FACILITATE CONSTRUCTION OF IN-RIVER IMPROVEMENTS.
12. FINISH GRADE, STABILIZE, AND RESTORE TEMPORARY HAUL ROAD AREA UPSTREAM OF FORMER SEDIMENT CONTAMINATION AREA. REMOVE TEMPORARY RIVER CROSSING AT CASHMAN'S PARK AND RESTORE AREA.
13. PERFORM ANY REMAINING RESTORATION ACTIVITIES ALONG THE RIVER.
14. FINISH CONSTRUCTION OF RIVER OVERLOOK AREA, UPPER PORTION OF WALL, AND INSTALL STABILIZATION/RESTORATION MEASURES AT PARCEL 516-304-1. REMOVE TEMPORARY STONE CONSTRUCTION ACCESS AT THIS PARCEL AND RESTORE ANY DAMAGED PAVEMENT TO ORIGINAL CONDITIONS OR BETTER.
15. FINISH CONSTRUCTION OF ANY IN-RIVER OR OUT-OF-RIVER IMPROVEMENTS AT CASHMAN PARK. ONCE IMPROVEMENTS HAVE BEEN ACCEPTED BY ENGINEER AND/OR OWNER, RESTORE UPLAND AREAS DISTURBED BY CONSTRUCTION WITHIN CASHMAN PARK AND DEMOBILIZE.

COMMONWEALTH OF MASSACHUSETTS
DEANE AUDET
CIVIL
No. 45977
REGISTERED
PROFESSIONAL ENGINEER

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER

SCALE:
HORZ.: 1" = 140'
VERT.:
DATUM:
HORZ.: NAD83
VERT.: NAVD88
0 70 140
GRAPHIC SCALE

CITY OF HAVERHILL

WATER CONTROL & CONSTRUCTION SEQUENCING PLAN NO. 2

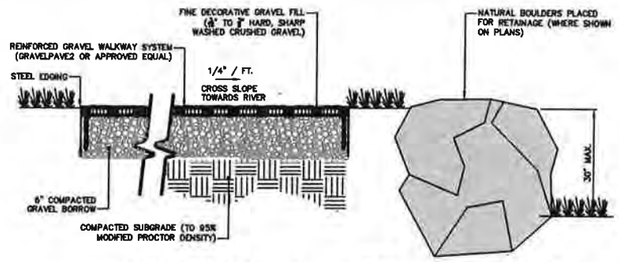
LITTLE RIVER DAM REMOVAL AND RESTORATION

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

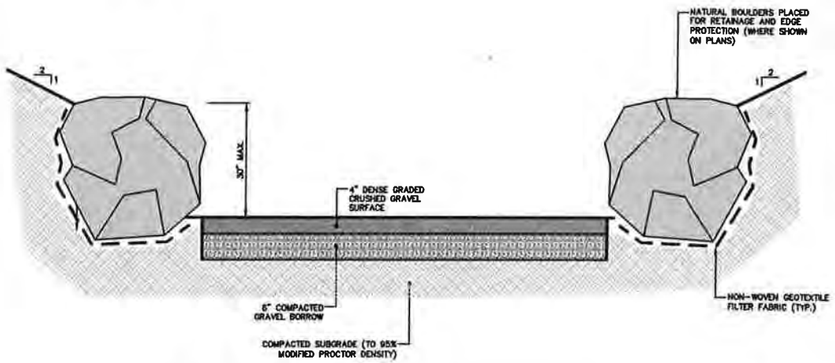
CW-102

LAYER STATE:
MS VIEW:



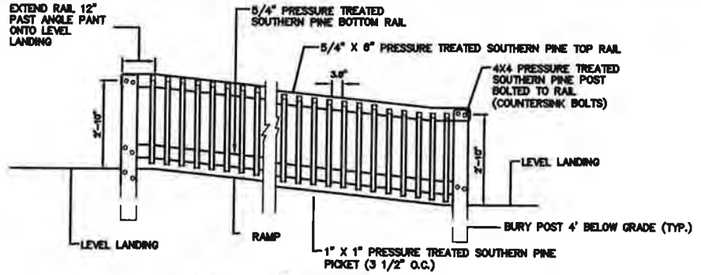
GRAVEL WALKWAY/ACCESS PATH (AT CASHMAN PARK)

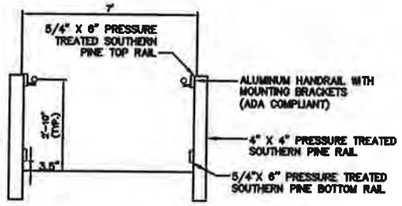
NOT TO SCALE



KAYAK/CANOE ACCESS PATH (AT CASHMAN PARK)

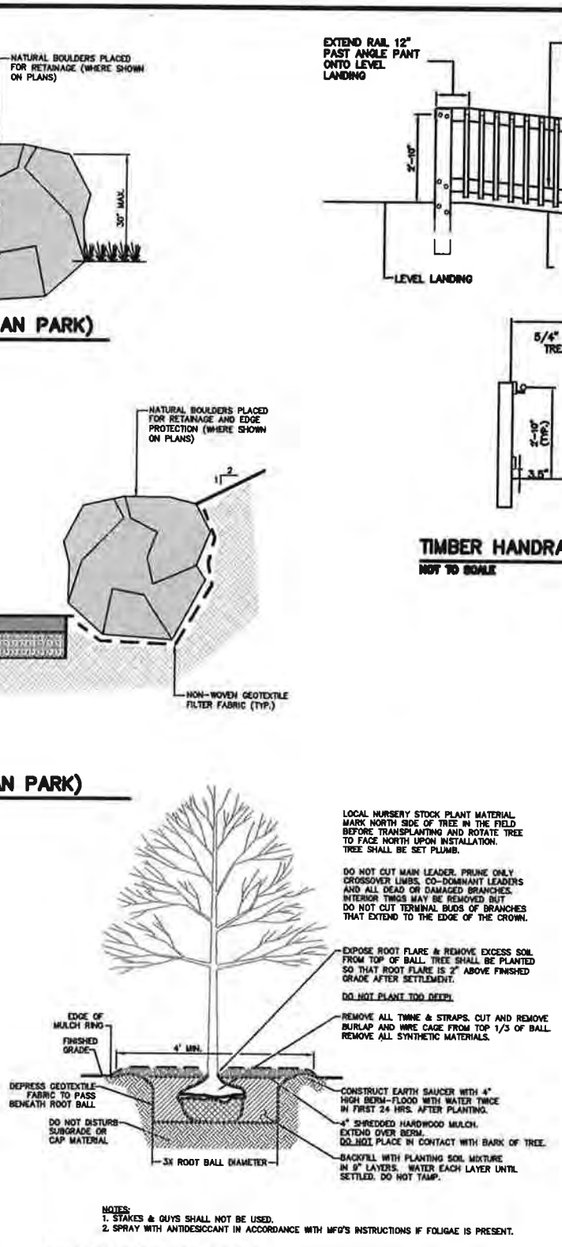
NOT TO SCALE





TIMBER HANDRAIL (AT KAYAK/CANOE ACCESS)

NOT TO SCALE



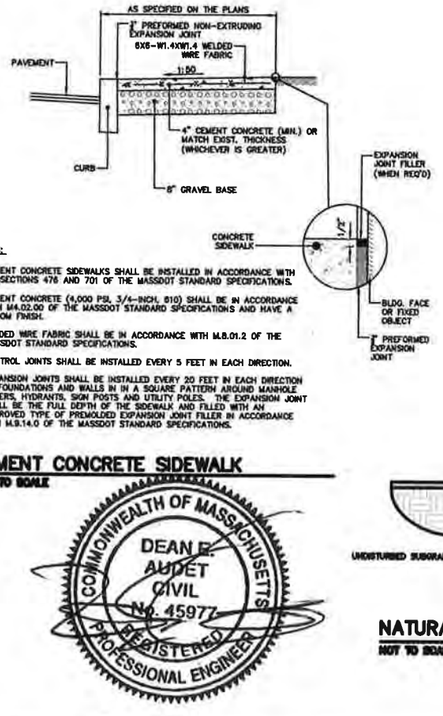
NOTES:
1. STAKES & GUYS SHALL NOT BE USED.
2. SPRAY WITH ANTIDESICCANT IN ACCORDANCE WITH MFG'S INSTRUCTIONS IF FOLIGAE IS PRESENT.

TREE PLANTING DETAIL

NOT TO SCALE

SHRUB PLANTING

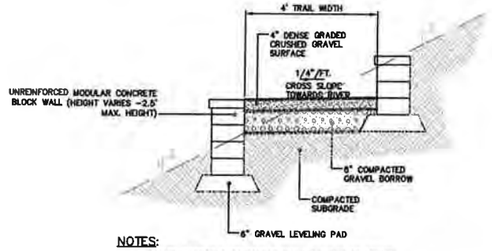
NOT TO SCALE



NOTES:
1. CEMENT CONCRETE SIDEWALKS SHALL BE INSTALLED IN ACCORDANCE WITH SUBSECTIONS 478 AND 701 OF THE MASSDOT STANDARD SPECIFICATIONS.
2. CEMENT CONCRETE (4,000 PSI, 3/4-INCH, 610) SHALL BE IN ACCORDANCE WITH M4.02.00 OF THE MASSDOT STANDARD SPECIFICATIONS AND HAVE A BROOM FINISH.
3. WELDED WIRE FABRIC SHALL BE IN ACCORDANCE WITH M.8.01.2 OF THE MASSDOT STANDARD SPECIFICATIONS.
4. CONTROL JOINTS SHALL BE INSTALLED EVERY 5 FEET IN EACH DIRECTION.
5. EXPANSION JOINTS SHALL BE INSTALLED EVERY 20 FEET IN EACH DIRECTION AT FOUNDATIONS AND WALLS IN IN A SQUARE PATTERN AROUND MANHOLE COVERS, HYDRANTS, SIGN POSTS AND UTILITY POLES. THE EXPANSION JOINT SHALL BE THE FULL DEPTH OF THE SIDEWALK AND FILLED WITH AN APPROVED TYPE OF PREMOLDED EXPANSION JOINT FILLER IN ACCORDANCE WITH M.9.14.0 OF THE MASSDOT STANDARD SPECIFICATIONS.

CEMENT CONCRETE SIDEWALK

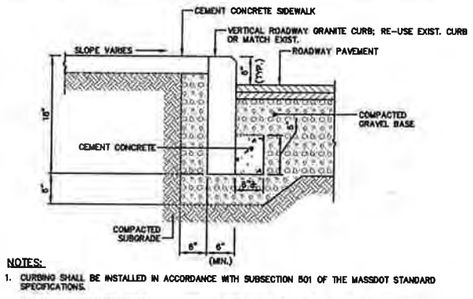
NOT TO SCALE



NOTES:
1. GRAVEL BORROW BASE COURSE SHALL CONSIST OF REUSED ON-SITE GRAVEL OR IMPORTED GRAVEL MEETING THE GRADATION REQUIREMENTS OF M.1.03 OF THE MASSDOT STANDARD SPECIFICATIONS.
2. DENSE GRADED CRUSHED GRAVEL SURFACE SHALL CONSIST OF GRAVEL SURFACE MATERIAL MEETING THE REQUIREMENTS OF M2.05.0 OF THE MASSDOT STANDARD SPECIFICATIONS.
3. ALIGNMENT OF TRAIL MAY VARY SLIGHTLY WITHIN LIMIT OF DISTURBANCE (AS FIELD DIRECTED BY ENGINEER) IN ORDER TO MINIMIZE TREE AND VEGETATION REMOVAL.

COMPACTED GRAVEL WALKING TRAIL

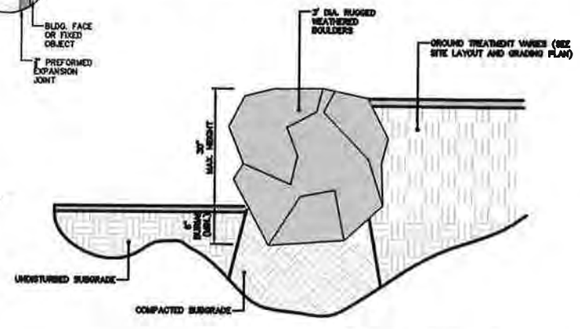
NOT TO SCALE



NOTES:
1. CURBING SHALL BE INSTALLED IN ACCORDANCE WITH SUBSECTION 501 OF THE MASSDOT STANDARD SPECIFICATIONS.
2. GRANITE CURB, GRANITE CURB INLETS, AND GRANITE CURB CORNERS SHALL BE IN ACCORDANCE WITH M9.04.1, M9.04.5, AND M9.04.6 OF THE MASSDOT STANDARD SPECIFICATIONS, RESPECTIVELY.
3. CEMENT CONCRETE (3,000 PSI, 3/4-INCH, 520) SHALL BE IN ACCORDANCE WITH M4.02.00 OF THE MASSDOT STANDARD SPECIFICATIONS AND INSTALLED IN ACCORDANCE WITH SUBSECTION 478 OF THE MASSDOT STANDARD SPECIFICATIONS.
4. MORTAR FOR CURBING JOINTS SHALL BE IN ACCORDANCE WITH M4.02.15 OF THE MASSDOT STANDARD SPECIFICATIONS.

VERTICAL ROADWAY GRANITE CURB

NOT TO SCALE



NATURAL BOULDER PLACEMENT (FOR RETAINAGE)

NOT TO SCALE

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER

SCALE:
HORZ.: AS NOTED
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DATUM:
HORZ.: NAD83
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GRAPHIC SCALE

CITY OF HAVERHILL

CONSTRUCTION DETAILS

LITTLE RIVER DAM REMOVAL AND RESTORATION

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

CD-501

File: J:\DWG\P20170390\U30\Civil\Plan\20170390U30_DET01.dwg Layout: 11X17-CD-501 Plotted: 2022-12-08 3:21 PM Saved: 2022-12-08 2:44 PM User: CNauman
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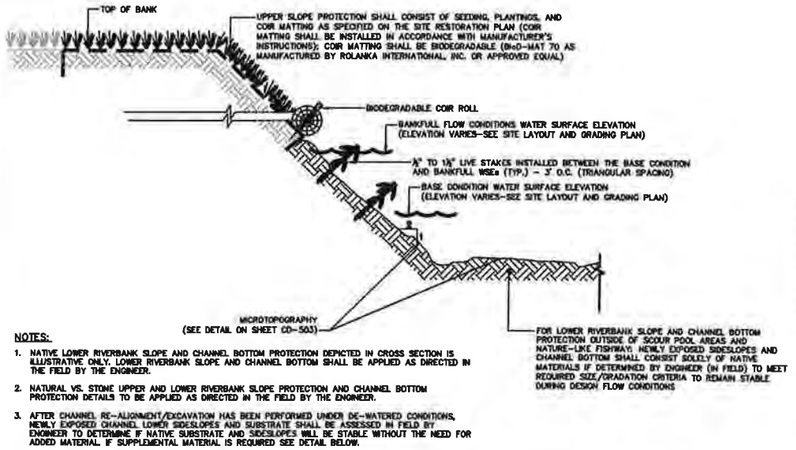
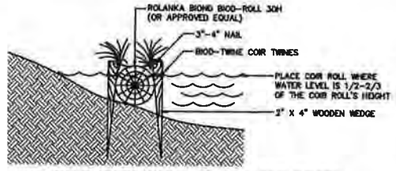


NOTES:

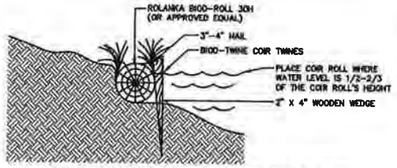
1. NATIVE LOWER RIVERBANK SLOPE AND CHANNEL BOTTOM PROTECTION DEPICTED IN CROSS SECTION IS ILLUSTRATIVE ONLY. LOWER RIVERBANK SLOPE AND CHANNEL BOTTOM SHALL BE APPLIED AS DIRECTED IN THE FIELD BY THE ENGINEER.
2. NATURAL VS. STONE UPPER AND LOWER RIVERBANK SLOPE PROTECTION AND CHANNEL BOTTOM PROTECTION DETAILS TO BE APPLIED AS DIRECTED IN THE FIELD BY THE ENGINEER.
3. AFTER CHANNEL RE-ALIGNMENT/EXCAVATION HAS BEEN PERFORMED UNDER DE-WATERED CONDITIONS, NEWLY EXPOSED CHANNEL LOWER SIDESLOPES AND SUBSTRATE SHALL BE ASSESSED IN FIELD BY ENGINEER TO DETERMINE IF NATIVE SUBSTRATE AND SIDESLOPES WILL BE STABLE WITHOUT THE NEED FOR ADDED MATERIAL. IF SUPPLEMENTAL MATERIAL IS REQUIRED SEE DETAIL BELOW.

NATURAL UPPER AND LOWER RIVERBANK SLOPE PROTECTION AND CHANNEL BOTTOM PROTECTION (OUTSIDE OF NATURE-LIKE FISHWAY, SCOUR HOLE, AND SCOUR COUNTERMEASURE LOCATIONS)

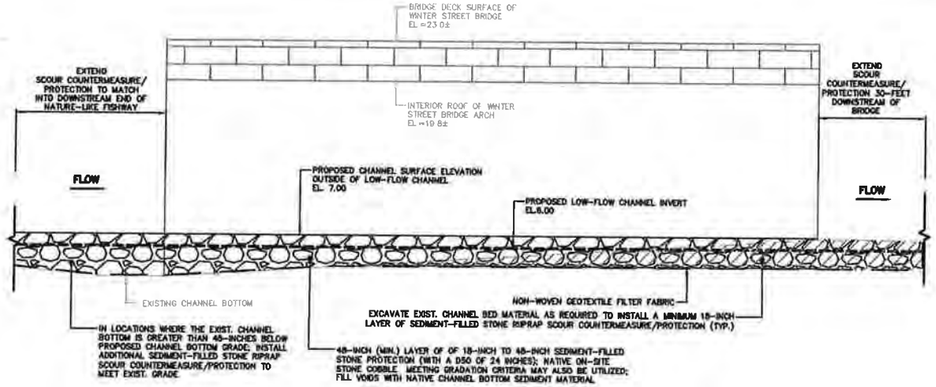
NOT TO SCALE



COIR ROLL PLACEMENT OPTION 1 – WITHOUT BANK SUPPORT

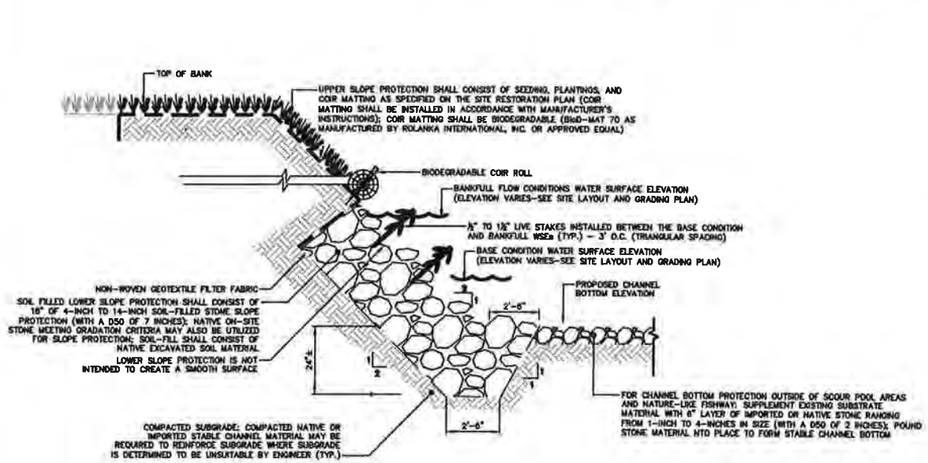


COIR ROLL PLACEMENT OPTION 2 – WITH BANK SUPPORT



WINTER STREET BRIDGE SCOUR COUNTERMEASURE/PROTECTION

NOT TO SCALE

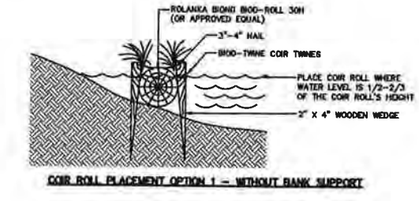


NOTE:

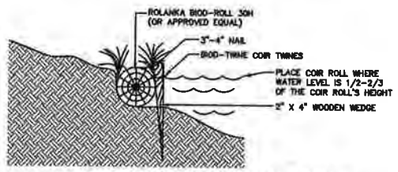
IMPORTED LOWER RIVERBANK SLOPE AND CHANNEL BOTTOM PROTECTION DEPICTED IN CROSS SECTION IS ILLUSTRATIVE ONLY. LOWER RIVERBANK SLOPE AND CHANNEL BOTTOM SHALL BE APPLIED AS DIRECTED IN THE FIELD BY THE ENGINEER.

STONE UPPER AND LOWER RIVERBANK SLOPE PROTECTION AND CHANNEL BOTTOM PROTECTION (OUTSIDE OF NATURE-LIKE FISHWAY, SCOUR HOLE, AND SCOUR COUNTERMEASURE LOCATIONS)

NOT TO SCALE



COIR ROLL PLACEMENT OPTION 1 – WITHOUT BANK SUPPORT



COIR ROLL PLACEMENT OPTION 2 – WITH BANK SUPPORT

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER

SCALE:
HORZ.: AS NOTED
VERT.:
DATUM:
HORZ.: NAD83
VERT.: NAVD88
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GRAPHIC SCALE

CITY OF HAVERHILL

CONSTRUCTION DETAILS

LITTLE RIVER DAM REMOVAL AND RESTORATION

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

CD-502

File: J:\DWG\P2017\20170390\U30\Civil\Plan\20170390U30_DET01.dwg Layout: 11X17-CD-502 Plotted: 2022-12-08 3:21 PM Saved: 2022-12-08 2:44 PM User: Chauman
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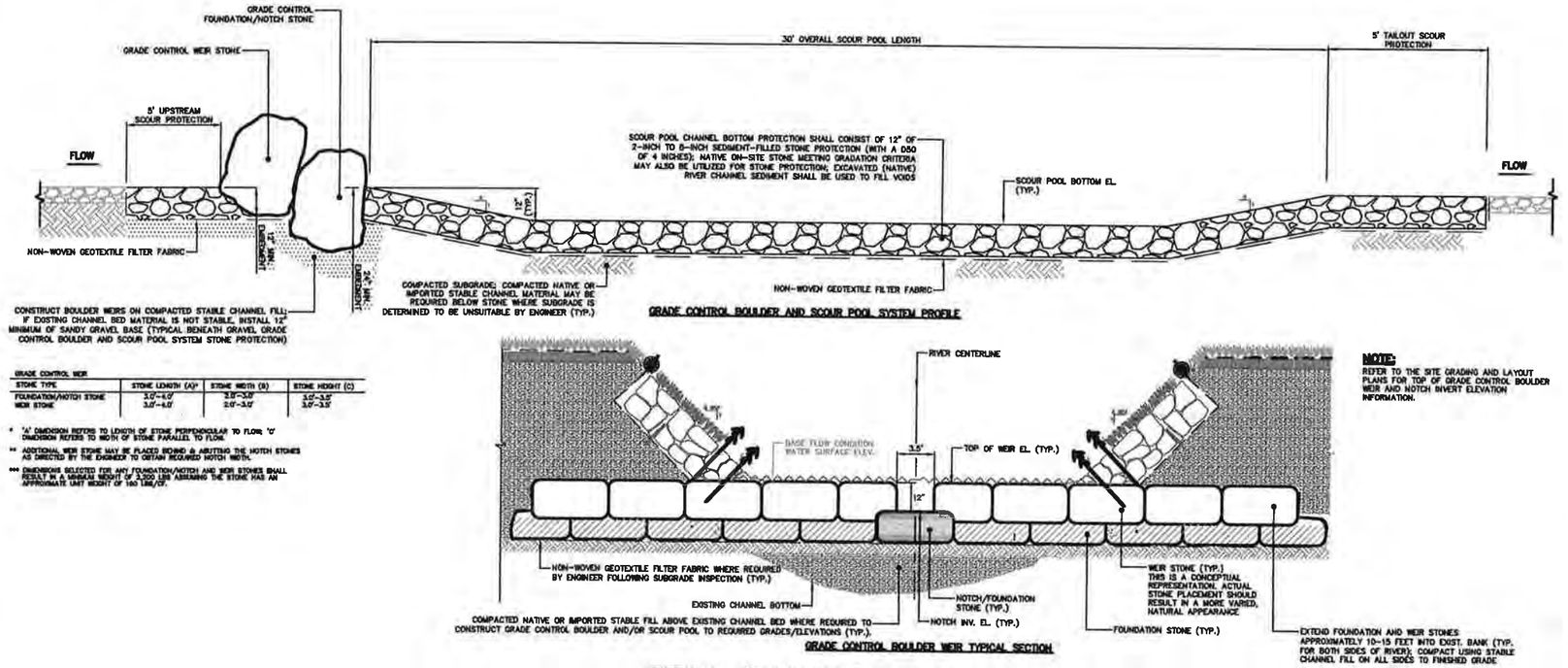
LAYER STATE:
MS VIEW:

MICROTOPOGRAPHY CROSS SECTION

SCALE: N.T.S.



GRADE CONTROL BOULDER AND SCOUR POOL SYSTEM PROFILE

GRADE CONTROL WEIR			
STONE TYPE	STONE LENGTH (A)*	STONE WIDTH (B)	STONE HEIGHT (C)
FOUNDATION/NOTCH STONE	3.0'-4.0'	2.0'-3.0'	1.0'-2.5'
WEIR STONE	3.0'-4.0'	2.0'-3.0'	1.0'-2.5'

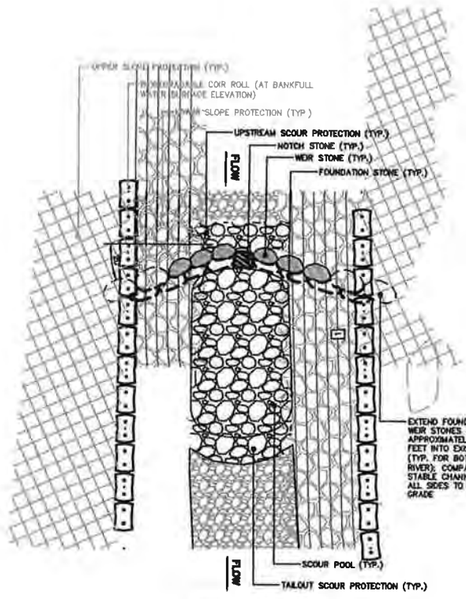
* "A" DIMENSION REFERS TO LENGTH OF STONE PERPENDICULAR TO FLOW; "C" DIMENSION REFERS TO WIDTH OF STONE PARALLEL TO FLOW.

** ADDITIONAL WEIR STONE MAY BE PLACED BEHIND & ABUTTING THE NOTCH STONES AS DIRECTED BY THE ENGINEER TO OBTAIN REQUIRED NOTCH WIDTH.

*** DIMENSIONS SELECTED FOR ANY FOUNDATION/NOTCH AND WEIR STONES SHALL RESULT IN A MINIMUM WEIGHT OF 3,200 LBS ASSUMING THE STONE HAS AN APPROXIMATE UNIT WEIGHT OF 160 LBS/CF.

GRADE CONTROL BOULDER WEIR TYPICAL SECTION

NOTE:
REFER TO THE SITE GRADING AND LAYOUT PLANS FOR TOP OF GRADE CONTROL BOULDER WEIR AND NOTCH INVERT ELEVATION INFORMATION.



TYPICAL PLAN VIEW

TYPICAL GRADE CONTROL BOULDER AND SCOUR POOL SYSTEM

NOT TO SCALE

COMMONWEALTH OF MASSACHUSETTS
DEAN E. AUDET
CIVIL
No. 25977
REGISTERED PROFESSIONAL ENGINEER

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER

SCALE:
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VERT.:
DATUM:
HORZ.: NAD83
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0
GRAPHIC SCALE

CITY OF HAVERHILL

CONSTRUCTION DETAILS

LITTLE RIVER DAM REMOVAL AND RESTORATION

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

CD-503

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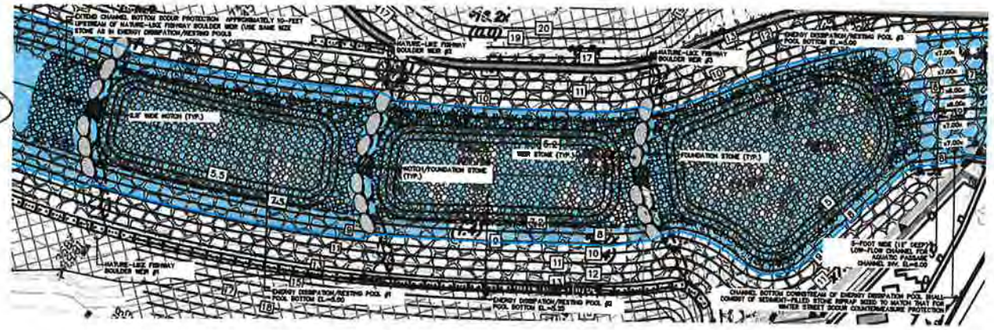
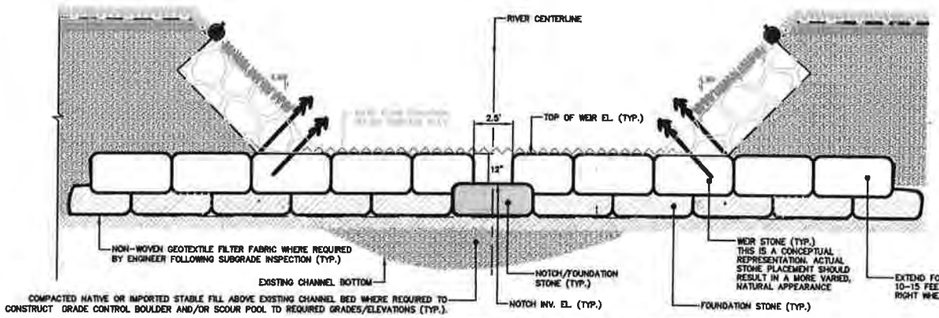
MS VIEW: LAYER STATE:
FO HALF STB

COMMONWEALTH OF MASSACHUSETTS
DEAN E. AUDET
CIVIL
No. 45977
REGISTERED
PROFESSIONAL ENGINEER



NATURE-LIKE FISHWAY LAYOUT

SCALE 1"=30'



NATURE-LIKE FISHWAY BOULDER WEIR TYPICAL SECTION

NOTE:
REFER TO THE SITE GRADING AND LAYOUT PLANS FOR TOP OF NATURE-LIKE FISHWAY BOULDER WEIR AND NOTCH INVERT ELEVATION INFORMATION.

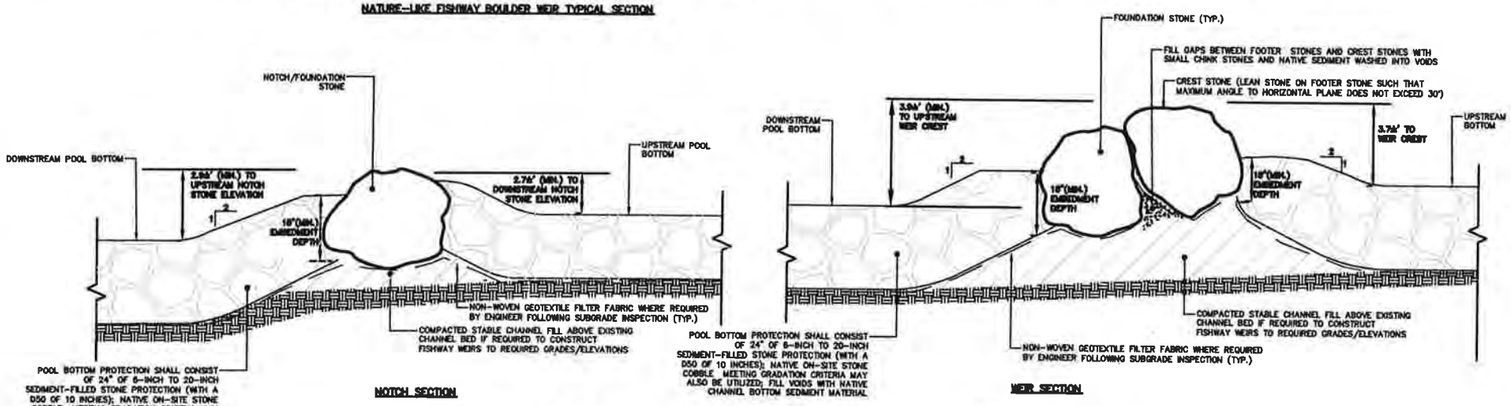
NATURE-LIKE FISHWAY BOULDER WEIR

STONE TYPE	STONE LENGTH (A)*	STONE WIDTH (B)	STONE HEIGHT (C)
FOUNDATION/NOTCH STONE	3.0'-4.0'	2.0'-3.0'	3.0'-3.5'
WEIR STONE	3.0'-4.0'	2.0'-3.0'	3.0'-3.5'

* 'A' DIMENSION REFERS TO LENGTH OF STONE PERPENDICULAR TO FLOW. 'B' DIMENSION REFERS TO WIDTH OF STONE PARALLEL TO FLOW.

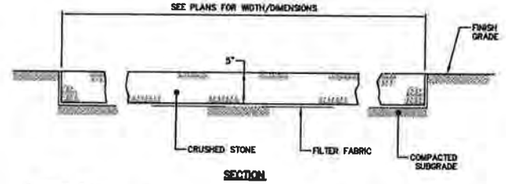
** ADDITIONAL WEIR STONE MAY BE PLACED BEHIND & ABUTTING THE NOTCH STONES AS DIRECTED BY THE ENGINEER TO OBTAIN REQUIRED NOTCH WIDTH.

*** DIMENSIONS SELECTED FOR ANY FOUNDATION/NOTCH AND WEIR STONES SHALL RESULT IN A MINIMUM WEIGHT OF 2,400 LBS ASSUMING THE STONE HAS AN APPROXIMATE UNIT WEIGHT OF 150 LBS/CF.



TYPICAL NATURE-LIKE FISHWAY WEIR AND RESTING POOL PROFILE

NOT TO SCALE



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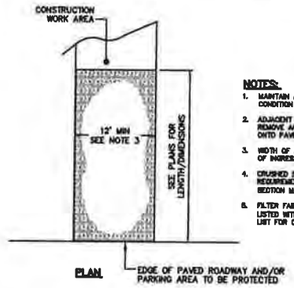
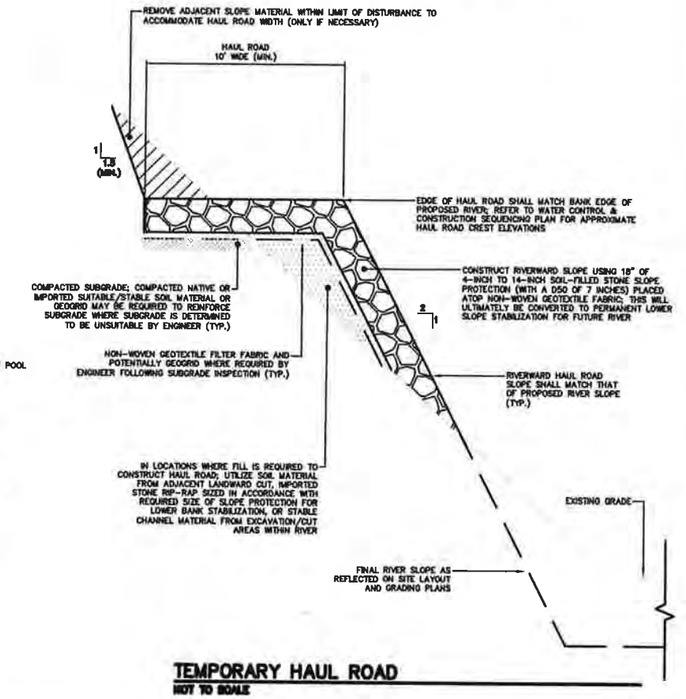


PLAN

NOTES:
1. MAINTAIN ANTI-TRACKING APRON IN GOOD CONDITION THROUGHOUT CONSTRUCTION PERIOD.
2. ADJACENT ROADWAY SHALL BE SWEPT DAILY TO REMOVE ANY MATERIAL THAT MAY BE TRACKED ONTO PAVEMENT.
3. WIDTH OF APRON SHALL NOT BE LESS THAN WIDTH OF INGRESS OR EGRESS.
4. CRUSHED STONE SHALL CONFORM TO THE REQUIREMENTS OF STANDARD SPECIFICATIONS SECTION M2.01.1 (1 1/2 INCH).
5. FILTER FABRIC SHALL BE NON-WOVEN AND BE LISTED WITHIN MASSDOT'S APPROVED MATERIALS LIST FOR CLASS 1 AND 2 APPLICATIONS.

TEMPORARY STONE CONSTRUCTION ACCESS

NOT TO SCALE



TEMPORARY HAUL ROAD

NOT TO SCALE

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER

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HORZ.: AS NOTED
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CITY OF HAVERHILL

CONSTRUCTION DETAILS

LITTLE RIVER DAM REMOVAL AND RESTORATION

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

CD-504

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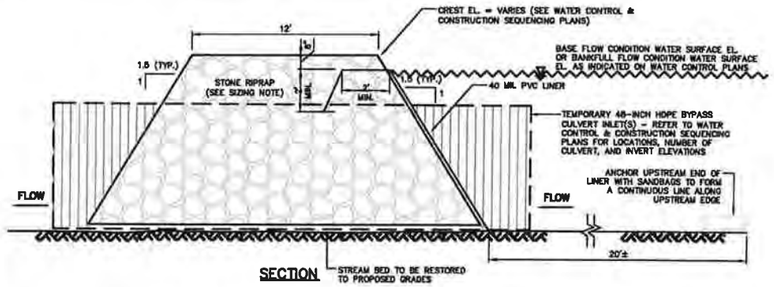
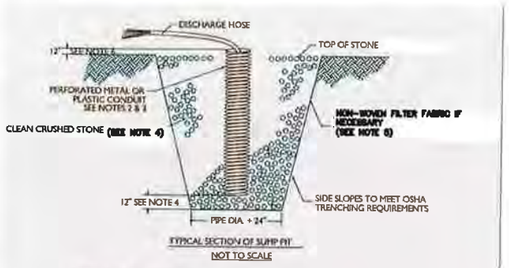


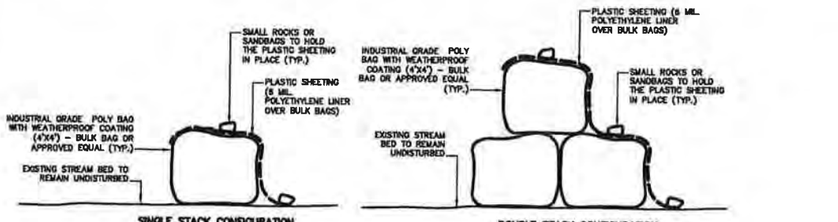
TEMPORARY RIVER CROSSING
NOT TO SCALE



TYPICAL SECTION OF SUMP PIT
NOT TO SCALE

1. OVERALL SUMP PIT DIMENSIONS SHALL BE COMPATIBLE WITH ANTICIPATED SEEPAGE RATES AND PUMP SIZE TO BE USED.
2. THE STANDPIPE DIAMETER AND NUMBER OF PERFORATIONS SHALL BE COMPATIBLE WITH THE PUMP SIZE BEING USED.
3. PERFORATIONS IN THE STANDPIPE SHALL BE EITHER CIRCULAR OR SLOTS. PERFORATION SIZE SHALL NOT EXCEED 1/2" IN DIAMETER.
4. **CRUSHED STONE SHALL CONFORM TO THE GRADATION LISTED FOR CRUSHED STONE IN SUBSECTION M1.01.4 OF THE MASSDOT STANDARD SPECIFICATIONS FOR 3/4-INCH CRUSHED STONE. CRUSHED STONE SHALL EXTEND A MINIMUM OF 12" BELOW THE BOTTOM OF THE STANDPIPE.**
5. IF EXCESSIVE MOVEMENT OF FINE SOIL PARTICLES FROM THE SURROUNDING EXISTING SOILS IS ANTICIPATED, A PROPERLY DESIGNED GEOTEXTILE SHALL BE PLACED BETWEEN THE EXISTING SOILS AND THE CRUSHED STONE OR GRAVEL BACKFILL
6. THE STANDPIPE SHALL EXTEND A MINIMUM OF 12" ABOVE THE SURROUNDING GROUND
7. **WHEN USED FOR WATER CONTROL DURING THE CONSTRUCTION OF THE LOWER SLOPE AND TOE PROTECTION ASSOCIATED WITH BIODEGRADEDED SLOPE STABILIZATION, TREE REVETMENT SYSTEM, AND THE OUTFALL HEADWALL AND ARMORED CHANNEL. BOTTOM SCOUR PROTECTION. PUMP DISCHARGE MAY NEED TO BE DIVERTED THROUGH A DEWATERING BAG PRIOR TO BEING DIRECTED INTO THE BROOK IF IT IS DETERMINED BY THE ENGINEER THAT THE DISCHARGE IS TURBID OR CLOUDY.**

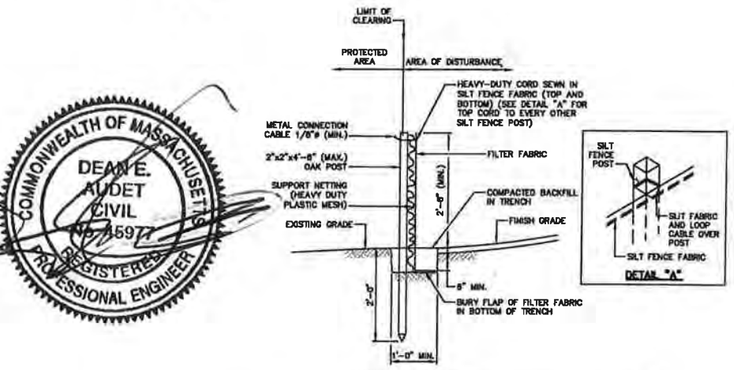
CRUSHED STONE SUMP DETAIL (FOR CONSTRUCTION DEWATERING PUMPS)
NOT TO SCALE



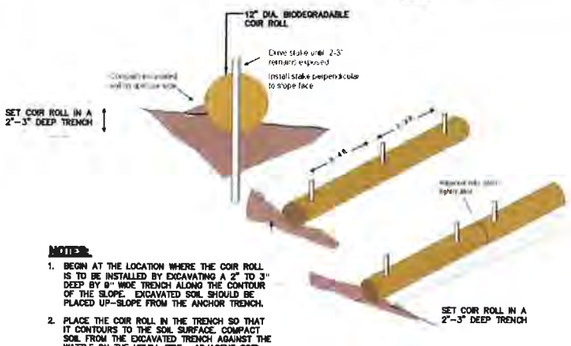
WATER CONTROL NOTES:

1. TEMPORARY SANDBAGS SHALL CONSIST OF POLYPROPYLENE LARGE SANDBAGS, BULK BAGS OR APPROVED EQUAL, AND SHALL BE FILLED WITH SAND CONFORMING TO SUBSECTION M1.04.0 (TYPE B) OF THE MASSDOT STANDARD SPECIFICATIONS.
2. INSTALL DURING PERIOD OF LOW-FLOW IN BROOK. MONITOR WATER CONTROL SYSTEM DAILY. PROMPTLY CORRECT SEEPAGE, BREAKAGE, OR OTHER EVIDENCE OF MOVEMENT TO ENSURE THAT TEMPORARY COFFERDAM(S) AND WATER BYPASS CONVEYANCES REMAIN STABLE AND FUNCTIONING AS INTENDED.
3. MAINTAIN CRUSHED STONE STUMP AND PUMPS AS NECESSARY TO MAINTAIN DEWATERED CONDITIONS WITHIN COFFERDAMMED AREAS SUFFICIENT FOR COMPLETION OF WORK AND PLACEMENT PROPOSED MATERIALS UNDER SAFE, CONTROLLED CONDITIONS.
4. REMOVE ALL SANDBAGS, ACCUMULATED SEDIMENT, AND OTHER COFFERDAM MATERIALS AFTER IN-RIVER CONSTRUCTION IN RESPECTIVE PHASE IS COMPLETE

TEMPORARY LARGE SANDBAG COFFERDAM (BULK BAGS OR APPROVED EQUAL)
NOT TO SCALE



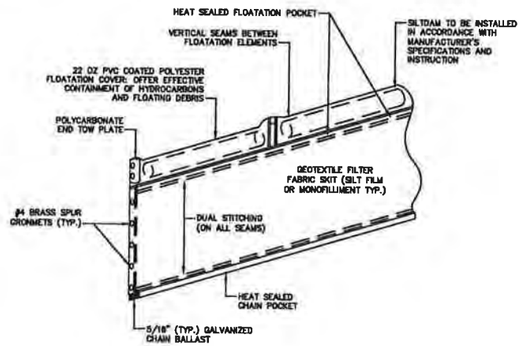
SILT FENCE
NOT TO SCALE



NOTES:

1. BEGIN AT THE LOCATION WHERE THE COIR ROLL IS TO BE INSTALLED BY EXCAVATING A 2" TO 3" DEEP BY 9" WIDE TRENCH ALONG THE CONTOUR OF THE SLOPE. EXCAVATED SOIL SHOULD BE PLACED UP-SLOPE FROM THE ANCHOR TRENCH.
2. PLACE THE COIR ROLL IN THE TRENCH SO THAT IT CONTOURS TO THE SOIL SURFACE. COMPACT SOIL FROM THE EXCAVATED TRENCH AGAINST THE WATTLE ON THE UPHILL SIDE. ADJACENT COIR ROLLS SHALL TIGHTLY ABUT.
3. SECURE THE COIR ROLL WITH 36" LONG (2"x2") STAKES SPACED EVERY 3' TO 4' ON CENTER AND WITH A STAKE ON EACH END. STAKES SHOULD BE DRIVEN THROUGH THE MIDDLE OF THE COIR ROLL LEAVING AT LEAST 2" TO 3" OF STAKE EXTENDING ABOVE THE COIR ROLL. STAKES SHALL BE DRIVEN PERPENDICULAR TO THE SLOPE FACE.

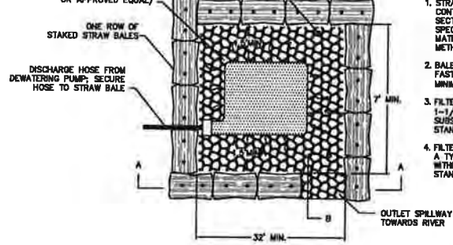
BIODEGRADABLE COIR ROLL (FOR PERIMETER EROSION CONTROL MEASURE)
NOT TO SCALE



NOTES:

1. CURTAIN SHALL BE A TYPE III HEAVY DUTY CURTAIN THAT IS SUITABLE FOR INSTALLATION WITH FLOWS UP TO 5 FEET PER SECOND (FPS).
2. FLOATATION SIZE (6", 8" OR 12" DIA.) DETERMINED BY SKIRT DEPTH/SITE VARIABLES.
3. OTHER END TYPES AVAILABLE SUCH AS ALUMINUM UNIVERSAL SLIDE OR SLOTTED TUBE.
4. OPTIONAL TOP TENSION CABLE (3/16" TYP.) AVAILABLE FOR INCREASED STRENGTH.

TYPE III FLOATING TURBIDITY CURTAIN
NOT TO SCALE



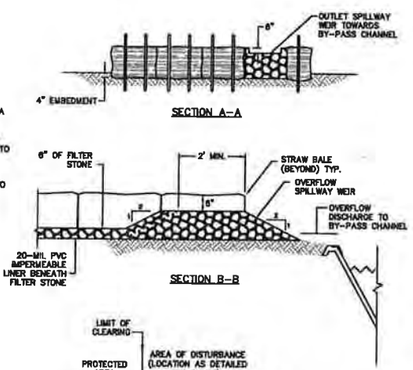
PLAN

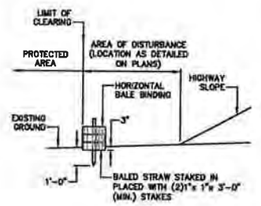
NOTES:

1. THE DEWATERING BAG, DIRTBAG® DB55 OR APPROVED EQUAL, SHALL BE HEAVY DUTY AND CONSIST OF A NONWOVEN BAG SEWN WITH A DOUBLE NEEDLE MATCHING USING A HIGH STRENGTH THREAD.
2. EACH DEWATERING BAG SHALL HAVE A FILL SPOUT LARGE ENOUGH TO ACCOMMODATE A 4-INCH DISCHARGE HOSE. THE BAG SHALL BE PROVIDED WITH STRAPS TO SECURE THE HOSE AND PREVENT PUMPED WATER FROM ESCAPING WITHOUT BEING FILTERED.
3. MAINTAIN DEWATERING BAG(S) AS NECESSARY TO EFFICIENTLY FILTER SEDIMENT OR PASS WATER AT A REASONABLE RATE. USE OF EXCESSIVE FLOW RATES OR OVERFILLING DIRTBAG® WITH SEDIMENT WILL CAUSE RUPTURES OF THE BAGS OR FAILURE OF THE HOSE ATTACHMENT STRAPS.
4. DISPOSE OF DEWATERING BAG AND CONTENTS AT OFF-SITE DISPOSAL FACILITY IN ACCORDANCE WITH THE APPROVED SOIL MANAGEMENT PLAN OR AS DIRECTED BY ENGINEER.
5. INSTALL DEWATERING BAG AND CRUSHED STONE BEDDING WITH A SLOPE SO INCOMING WATER FLOWS DOWNHILL THROUGH THE BAG WITHOUT CREATING MORE EROSION. STRAP THE NECK OF DEWATERING BAG TIGHTLY TO THE DISCHARGE HOSE.

NOTES:

1. STRAW BALES FOR EROSION CONTROL SHALL CONFORM TO SECTION 787 OF THE STANDARD SPECIFICATIONS INCLUDING MATERIALS AND CONSTRUCTION METHODS.
2. BALES OF STRAW SHALL BE FASTENED WITH WIRE AND HAVE A MINIMUM SIZE OF 1'x1.5'x3'.
3. FILTER STONE SHALL CONSIST OF 1-1/2 INCH STONE CONFORMING TO SUBSECTION M2.01.1 OF THE STANDARD SPECIFICATIONS.
4. FILTER FABRIC SHALL CONFORM TO A TYPE I FABRIC AS INCLUDED WITHIN SECTION M9.50.0 OF THE STANDARD SPECIFICATIONS.





ELEVATION

TEMPORARY DEWATERING BASIN WITH FILTER BAG
NOT TO SCALE

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER

SCALE:
HORZ.: AS NOTED
VERT.:
DATUM:
HORZ.: NAD83
VERT.: NAVD88
0
GRAPHIC SCALE

CITY OF HAVERHILL

CONSTRUCTION DETAILS

LITTLE RIVER DAM REMOVAL AND RESTORATION

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170380.U30
DATE: JUNE 2022

CD-505

DEANE. AUDET CIVIL No. 45971 REGISTERED PROFESSIONAL ENGINEER COMMONWEALTH OF MASSACHUSETTS

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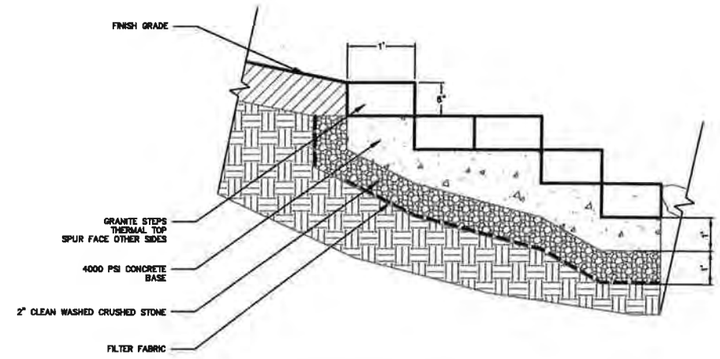
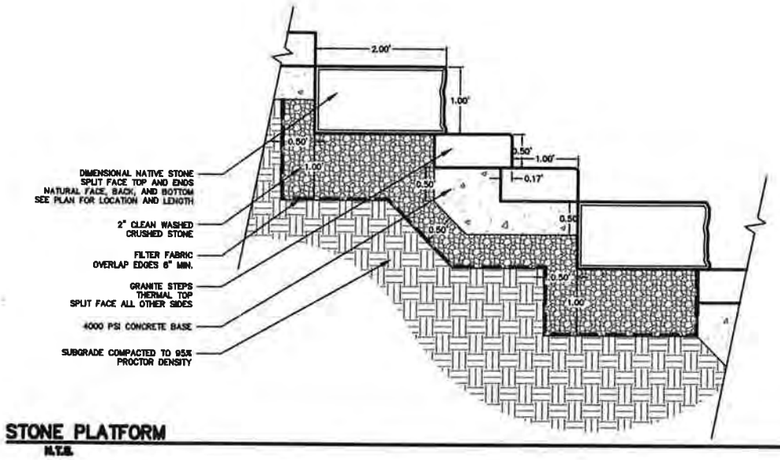
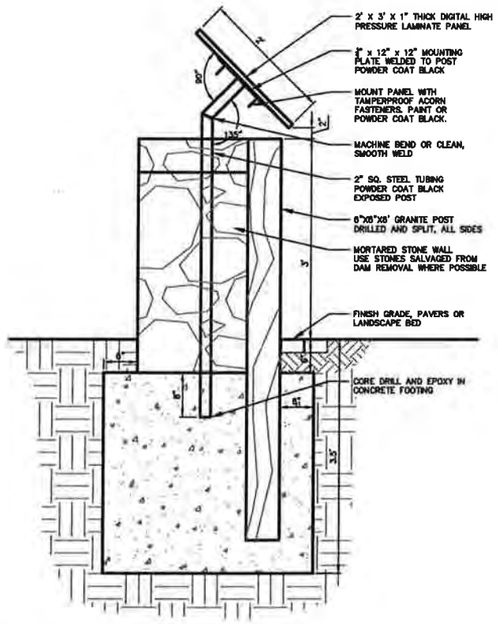
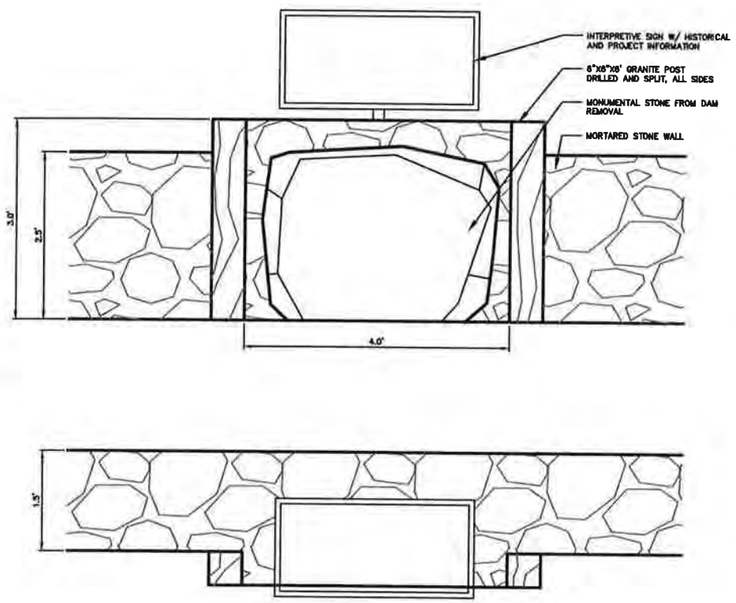


GRANITE STEPS
N.T.S.



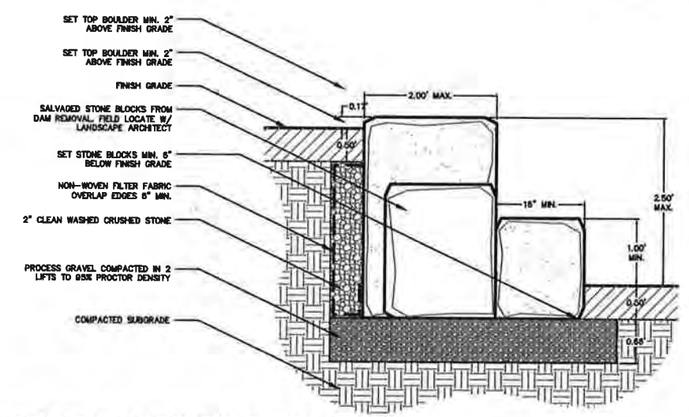
STONE PLATFORM
N.T.S.





NOTES:
PROVIDE SHOP DRAWING BY SIGN MANUFACTURER FOR APPROVAL.

STONE WALL AND INTERPRETIVE SIGN
SCALE: NOT TO SCALE



STACKED SALVAGED STONE BLOCKS
N.T.S.

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER

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HORZ.: AS NOTED
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DATUM:
HORZ.: NAD83
VERT.: NAVD88
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GRAPHIC SCALE

CITY OF HAVERHILL

CONSTRUCTION DETAILS

LITTLE RIVER DAM REMOVAL AND RESTORATION

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

CD-506

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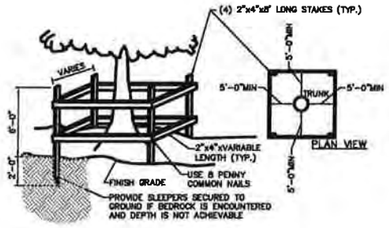
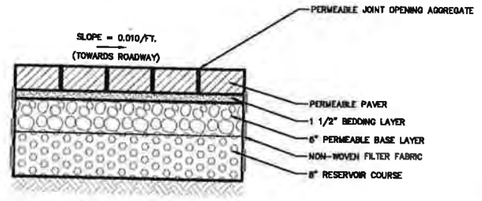


NOTES:
SEE LANDSCAPING PLAN FOR ADDITIONAL TREE PROTECTION NOTES.

TEMPORARY TREE PROTECTION
NOT TO SCALE

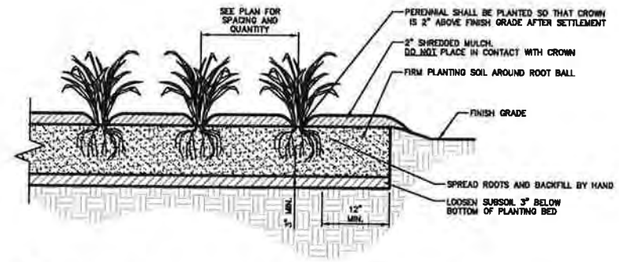
NOTES:
1. 16'-0" SECTIONS TO INCLUDE FIVE (5) 12" STAKES
2. 8'-0" SECTIONS TO INCLUDE THREE (3) 12" STAKES
3. COMPACT GRADES ADJACENT TO EDGING TO MINIMIZE SETTLING
4. CORNERS – CUT BASE OF EDGING HALF WAY AND FORM A CONTINUOUS CORNER.

LANDSCAPE EDGING
SCALE: NOT TO SCALE



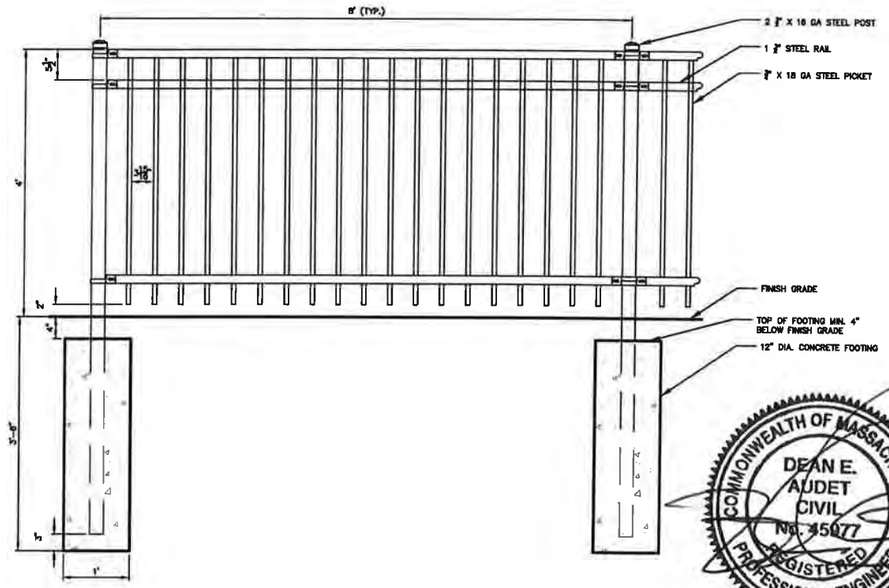
NOTES:
1. THICKNESS OF PERMEABLE CONCRETE PAVERS SHALL VARY BASED ON PRODUCT AND MANUFACTURER SELECTED.
2. THE MINIMUM THICKNESSES OF THE BEDDING LAYER, PERMEABLE BASE LAYER, AND RESERVOIR COURSE LAYER AS SPECIFIED ABOVE REPRESENT MINIMUM THICKNESSES AFTER COMPACTION.
3. PROTECT PERMEABLE PAVERS AND AGGREGATES FROM CONSTRUCTION VEHICLE TRAFFIC, RUNOFF FROM ADJACENT AREAS, AND SEDIMENTATION.

PERMEABLE PAVER SYSTEM
Scale: N.T.S.



NOTES:
- SPADED PLANTING SOIL MIX SHALL BE PLACED 3" BELOW ROOT BALL AND BE MIXED WITH FERTILIZER. DO NOT COMPACT AFTER PLANTING.
- WATER THOROUGHLY AFTER PLANTING.
- PROVIDE WELL DRAINING SUBSOIL WHEN SOIL IS HEAVY OR COMPACTED.
- FOR CONTAINER GROWN PLANTS, USE FINGERS OR SMALL HAND TOOLS TO PULL THE ROOTS OUT OF THE OUTER LAYER OF POTTING SOIL; THEN CUT OR PULL APART ANY ROOTS CIRCLING THE PERIMETER OF THE CONTAINER.

PERENNIAL PLANT BED
Scale: N.T.S.



DECORATIVE FENCE
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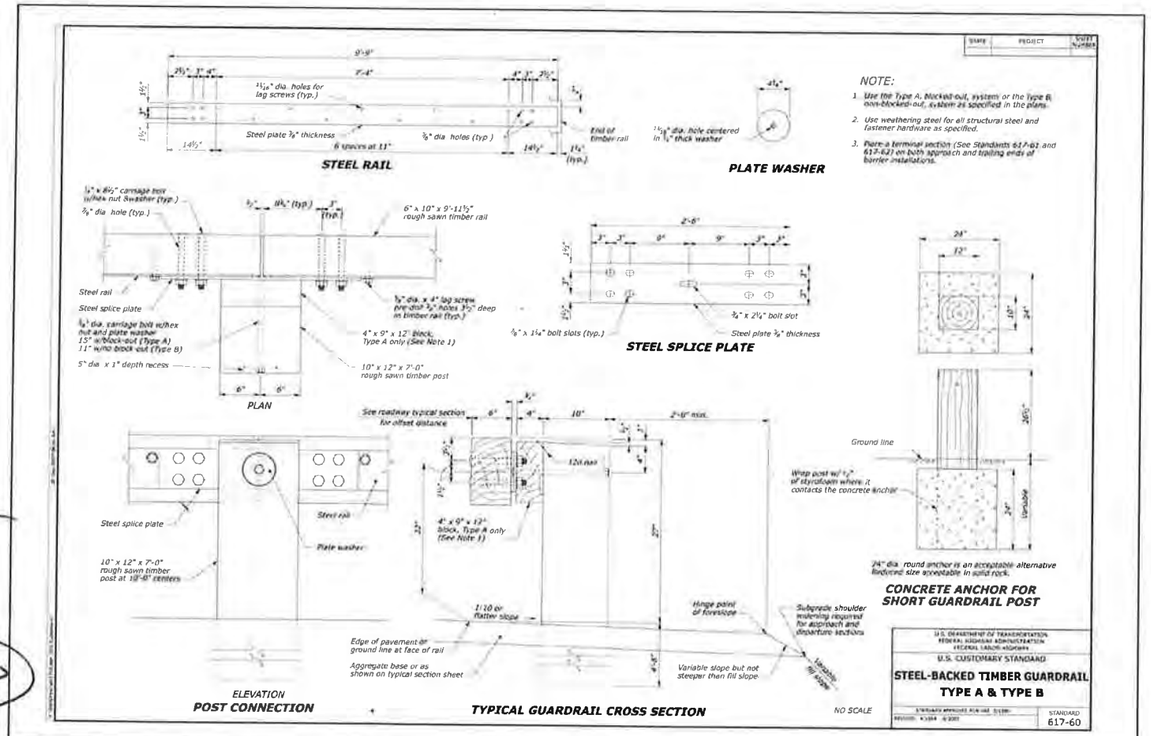

STEEL BACKED TIMBER GUARDRAIL
NOT TO SCALE

COMMONWEALTH OF MASSACHUSETTS
DEAN E. AUDET
CIVIL
No. 45077
REGISTERED
PROFESSIONAL ENGINEER

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER

SCALE:
HORZ.: AS NOTED
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DATUM:
HORZ.: NAD83
VERT.: NAVD88
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GRAPHIC SCALE

CITY OF HAVERHILL

CONSTRUCTION DETAILS

LITTLE RIVER DAM REMOVAL AND RESTORATION

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

CD-507

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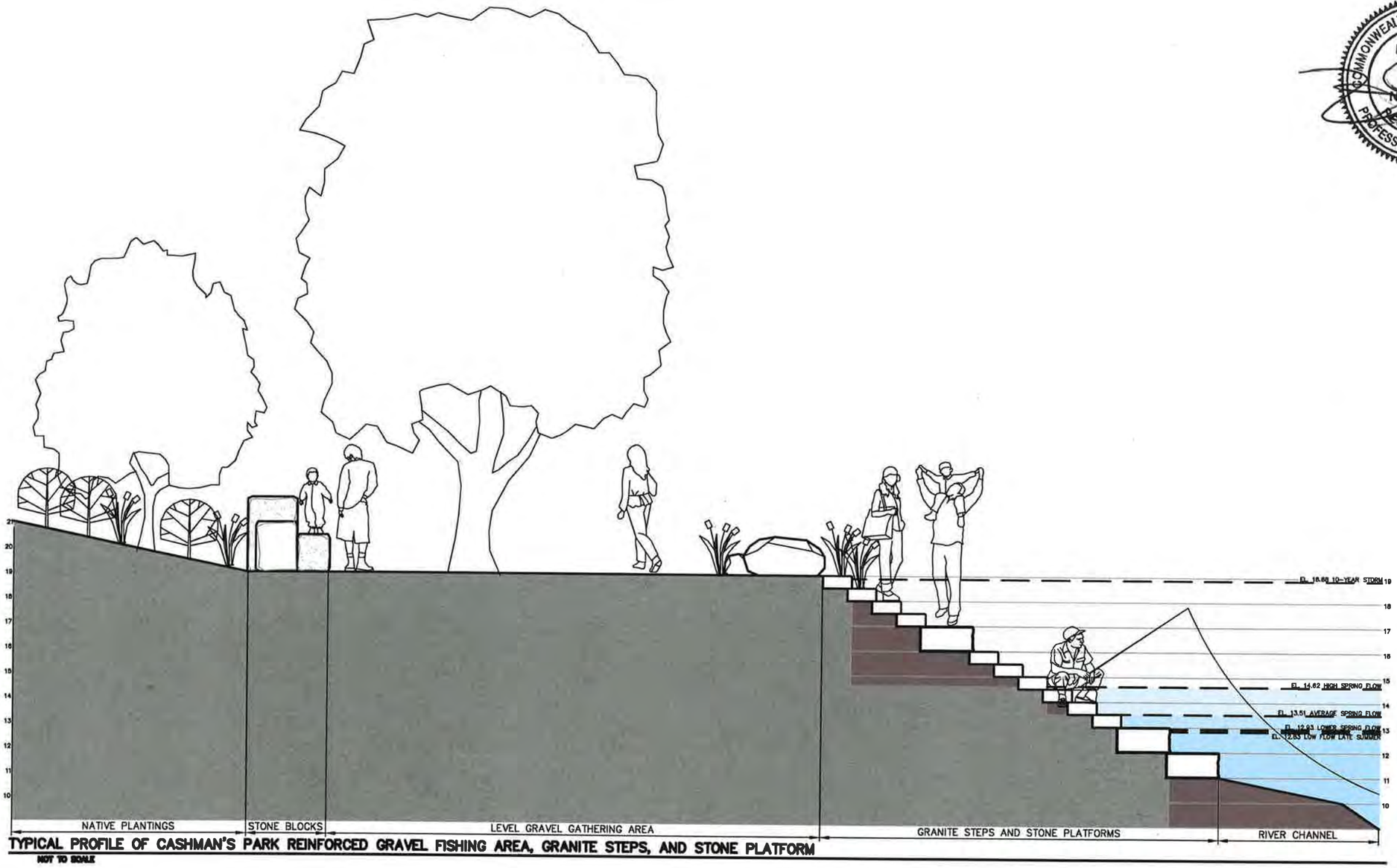

TYPICAL PROFILE OF CASHMAN'S PARK REINFORCED GRAVEL FISHING AREA, GRANITE STEPS, AND STONE PLATFORM

NOT TO SCALE

COMMONWEALTH OF MASSACHUSETTS
DEAN E. AUDET
CIVIL
No. 45977
REGISTERED PROFESSIONAL ENGINEER

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER

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GRAPHIC SCALE

CITY OF HAVERHILL

CONSTRUCTION DETAILS

LITTLE RIVER DAM REMOVAL AND RESTORATION

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

CD-508

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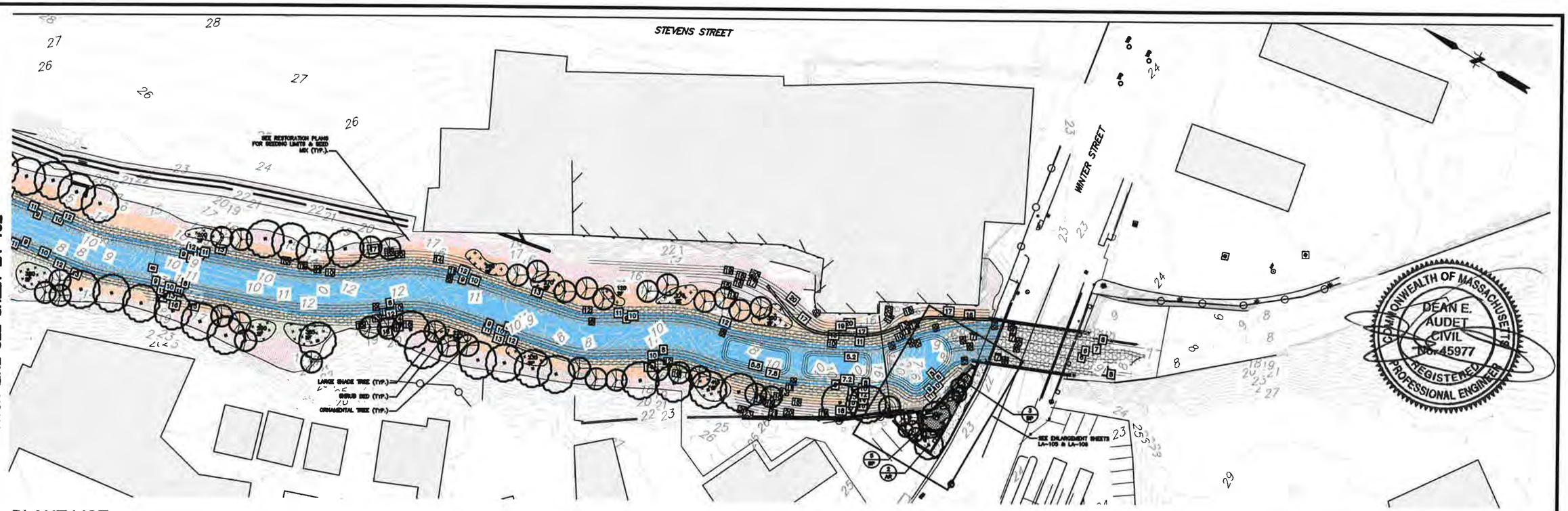

PLANT LIST

KEY	BOTANICAL NAME	COMMON NAME	SIZE
	LARGE SHADE TREES		
AB	ABIES BALSAMEA	BALSAM FIR	6–7' HT.
AR	ACER RUBRUM	RED MAPLE	2"–2 ½" CAL.
AS	ACER SACCHARINUM	SILVER MAPLE	2"–2 ½" CAL.
BA	BETULA ALLEGHANIENSIS	YELLOW BIRCH	2"–2 ½" CAL.
LL	LARIX LARCINA	AMERICAN LARCH	6–7' HT.
PO	PLATANUS OCCIDENTALIS	AMERICAN SYCAMORE	2"–2 ½" CAL.
PS	PRUNUS SEROTINA	BLACK CHERRY	2"–2 ½" CAL.
UA	ULMUS AMERICANA	AMERICAN ELM	2"–2 ½" CAL.
	ORNAMENTAL TREES		
AL	AMELANCHIER LAEVIS	ALLEGHENY SERVICEBERRY	6–8' HT.
BP	BETULA POPULIFOLIA	GREY BIRCH	1"–1 ½" CAL.
CA	CORNUS ALTERNIFOLIA	PAGODA DOGWOOD	1"–1 ½" CAL.
OC	CARPINUS CAROLINIANA	AMERICAN HORNBEAM	1"–1 ½" CAL.

KEY	SHRUBS		
AA	ARONIA ARBUTIFOLIA	RED CHOKEBERRY	3 GAL.
AI	ALNUS INCANA	SPECKLED ALDER	3 GAL.
AM	ARONIA MELANOCARPA	BLACK CHOKEBERRY	3 GAL.
CP	CLETHRA ALNIFOLIA	SWEET PEPPERBUSH	3 GAL.
CR	CORNUS RACEMOSA	GRAY DOGWOOD	3 GAL.
HV	HAMAMELIS VIRGINIANA	WITCH HAZEL	3 GAL.
IV	ILEX VERTICILLATA	WINTERBERRY HOLLY	3 GAL.
KA	KALMIA ANGUSTIFOLIA	SHEEP LAUREL	3 GAL.
SL	SPIRAEA LATIFOLIA	MEADOWSWEET	3 GAL.
ST	SPIRAEA TOMENTOSA	STEEPLEBUSH	3 GAL.
VL	VIBURNUM LENTAGO	NANNYBERRY	3 GAL.

LEGEND:

LARGE SHADE TREE
TOTAL QTY: 222

UNLESS OTHERWISE NOTED ON LANDSCAPE PLAN, SELECT AT LEAST 2 OF THE FOLLOWING SPECIES IN EQUAL QUANTITIES
–AMERICAN SYCAMORE (PLATANUS OCCIDENTALIS, FACW)
–AMERICAN ELM (ULMUS AMERICANA, FACW)
–AMERICAN LARCH (LARIX LARCINA, FACW)
–BLACK CHERRY (PRUNUS SEROTINA, FACU)
–SILVER MAPLE (ACER SACCHARINUM, FACW)

UNLESS OTHERWISE NOTED ON LANDSCAPE PLAN, SELECT AT LEAST 2 OF THE FOLLOWING SPECIES IN EQUAL QUANTITIES
–RED MAPLE (ACER RUBRUM, FAC)
–YELLOW BIRCH (BETULA ALLEGHANIENSIS, FAC)
–BALSAM FIR (ABIES BALSAMEA, FAC)

ORNAMENTAL TREE
TOTAL QTY: 258

UNLESS OTHERWISE NOTED ON LANDSCAPE PLAN, SELECT AT LEAST 3 OF THE FOLLOWING SPECIES IN EQUAL QUANTITIES
–GRAY BIRCH (BETULA POPULIFOLIA, FAC)
–AMERICAN HORNBEAM (CARPINUS CAROLINIANA, FAC)
–ALTERNATE LEAF DOGWOOD (CORNUS ALTERNIFOLIA, FACU)
–SHADBUSH (AMELANCHIER LAEVIS, NI)

SHRUBS
TOTAL AREA: 30,000 SF

SELECT AT LEAST 2 OF THE FOLLOWING SPECIES IN EQUAL QUANTITIES, PLANTED AT 6' O.C.
–MEADOWSWEET (SPIRAEA LATIFOLIA, FACW)
–STEEPLEBUSH (SPIRAEA TOMENTOSA, FACW)
–SPECKLED ALDER (ALNUS INCANA, FACW)
–RED CHOKEBERRY (ARONIA ARBUTIFOLIA, FACW)
–WINTERBERRY HOLLY (ILEX VERTICILLATA, FACW)

SELECT AT LEAST 2 OF THE FOLLOWING SPECIES IN EQUAL QUANTITIES, PLANTED AT 6' O.C.
–BLACK CHOKEBERRY (ARONIA MELANOCARPA, FAC)
–SWEET PEPPERBUSH (CLETHRA ALNIFOLIA, FAC)
–GRAY DOGWOOD (CORNUS RACEMOSA, FAC)
–NANNYBERRY (VIBURNUM LENTAGO, FAC)
–SHEEP LAUREL (KALMIA ANGUSTIFOLIA, FAC)
–WITCH HAZEL (HAMAMELIS VIRGINIANA, FACU)

EXISTING TREE TO REMAIN

PLANTING NOTES:

1. ALL PLANTING MATERIAL TO BE NURSERY GROWN STOCK SUBJECT TO A.A.N. STANDARDS
2. THE CONTRACTOR SHALL SUPPLY ALL PLANTS IN QUANTITIES SUFFICIENT TO COMPLETE THE WORK SHOWN ON THE DRAWINGS AND LISTED IN THE PLANT LIST. IN THE EVENT OF A DISCREPANCY BETWEEN QUANTITIES SHOWN IN THE PLANT LIST AND THOSE REQUIRED BY THE DRAWINGS, THE LARGER NUMBER SHALL APPLY.
3. PRECISE LOCATION OF ITEMS NOT DIMENSIONED ON THE PLAN ARE TO BE FIELD STAKED BY THE CONTRACTOR AND SHALL BE SUBJECT TO THE REQUIREMENTS SPECIFIED IN THE PREVIOUS NOTE.
4. ALL SHRUB MASSINGS AND TREE PITS SHALL BE MULCHED TO A DEPTH OF 3" WITH SHREDDED PINE BARK MULCH.
5. TREES SHALL NOT BE STAKED UNLESS OTHERWISE NOTED.
6. THE CONTRACTOR IS RESPONSIBLE FOR ANY DAMAGED VEGETATION AND SHALL REPLACE OR REPAIR ANY DAMAGED MATERIAL, AT HIS OWN EXPENSE. THE CONTRACTOR SHALL CONTACT "CALL BEFORE YOU DIG" AT 1-800-922-4455 PRIOR TO CONSTRUCTION.
7. ALL SHRUB AND GROUNDCOVER PLANTING AREAS SHALL HAVE CONTINUOUS BEDS OF TOPSOIL 12" DEEP. ALL SOD AND HYDROSEED AREAS SHALL HAVE A MINIMUM TOPSOIL BED OF 6".
8. THE CONTRACTOR IS RESPONSIBLE FOR LOCATING ALL UTILITIES IN THE FIELD. WHERE PLANT MATERIAL MAY INTERFERE WITH UTILITIES, THE CONTRACTOR SHALL NOTIFY THE LANDSCAPE ARCHITECT TO COORDINATE THEIR INSTALLATION.
9. FOR PLANTING SOIL MIX, SEE SPECIFICATIONS OR PLANTING DETAILS.
10. ALL EXISTING RILL, GULLY OR CHANNEL EROSION SHALL BE FILLED WITH APPROPRIATE BACKFILL MATERIAL, FINE RAKED, SCARIFIED AND STABILIZED WITH APPROPRIATE VEGETATIVE MATERIAL AND / OR APPROPRIATE SEDIMENTATION AND EROSION CONTROL MEASURES.
11. ADJUSTMENTS IN THE LOCATION OF THE PROPOSED PLANT MATERIAL AS A RESULT OF EXISTING VEGETATION TO REMAIN SHALL BE APPROVED BY THE LANDSCAPE ARCHITECT PRIOR TO INSTALLATION.
12. THE CONTRACTOR IS RESPONSIBLE FOR ALL MAINTENANCE REPAIR AND REPLACEMENT OF PLANT MATERIAL, AS REQUIRED, FOR THE DURATION OF THE PROJECT AND SUBSEQUENT WARRANTY PERIOD.
13. PLANTINGS INSTALLED IN THE DRY SUMMER MONTHS AND / OR LAWN SEEDED OUT OF SPRING OR FALL PERIODS, IF ALLOWED BY OWNER, WILL REQUIRE AGGRESSIVE IRRIGATION PROGRAMS AT THE CONTRACTOR'S EXPENSE, UNLESS OTHERWISE DIRECTED BY THE OWNER.
14. UPON COMPLETION OF PLANTING, REMOVE FROM SITE ALL EXCESS SOIL, MULCH, AND MATERIALS AND DEBRIS RESULTING FROM WORK OPERATIONS. CLEAN UP SHOULD BE COMPLETED AT THE END OF EACH WORKING DAY. RESTORE TO ORIGINAL CONDITIONS ALL DAMAGED PAVEMENTS, PLANTING AREAS, STRUCTURES AND LAWN AREAS RESULTING FROM LANDSCAPING OPERATIONS.
15. CONTRACTOR SHALL SURVEY, LOCATE, AND PROTECT ALL TREES WITHIN AREAS SHOWN AS "EXISTING VEGETATION TO REMAIN" WITHIN THE DEVELOPMENT ENVELOPE FOR REVIEW BY L.A. PRIOR TO CLEARING OPERATIONS.
16. CONTRACTOR TO RESEED ALL DISTURBED AREAS.

UTILITY NOTE

THE CONTRACTOR SHALL BE RESPONSIBLE FOR NOTIFYING "DIG SAFE" AT 811 OR 888-344-7233 TO ARRANGE FOR MARKING OUT EXISTING UNDERGROUND UTILITIES AT LEAST TWO WORKING DAYS PRIOR TO EXCAVATION.

THE UNDERGROUND UTILITIES DEPICTED HEREON ARE BASED ON FIELD LOCATION OF VISIBLE FEATURES, MAPS AND PLANS OF RECORD, UTILITY MAPPING OR OTHER SOURCES OF INFORMATION. THE ENGINEER MAKES NO GUARANTEE THAT THE UNDERGROUND UTILITIES SHOWN COMPRISE ALL SUCH UTILITIES IN THE AREA, EITHER IN SERVICE OR ABANDONED. THE ENGINEER FURTHER DOES NOT WARRANT THAT THE UNDERGROUND UTILITIES SHOWN ARE IN THE EXACT LOCATION INDICATED ALTHOUGH THE ENGINEER DOES DECLARE THAT THEY ARE DEPICTED AS ACCURATELY AS POSSIBLE FROM INFORMATION AVAILABLE. THE ENGINEER HAS NOT PHYSICALLY LOCATED THE UNDERGROUND UTILITIES.

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER

SCALE:
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VERT.:
DATUM:
HORZ.: NAD83
VERT.: NAVD88
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GRAPHIC SCALE

CITY OF HAVERHILL

LANDSCAPE AND PLANTING PLAN NO. 1

LITTLE RIVER DAM REMOVAL AND RESTORATION

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

LA-101

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COMMONWEALTH OF MASSACHUSETTS
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CIVIL
No. 45977
REGISTERED PROFESSIONAL ENGINEER

MATCH LINE SEE SHEET LA-103

MATCH LINE SEE SHEET LA-101

SEE RESTORATION PLANS FOR SEEDING LIMITS & SEED MIX (TYP.)

LARGE SHADE TREE (TYP.)

ORNAMENTAL TREE (TYP.)

SHRUB BED (TYP.)

MBTA RAILROAD

STEVENS STREET

LITTLE RIVER STREET

APPLE STREET

BENJAMIN STREET

CLIFF STREET

File: J:\DWG\P20170390\U30\Civil\Plan\20170390U30_LND01.dwg Layout: 11X17-LA-102 Plotted: 2022-12-08 3:24 PM Saved: 2022-12-08 2:50 PM User: CNauman
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LAYER STATE:
MS VIEW:

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER

SCALE:
HORZ.: 1" = 70'
VERT.:
DATUM:
HORZ.: NAD83
VERT.: NAVD88
0 35 70
GRAPHIC SCALE

CITY OF HAVERHILL

LANDSCAPE AND PLANTING PLAN NO. 2

LITTLE RIVER DAM REMOVAL AND RESTORATION

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

LA-102

COMMONWEALTH OF MASSACHUSETTS
DEAN E. AUDET
CIVIL
No. 45977
REGISTERED PROFESSIONAL ENGINEER

MBTA RAILROAD

MBTA RAILROAD

SEE RESTORATION PLANS FOR SEEDING LIMITS & SEED MIX (TYP.).

SEE ENLARGEMENT SHEETS LA-105 & LA-106

SKATE PARK

CASHMAN'S FIELD

EXISTING TREE TO REMAIN AND BE PROTECTED DURING CONSTRUCTION (TYP.)

CASHMAN'S FIELD

LEBLANC STREET

LARGE SHADE TREE (TYP.)

ORNAMENTAL TREE (TYP.)

SHRUB BED (TYP.)

MATCH LINE SEE SHEET LA-104

MATCH LINE SEE SHEET LA-102

File: J:\DWG\P20170390\U30\Civil\Plan\20170390U30_LND01.dwg Layout: 11X17-LA-103 Plotted: 2022-12-08 3:24 PM Saved: 2022-12-08 2:59 PM User: CNauman
PC3: AUTOCAD PDF (GENERAL DOCUMENTATION).PC3 STB\CTB: FO HALF.STB

LAYER STATE:

MS VIEW:

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER

SCALE:
HORZ.: 1" = 70'
VERT.:
DATUM:
HORZ.: NAD83
VERT.: NAVD88
0 35 70
GRAPHIC SCALE

CITY OF HAVERHILL

LANDSCAPE AND PLANTING PLAN NO. 3

LITTLE RIVER DAM REMOVAL AND RESTORATION

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

LA-103

COMMONWEALTH OF MASSACHUSETTS
DEAN E. AUDET
CIVIL
No. 45877
REGISTERED
PROFESSIONAL ENGINEER

MBTA RAILROAD

SEE RESTORATION PLANS FOR SEEDING LIMITS & SEED MIX (TYP.).

ORNAMENTAL TREE (TYP.)

LARGE SHADE TREE (TYP.)

SHRUB PLANTING BED (TYP.)

WHITTIER PLACE

MATCH LINE SEE SHEET LA-103

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER

SCALE:
HORZ.: 1" = 70'
VERT.:
DATUM:
HORZ.: NAD83
VERT.: NAVD88
0 35 70
GRAPHIC SCALE

CITY OF HAVERHILL

LANDSCAPE AND PLANTING PLAN NO. 4

LITTLE RIVER DAM REMOVAL AND RESTORATION

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

LA-104

File: J:\DWG\P2017\0390\U30\Civil\Plan\20170390U30_LND01.dwg Layout: 11X17-LA-104 Plotted: 2022-12-08 3:24 PM Saved: 2022-12-08 2:50 PM User: CNauman
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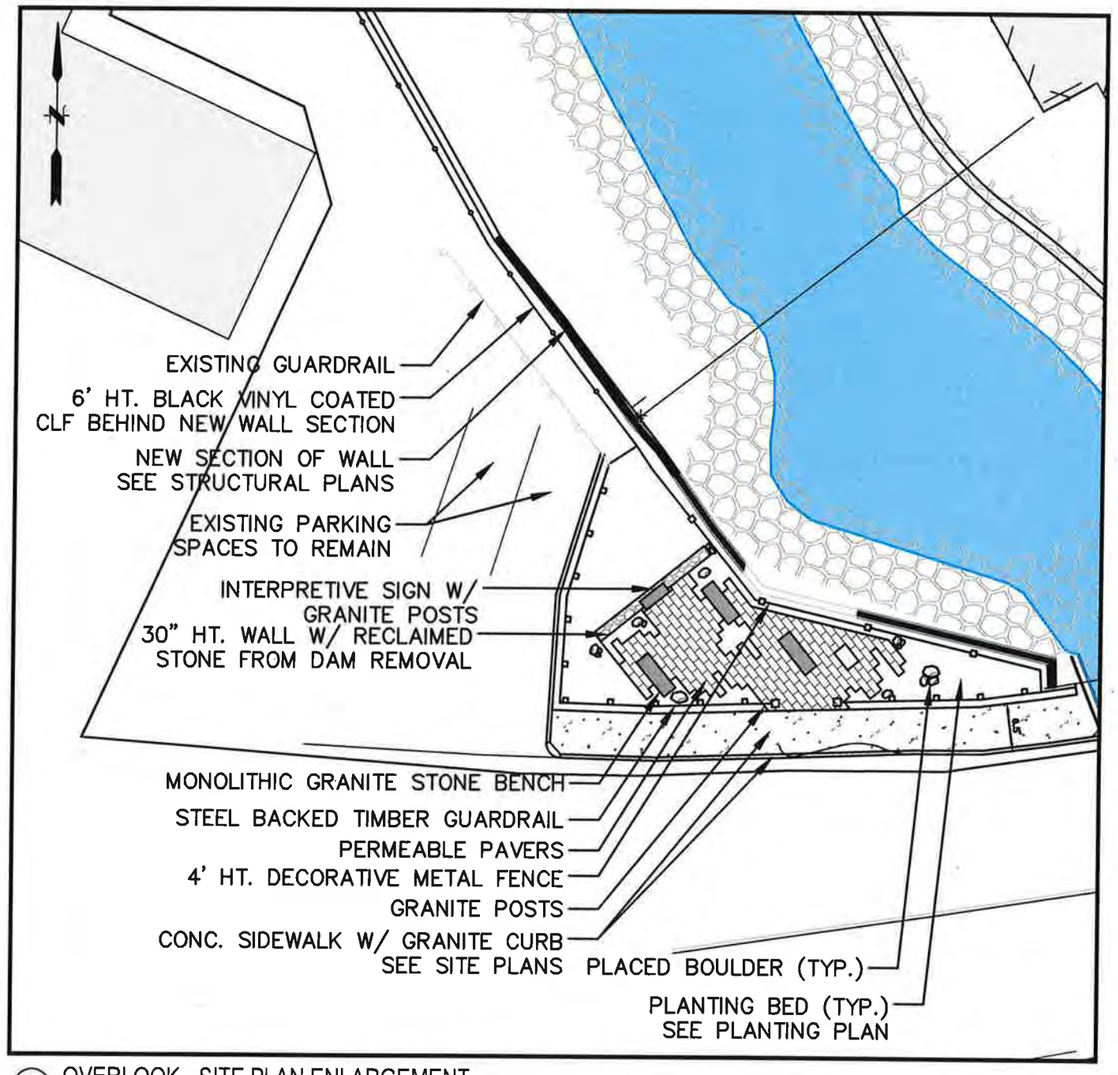
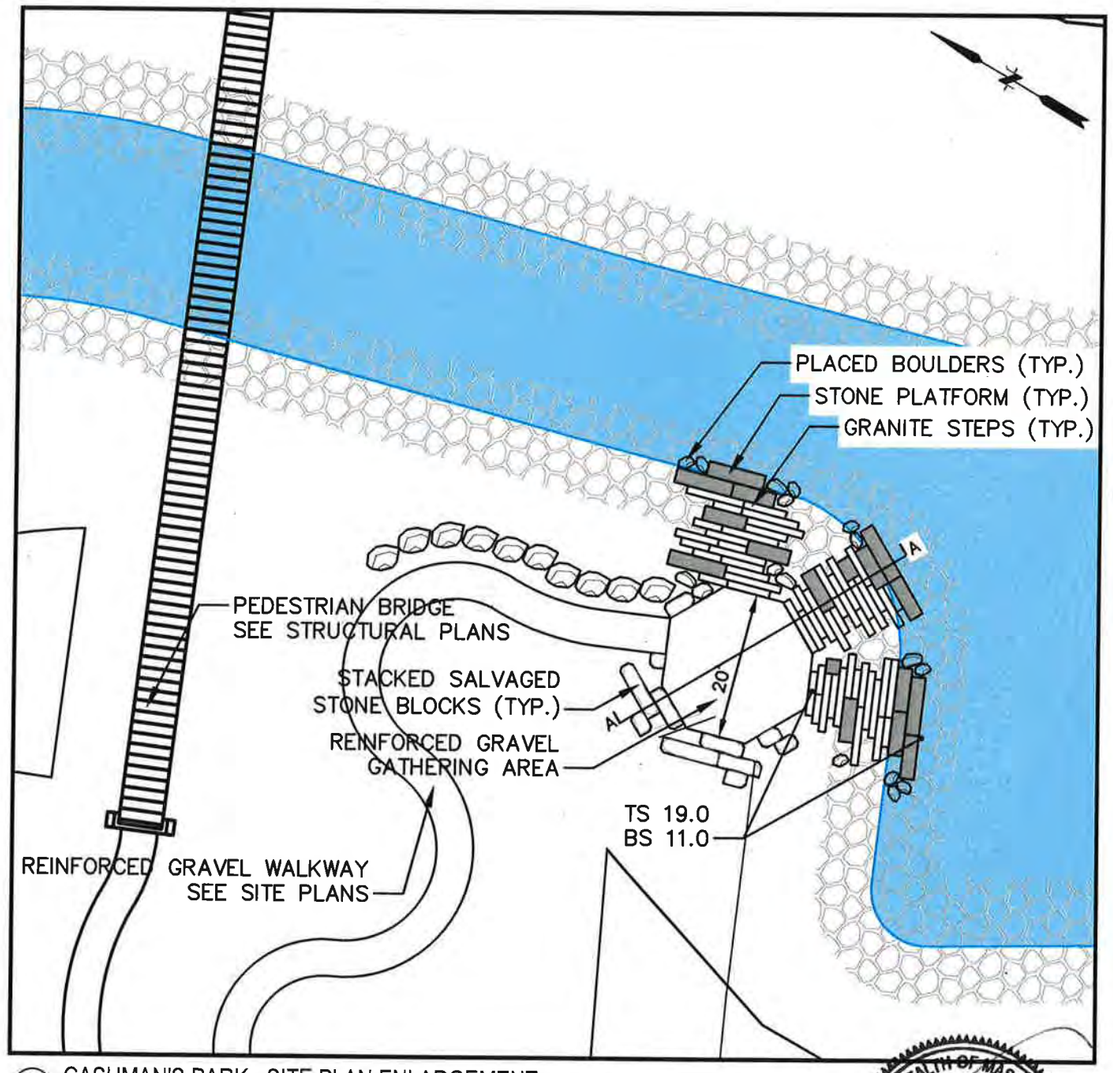


1 OVERLOOK - SITE PLAN ENLARGEMENT
SCALE: 1" = 20'



2 CASHMAN'S PARK - SITE PLAN ENLARGEMENT
SCALE: 1" = 20'

COMMONWEALTH OF MASSACHUSETTS
DEAN E. AUDET
CIVIL
No. 45977
REGISTERED PROFESSIONAL ENGINEER

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER

SCALE:
HORZ.: 1" = 20'
VERT.:
DATUM:
HORZ.: NAD83
VERT.: NAVD88
0 10 20
GRAPHIC SCALE

CITY OF HAVERHILL

PLANTING PLAN ENLARGEMENTS

LITTLE RIVER DAM REMOVAL AND RESTORATION

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

LA-106

File: J:\DWG\P20170390\U30\Civil\Plan\20170390U30_LND01.dwg Layout: 11X17-LA-105 Plotted: 2022-12-08 3:25 PM Saved: 2022-12-08 2:50 PM User: CNauman
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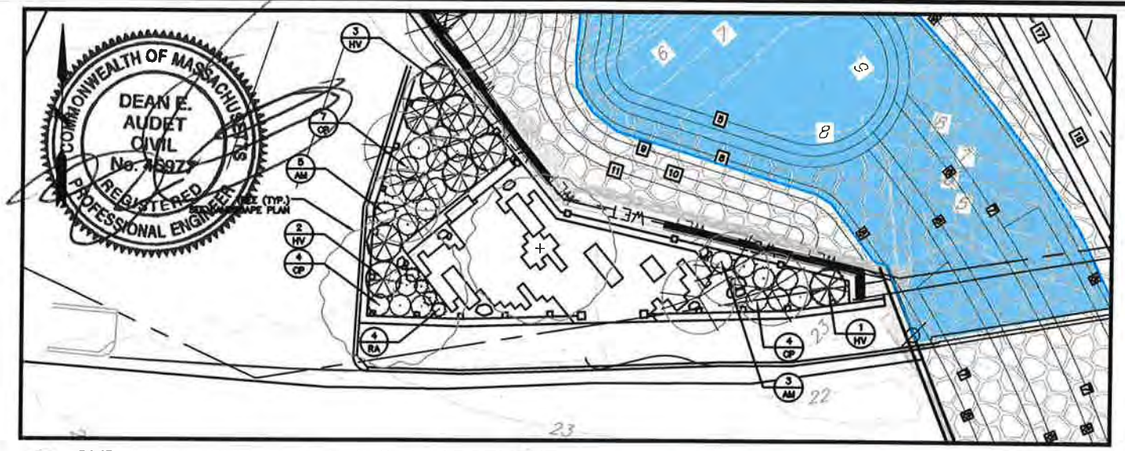
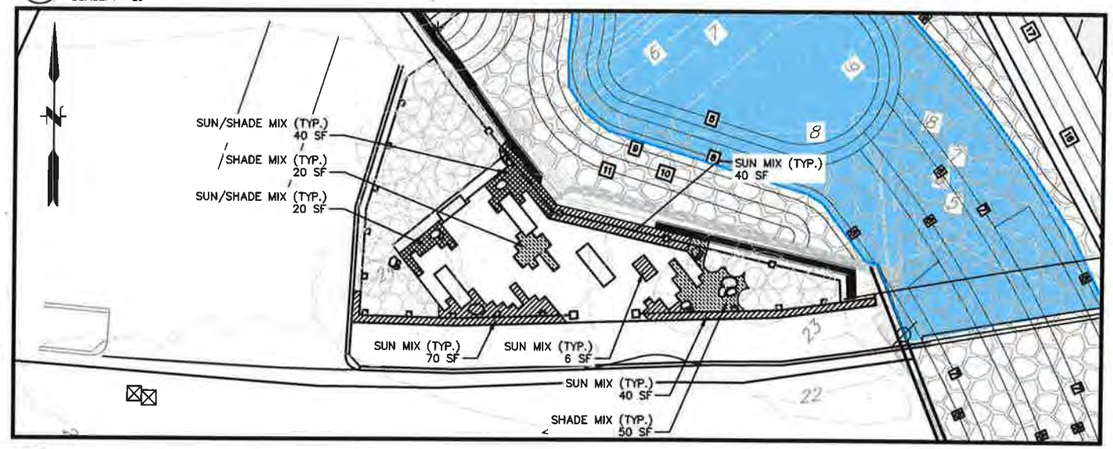
LAYER STATE:
MS VIEW:



1 OVERLOOK - SHRUB PLANTING ENLARGEMENT
SCALE: 1" = 20'



2 OVERLOOK - PERENNIAL PLANTING ENLARGEMENT
SCALE: 1" = 20'

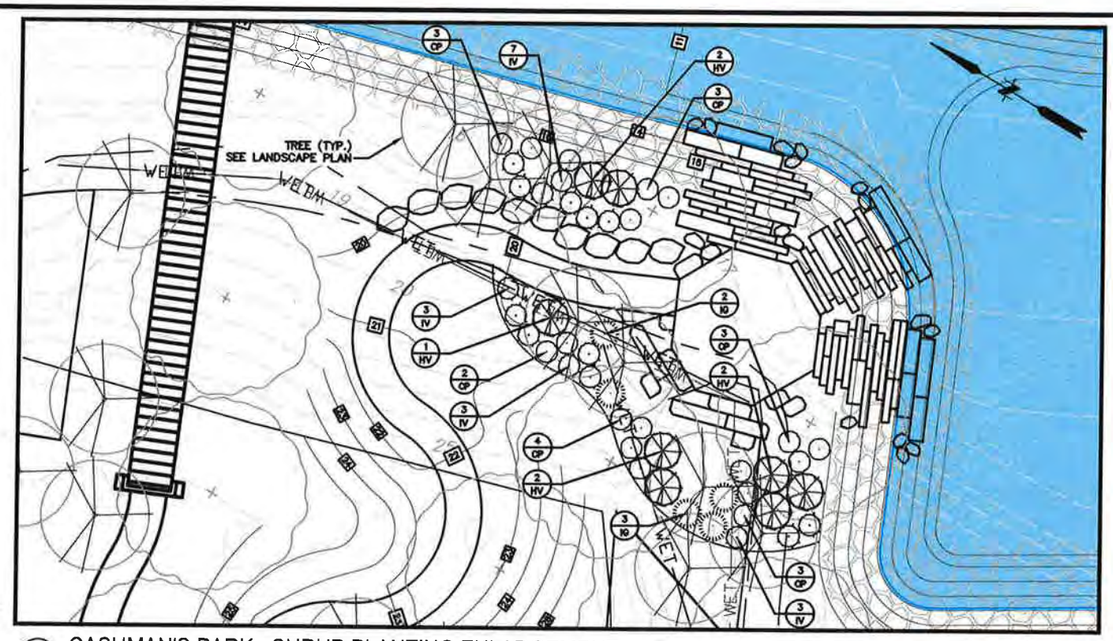
PLANT LIST

KEY	BOTANICAL NAME	COMMON NAME	QTY	SIZE
	SHRUBS			
AM	ARONIA MELANOCARPA	BLACK CHOKEBERRY	8	3 GAL.
CP	CLETHRA ALNIFOLIA	SWEET PEPPERBUSH	33	3 GAL.
HV	HAMAMELIS VIRGINIANA	WITCH HAZEL	16	5-6' HT.
IG	ILEX GLABRA	INKBERRY	6	5 GAL.
IV	ILEX VERTICILLATA 'RED SPRITE'	RED SPRITE WINTERBERRY	16	3 GAL.
RA	RHUS AROMATICA 'GRO LOW'	GRO LOW SUMAC	4	3 GAL.

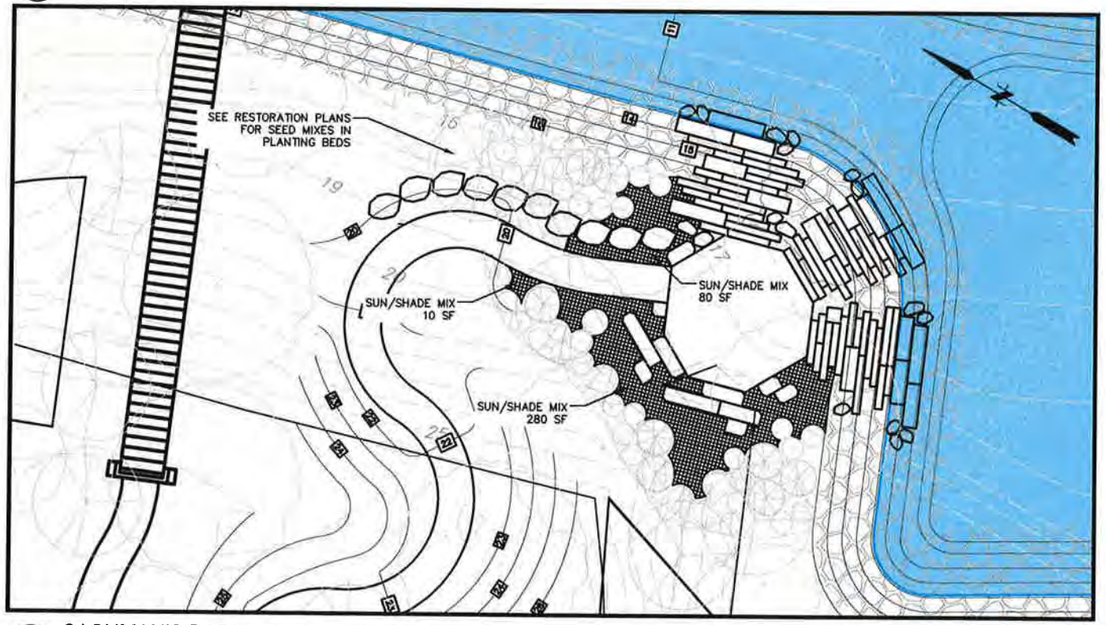
SUN MIX
PLANT THE FOLLOWING SPECIES AT 18" O.C. IN EQUAL QUANTITIES
- –CAREX ROSEA (ROSY SEDGE)
- –PANICUM VIRGATUM (SWITCHGRASS)
- –ASTER NOVAE–ANGLIAE (NEW ENGLAND ASTER)
- –ASCLEPIAS TUBEROSA (BUTTERFLY MILKWEED)

SHADE MIX
PLANT THE FOLLOWING SPECIES AT 18" O.C. IN EQUAL QUANTITIES
- –DENNSTAEDIA PUNCTILOBULA (HAY–SCENTED FERN)
- –THELYPTERIS NOVEBORACENSIS (NEW YARD FARN)
- –AQUILEGIA CANADENSIS (RED COLUMBINE)
- –CAREX ROSEA (ROSY SEDGE)

SUN/SHADE MIX
PLANT THE FOLLOWING SPECIES AT 18" O.C. IN EQUAL QUANTITIES
- –DENNSTAEDIA PUNCTILOBULA (HAY–SCENTED FERN)
- –ASTER NOVAE–ANGLIAE (NEW ENGLAND ASTER)
- –ASCLEPIAS TUBEROSA (BUTTERFLY MILKWEED)
- –CAREX ROSEA (ROSY SEDGE)



3 CASHMAN'S PARK - SHRUB PLANTING ENLARGEMENT
SCALE: 1" = 20'



4 CASHMAN'S PARK - PERENNIAL PLANTING ENLARGEMENT
SCALE: 1" = 20'

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER

SCALE:
HORZ.: 1" = 20'
VERT.:
DATUM:
HORZ.: NAD83
VERT.: NAVD88
0 10 20
GRAPHIC SCALE

CITY OF HAVERHILL

SITE PLAN ENLARGEMENTS

LITTLE RIVER DAM REMOVAL AND RESTORATION

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

LA-105

File: J:\DWG\P2017\0390\U30\Civil\Plan\20170390U30_LND01.dwg Layout: 11X17-LA-106 Plotted: 2022-12-08 3:26 PM Saved: 2022-12-08 2:50 PM User: CNauman
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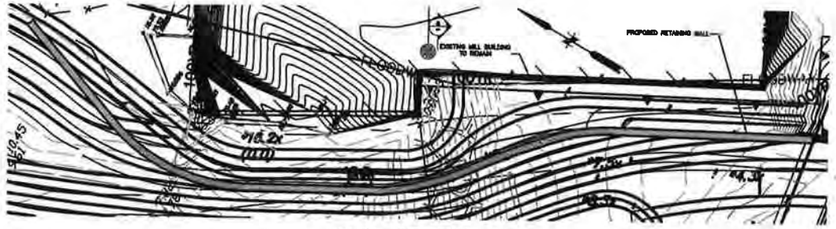
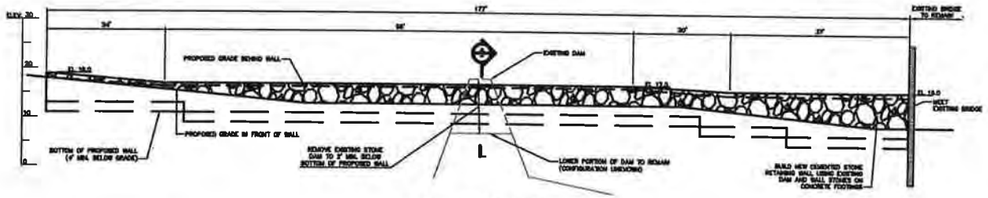
MS VIEW:

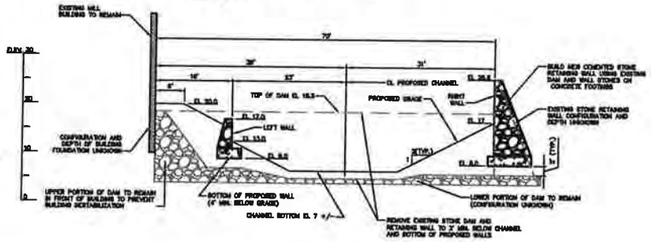


PLAN – LEFT WALL

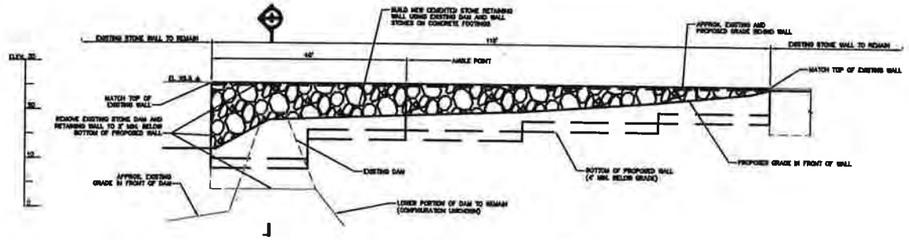
PLAN – RIGHT WALL



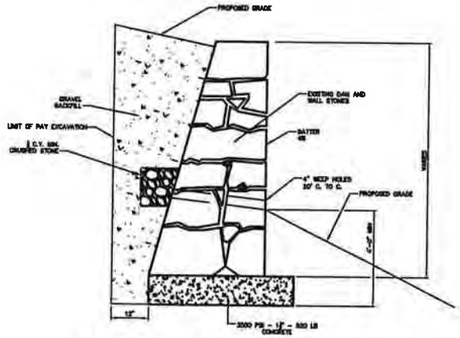
LEFT WALL ELEVATION



SECTION A – LOOKING DOWNSTREAM AT DAM



RIGHT WALL ELEVATION



TYPICAL SECTION – CEMENTED STONE MASONRY WALL

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER

SCALE:
HORZ.: 1" = 30'
VERT.:
DATUM:
HORZ.: NAD83
VERT.: NAVD88
0 15 30
GRAPHIC SCALE

FUSS & O'NEILL
1550 MAIN STREET, SUITE 400
SPRINGFIELD, MA 01103
413.452.0445
www.fando.com

CITY OF HAVERHILL

RETAINING WALL DETAILS

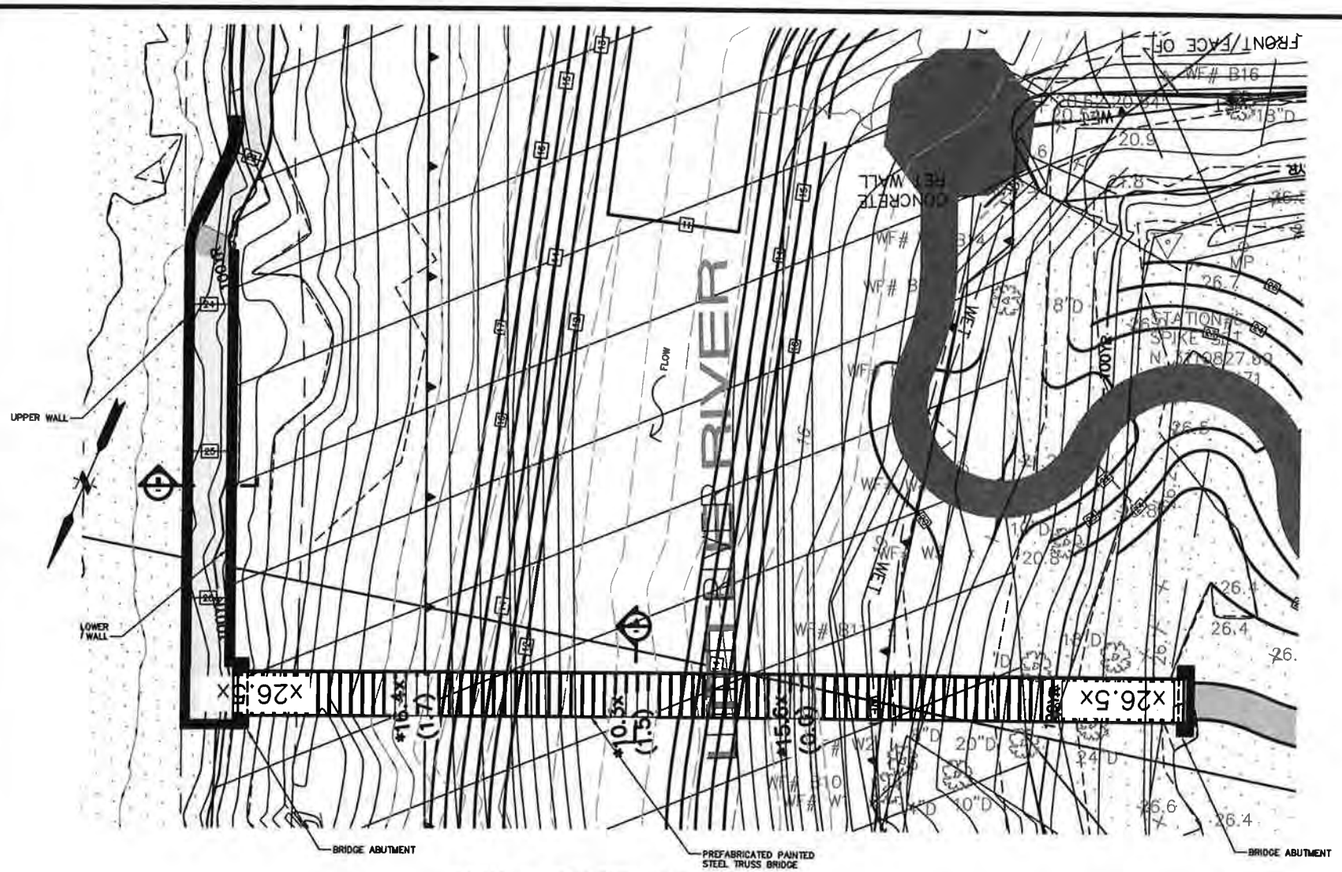
LITTLE RIVER DAM REMOVAL AND RESTORATION

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

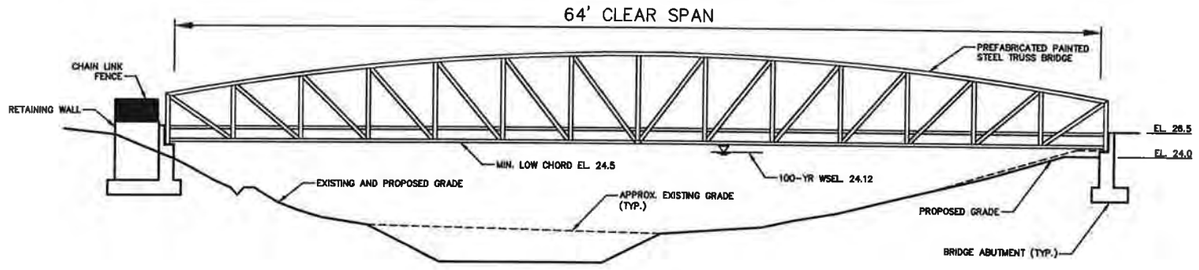
S-101

MS VIEW:
LAYER STATE:



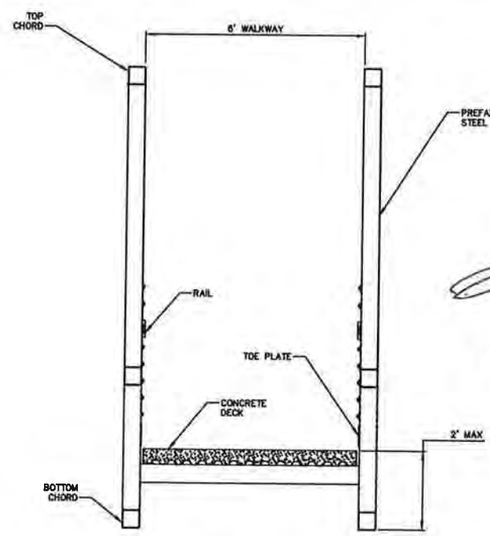
PLAN – PEDESTRIAN BRIDGE

SCALE: 1"=20'



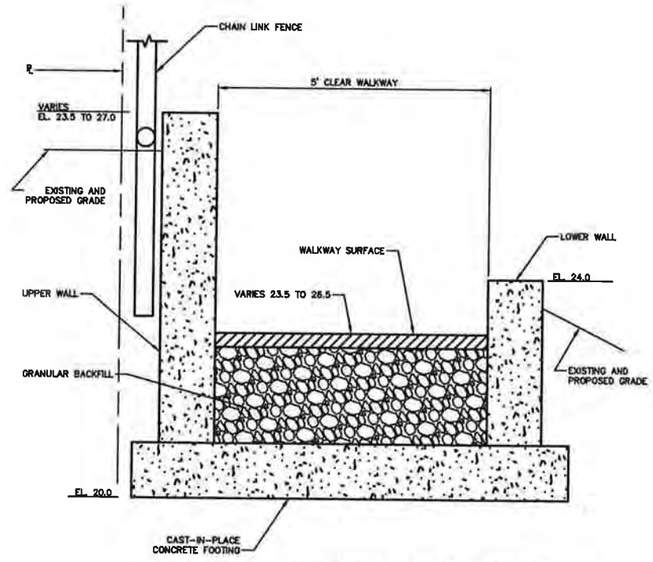
PEDESTRIAN BRIDGE NORTH ELEVATION

SCALE: 1"=20'



SECTION A – BRIDGE SECTION

SCALE: 1"=1'-0"



SECTION B – RETAINING WALL SECTION

SCALE: 3/8"=1'-0"

COMMONWEALTH OF MASSACHUSETTS
DEAN E. AUDET
CIVIL
No. 45977
REGISTERED PROFESSIONAL ENGINEER

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER

SCALE:
HORZ.:
VERT.:
DATUM:
HORZ.: NAD83
VERT.: NAVD88
0
GRAPHIC SCALE

FUSS & O'NEILL
1550 MAIN STREET, SUITE 400
SPRINGFIELD, MA 01103
413 452 0445
www.fando.com

CITY OF HAVERHILL

PEDESTRIAN BRIDGE DETAILS

LITTLE RIVER DAM REMOVAL AND RESTORATION

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

S-102

LAYER STATE:
MS VIEW

dcr
Massachusetts

SO.ESSEX #186 Bk:41538 Pg:273
04/27/2023 12:14 PM PERMIT Pg 1/5
eRecorded

Certified Mail No. 7018 0680 0001 3243 0230
Return Receipt Requested

M.G.L. Chapter 253
Dam Safety Permit
Permit No. 104-2023-415

Applicant

Dean Audet, PE
Fuss & O'Neill, Inc.
146 Hartford Road
Manchester, CT 06040

On behalf of:
City of Haverhill
c/o James J. Fiorentini, Mayor
4 Summer Street
Haverhill, MA 01830

Re: Little River Dam Removal and River Restoration Project
National Dam ID: MA00739
Registry Location: Essex South, Deed Book 39278, Page 35
Owner: Little River Dam Owner, LLC
Dam Location: Haverhill

Date: April 18, 2023

Dear Mr. Audet:

Reference is made to the application dated February 15, 2023 and supplemental information provided by Fuss & O'Neill, Inc. (F&O). These were submitted for Department of Conservation and Recreation (DCR) Office of Dam Safety (ODS) regulatory review of the above-referenced dam removal project.

Permission is hereby granted under M.G.L. Chapter 253, as amended, to perform work indicated on the drawings titled "**Little River Dam Removal and River Restoration, Haverhill, Massachusetts**" dated June 30, 2022 and as described in supporting documentation provided by F&O.

Permission is granted subject to the following conditions:

(a) At least 21 days before the start of construction, the dam owner shall provide the DCR/ODS - Permits Section a completed **DAM SAFETY IMPROVEMENTS – NOTICE OF CONSTRUCTION** (form attached) with a construction schedule and proof of recording of the Ch. 253 Permit at the Registry of Deeds in the county where the dam lies. If the Notice of Construction provided to ODS lacks a construction schedule, proof of recording of the permit, or an explanation of why permit recording is not possible, ODS will return the Notice of Construction to the dam owner indicating the Notice of Construction is incomplete and informing the owner that construction shall not commence until ODS has received a complete Notice of Construction with the required attachments.

(b) For all features of the project, the Dam Engineer (F&O) shall notify ODS of any design change from the original design submitted with the permit application due to regulatory requirements, changes in field conditions or any other unanticipated occurrence. This notification shall be a formal submittal to ODS which includes all relevant revised plans, computations and data (survey, geotechnical, etc.) supporting the design change(s). This submittal shall be forwarded to ODS by registered mail, return receipt requested, and will require an amendment to the permit. Review time may vary based upon the complexity of the design change(s), however, ODS will generally issue the permit amendment within five (5) business days of receipt of a complete design revision submittal.

(c) The Dam Engineer must report to ODS any unforeseen incidents that occur at the work site during project work. Unforeseen incidents include, but are not limited to, significant uncontrolled seepage into the work area, significant earth support failures or slope failures. The report must explain in detail what occurred, corrective measures taken to mitigate the occurrence and any impacts the occurrence may have had on the project. If the incident results in a design change, ODS must be provided revised design documents (refer to Condition (b), above).

(d) The following shall be prepared by the contractor, approved by the Dam Engineer, and submitted to ODS prior to construction:

- Cofferdam designs. The cofferdams shall be carefully designed to resist anticipated forces without failing and to ensure that seepage around, under, or through the cofferdams is manageable;
- A water control and diversion plan describing methods to be employed to allow work to be performed "in the dry" and to manage both the water level in Little River and outflow from Little River while construction is in progress; and
- A flood response plan. While construction is underway, weather forecasts, stream flows and water levels shall be monitored to allow adequate time to respond to rising water levels at the construction site. If high water levels are expected, equipment and materials shall be removed from the work area and personnel

evacuated. Sufficient materials and equipment required for flood response shall be maintained in a safe location at, or near, the construction site.

(e) A sufficient level of construction oversight shall be provided by the Dam Engineer to ensure the work conforms to: the project plans and specifications; the Ch. 253 Permit conditions; and generally-accepted dam construction practices as determined by the U.S. Army Corps of Engineers, the U.S. Bureau of Reclamation and/or the U.S. Natural Resources Conservation Service.

Guidance, procedures, checklists, worksheets, and references to aid in construction quality assurance are available in the United States Department of Agriculture Natural Resources Conservation Service National Engineering Handbook Part 645-Construction Inspection and can be accessed at this link: https://directives.sc.egov.usda.gov/viewerFS.aspx?hid=31701 .

(f) The Dam Engineer shall invite ODS to the preconstruction meeting, another project meeting at 50% completion and the final inspection meeting. ODS reserves the right to make site visits and inspections at any time during the permit period. ODS requests the following items be addressed at the pre-construction meeting:

- Identification of the
  - o resident engineer (Owner's representative overseeing the project);
  - o contractor's qualified site superintendent; and
  - o Dam Engineer's representative overseeing the project.
- Provide emergency contact information for the contractor and resident engineer;
- Presentation of the resident engineer's weekly work schedule and discussion of the level of construction oversight to be provided by the resident engineer;
- Water control features anticipated and the process for the Dam Engineer to either develop or approve the overall control and diversion of water plan. Flood emergency warning and response procedures must be identified;
- Level of Dam Engineer construction oversight including: identification of any critical construction items to be overseen by the Dam Engineer; procedures for the Dam Engineer's review and approval of shop drawings and other submittals; documentation of Dam Engineer's approval of any design modifications; procedures for coordinating and scheduling the Dam Engineer's inspection of critical construction elements;
- Anticipated schedule of construction meetings and required attendees. It is expected that while construction is ongoing, weekly construction meetings will be held and attended by the Dam Engineer, the resident engineer, the contractor's superintendent and other appropriate participants; and
- Presentation of the initial construction schedule with identification and discussion of major items.

ODS shall be provided a copy of the preconstruction meeting minutes.

(g) The Dam Engineer shall provide ODS written documentation that he/she has reviewed and approved all pertinent submittals or samples concerning critical project features. This documentation may be in the form of a submittal log which may be submitted as part of the "as-built" report, described below.

(h) Upon completion of work the Applicant shall submit to ODS a **DAM SAFETY CERTIFICATE OF COMPLETION** (form attached). With this certificate of completion submit one bound (utilizing plastic comb bindings) as-built report with 11"x17" record drawings signed and stamped by a registered professional civil engineer with contractor's signature attesting that all work was performed according to the plans and specifications. The as-built report shall include documentation of submittals reviewed and approved by the Dam Engineer, copies of any materials or construction testing reports and color photos of construction phases and appurtenant installations. Photograph numbers, location and direction in which each photo was taken must be identified. An electronic copy (as a .pdf) of the as-built report and record drawings shall be provided to ODS via email, .ftp site or on a USB flash drive.

(i) Upon completion of work, the Dam Engineer shall submit an **APPLICATION TO CHANGE HAZARD CLASSIFICATION OF DAM** with supporting documentation demonstrating that the former dam can no longer re-impound and no longer meets the jurisdictional requirements of ODS. Refer to the ODS website for the application form and description of required information.

(j) The Certificate of Completion, as-built report and Application to Change Hazard Classification of Dam shall be provided to ODS within 90 days of substantial completion of work unless ODS agrees to later submission of these documents. Submission of these documents is required prior to ODS issuing a Certificate of Approval.

Any permit issued by DCR shall be subject to revocation by order of the Commissioner if the permittee fails to conform to 302 CMR 10.00, Dam Safety Rules and Regulations, provisions of this permit, or any other applicable laws and regulations.

This permit does not release the applicant from the requirements of any other regulatory authority. Such authorizations and/or notifications include, but are not limited to:

Local Conservation Commission;
Massachusetts Department of Environmental Protection (DEP);
Massachusetts Department of Fish and Game (DFG);
Massachusetts Executive Office of Environmental Affairs (EOEA), MEPA Unit; and
U.S. Army Corps of Engineers.

This permit must be recorded by the applicant at the Registry of Deeds in the county where the dam lies. Recording must be done prior to the commencement of construction and a copy of the recorded permit filed with the Office of Dam Safety.

This permit remains valid for two (2) years from the date of issue: **April 18, 2023**.

Permit expiration date: **April 18, 2025**.

William Salomaa, Director
DCR, Office of Dam Safety

David Ouellette, Permit Engineer
DCR, Office of Dam Safety

Attachments: Dam Safety Improvements – Notice of Construction form
Dam Safety Certificate of Completion form

CERTIFIED MAIL®

dcr
Massachusetts

Department of
Conservation and Recreation
Office of Dam Safety
180 Beaman Street
West Boylston,MA 01583
www.mass.gov/dcr

9589 0710 5270 0474 6307 55

PITNEY-BOWES
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US POSTAGE IMI
FIRST-CLASS
028W0002310939
2000361172
ZIP 01583
MAR 20 2025

DEAN AUDET, PE
FUSS & O'NEILL, INC.
146 HARTFOR
MANCHESTE

FWD

061 NFE 1 A24C0003/25/25
NOTIFY SENDER OF NEW ADDRESS
FUSS & ONEILL TRILON HOLDINGS INC
1 FINANCIAL PLZ FL 15
HARTFORD CT 06103-2601

BC: 06103260115 *0121-01018-21-04

It's your nature.

dcr
Massachusetts

Certified Mail No. 9589 0710 5270 0474 6307 55
Return Receipt Requested

M.G.L. Chapter 253
Dam Safety Permit
Permit No. 104-2023-415
Extension 1

Applicant

Dean Audet, PE
Fuss & O'Neill, Inc.
146 Hartford Road
Manchester, CT 06040

On behalf of:
City of Haverhill
c/o James J. Fiorentini, Mayor
4 Summer Street
Haverhill, MA 01830

Re: Little River Dam Removal and River Restoration Project
National Dam ID: MA00739
Registry Location: Essex South, Deed Book 39278, Page 35
Owner: Little River Dam Owner, LLC
Dam Location: Haverhill

Date: March 3, 2025

Dear Mr. Audet:

On February 28, 2025, the Department of Conservation and Recreation (DCR) Office of Dam Safety (ODS) received an email from the Fuss & O'Neill (F&O) requesting extension of the Ch. 253 Dam Safety Permit previously issued for the proposed removal of Little River Dam. Per the email, ODS understands that project work was delayed due to funding issues and is now anticipated to begin in July 2025.

Dam Safety Permit No. 104-2023-415 is hereby extended to permit the work indicated on the drawings titled "**Little River Dam Removal and River Restoration, Haverhill,**

Department of Conservation and Recreation
251 Causeway Street, Suite 600
Boston, MA 02114-2199
617-626-1250 617-626-1351 Fax
www.mass.gov/dcr

Maura T. Healey
Governor

Kimberley Driscoll
Lt. Governor

Rebecca L. Tepper, Secretary
Executive Office of Energy & Environmental Affairs

Douglas J. Rice, Commissioner
Department of Conservation & Recreation

Massachusetts" dated June 30, 2022 and as described in supporting documentation provided by F&O.

Permission is granted subject to the following conditions:

(a) At least 21 days before the start of construction, the dam owner shall provide the DCR/ODS - Permits Section a completed **DAM SAFETY IMPROVEMENTS – NOTICE OF CONSTRUCTION** (form attached) with a construction schedule and proof of recording of the Ch. 253 Permit at the Registry of Deeds in the county where the dam lies. If the Notice of Construction provided to ODS lacks a construction schedule, proof of recording of the permit, or an explanation of why permit recording is not possible, ODS will return the Notice of Construction to the dam owner indicating the Notice of Construction is incomplete and informing the owner that construction shall not commence until ODS has received a complete Notice of Construction with the required attachments.

(b) For all features of the project, the Dam Engineer (F&O) shall notify ODS of any design change from the original design submitted with the permit application due to regulatory requirements, changes in field conditions or any other unanticipated occurrence. This notification shall be a formal submittal to ODS which includes all relevant revised plans, computations and data (survey, geotechnical, etc.) supporting the design change(s). This submittal shall be forwarded to ODS by registered mail, return receipt requested, and will require an amendment to the permit. Review time may vary based upon the complexity of the design change(s), however, ODS will generally issue the permit amendment within five (5) business days of receipt of a complete design revision submittal.

(c) The Dam Engineer must report to ODS any unforeseen incidents that occur at the work site during project work. Unforeseen incidents include, but are not limited to, significant uncontrolled seepage into the work area, significant earth support failures or slope failures. The report must explain in detail what occurred, corrective measures taken to mitigate the occurrence and any impacts the occurrence may have had on the project. If the incident results in a design change, ODS must be provided revised design documents (refer to Condition (b), above).

(d) The following shall be prepared by the contractor, approved by the Dam Engineer, and submitted to ODS prior to construction:

- Cofferdam designs. The cofferdams shall be carefully designed to resist anticipated forces without failing and to ensure that seepage around, under, or through the cofferdams is manageable;
- A water control and diversion plan describing methods to be employed to allow work to be performed "in the dry" and to manage both the water level in Little River and outflow from Little River while construction is in progress; and
- A flood response plan. While construction is underway, weather forecasts, stream flows and water levels shall be monitored to allow adequate time to respond to

rising water levels at the construction site. If high water levels are expected, equipment and materials shall be removed from the work area and personnel evacuated. Sufficient materials and equipment required for flood response shall be maintained in a safe location at, or near, the construction site.

(e) A sufficient level of construction oversight shall be provided by the Dam Engineer to ensure the work conforms to: the project plans and specifications; the Ch. 253 Permit conditions; and generally-accepted dam construction practices as determined by the U.S. Army Corps of Engineers, the U.S. Bureau of Reclamation and/or the U.S. Natural Resources Conservation Service.

Guidance, procedures, checklists, worksheets, and references to aid in construction quality assurance are available in the United States Department of Agriculture Natural Resources Conservation Service National Engineering Handbook Part 645-Construction Inspection and can be accessed at this link: https://directives.sc.egov.usda.gov/viewerFS.aspx?hid=31701 .

(f) The Dam Engineer shall invite ODS to the preconstruction meeting, another project meeting at 50% completion and the final inspection meeting. ODS reserves the right to make site visits and inspections at any time during the permit period. ODS requests the following items be addressed at the pre-construction meeting:

- Identification of the
  - o resident engineer (Owner's representative overseeing the project);
  - o contractor's qualified site superintendent; and
  - o Dam Engineer's representative overseeing the project.
- Provide emergency contact information for the contractor and resident engineer;
- Presentation of the resident engineer's weekly work schedule and discussion of the level of construction oversight to be provided by the resident engineer;
- Water control features anticipated and the process for the Dam Engineer to either develop or approve the overall control and diversion of water plan. Flood emergency warning and response procedures must be identified;
- Level of Dam Engineer construction oversight including: identification of any critical construction items to be overseen by the Dam Engineer; procedures for the Dam Engineer's review and approval of shop drawings and other submittals; documentation of Dam Engineer's approval of any design modifications; procedures for coordinating and scheduling the Dam Engineer's inspection of critical construction elements;
- Anticipated schedule of construction meetings and required attendees. It is expected that while construction is ongoing, weekly construction meetings will be held and attended by the Dam Engineer, the resident engineer, the contractor's superintendent and other appropriate participants; and
- Presentation of the initial construction schedule with identification and discussion of major items.

ODS shall be provided a copy of the preconstruction meeting minutes.

(g) The Dam Engineer shall provide ODS written documentation that he/she has reviewed and approved all pertinent submittals or samples concerning critical project features. This documentation may be in the form of a submittal log which may be submitted as part of the "as-built" report, described below.

(h) Upon completion of work the Applicant shall submit to ODS a **DAM SAFETY CERTIFICATE OF COMPLETION** (form attached). With this certificate of completion submit one bound (utilizing plastic comb bindings) as-built report with 11"x17" record drawings signed and stamped by a registered professional civil engineer with contractor's signature attesting that all work was performed according to the plans and specifications. The as-built report shall include documentation of submittals reviewed and approved by the Dam Engineer, copies of any materials or construction testing reports and color photos of construction phases and appurtenant installations. Photograph numbers, location and direction in which each photo was taken must be identified. An electronic copy (as a .pdf) of the as-built report and record drawings shall be provided to ODS via email, .ftp site or on a USB flash drive.

(i) Upon completion of work, the Dam Engineer shall submit an **APPLICATION TO CHANGE HAZARD CLASSIFICATION OF DAM** with supporting documentation demonstrating that the former dam can no longer re-impound and no longer meets the jurisdictional requirements of ODS. Refer to the ODS website for the application form and description of required information.

(j) The Certificate of Completion, as-built report and Application to Change Hazard Classification of Dam shall be provided to ODS within 90 days of substantial completion of work unless ODS agrees to later submission of these documents. Submission of these documents is required prior to ODS issuing a Certificate of Approval.

Any permit issued by DCR shall be subject to revocation by order of the Commissioner if the permittee fails to conform to 302 CMR 10.00, Dam Safety Rules and Regulations, provisions of this permit, or any other applicable laws and regulations.

This permit does not release the applicant from the requirements of any other regulatory authority. Such authorizations and/or notifications include, but are not limited to:

Local Conservation Commission;
Massachusetts Department of Environmental Protection (DEP);
Massachusetts Department of Fish and Game (DFG);
Massachusetts Executive Office of Environmental Affairs (EOEA), MEPA Unit; and
U.S. Army Corps of Engineers.

This extended permit must be recorded by the applicant at the Registry of Deeds in the county where the dam lies. Recording must be done prior to the commencement of construction and a copy of the recorded permit filed with the Office of Dam Safety.

This extended permit remains valid for three (3) years from the original date of permit issuance: **April 18, 2023.**

Permit expiration date: **April 18, 2026.**

William Salomaa, Director
DCR, Office of Dam Safety

David Ouellette, Permit Engineer
DCR, Office of Dam Safety

Attachments: Dam Safety Improvements – Notice of Construction form
Dam Safety Certificate of Completion form
Application to Change Hazard Classification of Dam

cc: Julianne Busa, PhD, CSE, PWS (via email to Julianne.Busa@fando.com)

Informational (NOT TO BE RECORDED AT REGISTRY OF DEEDS)

Excerpts from Dam Safety Rules Regulations:

302 CMR 10.09(5): Recording a Chapter 253 Permit.

A permit to construct, drawdown, repair, alter, breach or remove a dam shall be recorded at the Registry of Deeds in the county where the dam lies. Recording must be done prior to the commencement of construction and a copy of the recorded permit filed with the Commissioner.

To: DCR, Office of Dam Safety – Permits Section
180 Beaman Street
West Boylston, MA 01583

DAM SAFETY IMPROVEMENTS - NOTICE OF CONSTRUCTION

Dam Owner/Applicant
Name:
Representative:
Address:
Phone:
Fax:
Email Address:

Project
Project location Town/City:
Dam name:
National Dam ID Number:
State Dam ID Number:
Nature of Dam Safety Improvements:
Chapter 253 Permit date of issue:
Chapter 253 Permit expiration date:
Permit Recorded at_____ Registry of Deeds
Dam Parcel Registry of Deeds Book Number:
Dam Parcel Registry of Deeds Page Number:
Recorded Permit Registry of Deeds Book Number:
Recorded Permit Registry of Deeds Page Number:
Copy of the recorded permit attached Yes ( )
Construction start date:
Construction schedule attached Yes ( )

Engineer
Company Name:
Representative:
Address:
Phone:
Fax:
Email Address:

Contractor
Company Name:
Representative:
Address:
Phone:
Fax:
Email Address :

Brief description of project, note location and dates of construction:

_____

_____

_____

By Contractor

Print name and title: _____

Signature and date: _____

By Engineer

Print name, title: _____

Signature and date: _____

By Dam Owner/Applicant

Print name and title: _____

Signature and date: _____

To: DCR, Office of Dam Safety – Permits Section
180 Beaman Street
West Boylston, MA 01583

DAM SAFETY CERTIFICATE OF COMPLETION

Dam Owner/Applicant
Name:
Representative:
Address:
Phone:
Fax:
Email Address:

Project
Project location Town/City:
Dam name:
National Dam ID Number:
State Dam ID Number:
Nature of Dam Safety Improvements:
Chapter 253 Permit date of issue:
Chapter 253 Permit expiration date:
Permit Recorded at_____ Registry of Deeds
Dam Parcel Registry of Deeds Book Number:
Dam Parcel Registry of Deeds Page Number:
Recorded Permit Registry of Deeds Book Number:
Recorded Permit Registry of Deeds Page Number:
Project completion date:

Engineer
Company Name:
Representative:
Address:
Phone:
Fax:
Email Address:

Contractor
Company Name:
Representative:
Address:
Phone:
Fax:
Email Address :

Brief description of project and dates of construction:

_____

_____

_____

Statement of project completion in accordance with plans, specifications, dam safety permit conditions and standard construction practices:

_____

_____

_____

By Contractor

Print name and title:_____

Signature and date:_____

By Engineer

Print name, title and PE stamp here:_____

Signature and date:_____

By Dam Owner/Applicant

Print name and title:_____

Signature and date:_____

dcr
Massachusetts

APPLICATION TO CHANGE HAZARD CLASSIFICATION OF DAM

In accordance with 302 CMR 10.06 (6) Hazard Reconsideration. An owner may at any time request the Commissioner to reconsider the hazard determination. The owner's request must be filed by a registered professional civil engineer, specifying the findings and analyses with which the owner disagrees. The Commissioner will issue a written decision to the owner and the registered professional civil engineer within 30 days of receipt of a request for hazard reconsideration, and such decision shall be final and binding upon the parties.

To request a reconsideration of hazard classification, this application and all supporting information must be completed and sent via certified mail to the Commissioner of DCR at the following address:

Department of Conservation and Recreation
Office of Dam Safety – Hazard Reclassification
180 Beaman Street
West Boylston, MA 01583

All materials submitted must be sent under cover letter by the dam owner's registered professional civil engineer and accompanied by a PDF copy.

Date: _____

National ID Number: _____

Dam Name: _____

Dam Location (City or Town): _____

Owner(s) Name and Address: _____

_____

_____

_____

Engineering Firm (or Engineer) Submitting Request_____

Fill in Part A or Part B

PART A: Application to Raise Hazard Classification (e.g., from Significant to High)

Current Hazard Classification: _____
(as listed in DCR Office of Dam Safety Database)

Proposed Hazard Classification: _____

Reason for Change: _____

_____

_____

_____

Attach any applicable supporting information.

_____

PART B: Application to Reduce Hazard Classification (e.g., from Significant to Low)

Current Hazard Classification: _____
(as listed in DCR Office of Dam Safety Database)

Proposed Hazard Classification: _____

Applicant must submit engineering studies to justify the change in Hazard Class. Please note that studies must be signed and stamped by the responsible engineer. Indicate the studies that accompany this application:

Hydrologic / Hydraulic Analyses
Dam Breach / Inundation Analyses
Incremental Damage Assessment
Other_____

Reason for Change: _____

_____

_____

_____

Commonwealth of Massachusetts
Executive Office of Energy & Environmental Affairs

Department of Environmental Protection
100 Cambridge Street Suite 900 Boston, MA 02114 • 617-292-5500

Maura T. Healey
Governor

Kimberley Driscoll
Lieutenant Governor

Rebecca L. Tepper
Secretary

Bonnie Heiple
Commissioner

February 8, 2024

James J. Fiorentini
4 Summer Street
Haverhill, MA 01830

DEP WQC AUTHORIZATION #
23-WW26-0006-APP
MassDEP File #s 033-1551, 033-1552
ACOE Project No. NAE-2022-00119
401 WQC Application Completion on 7/21/23

RE: Application for: COMBINED PERMIT – BRP WW 26
401 WATER QUALITY CERTIFICATION FOR MAJOR DREDGING AND FOR MAJOR FILL AND EXCAVATION PROJECT

AT: Little River Dam Removal and River Restoration Project, Haverhill, MA
Merrimack River Basin Drainage Area

Dear Mr. Fiorentini:

The Department of Environmental Protection ("MassDEP") has reviewed your application for a Combined 401 Water Quality Certification for Minor Dredging and Major Fill and Excavation ("Combined Permit"), as referenced above and is basing its certification upon an evaluation of the information contained in the application which is relevant to water quality considerations. In accordance with the provisions of Section 401 of the Federal Clean Water Act (33 U.S.C. § 1251 *et seq*.), M.G.L. c. 21, §§ 26-53, and 314 CMR 9.00, MassDEP has determined there is reasonable assurance the project or activity, as conditioned herein, will be conducted in a manner which will not violate applicable water quality standards (314 CMR 4.00) and other appropriate requirements of state law.

The waters of the Little River, which is part of the Merrimack River Basin Drainage Area, is designated in the Massachusetts Surface Water Quality Standards as B. These waters are designated as a "habitat for fish, other aquatic life, and wildlife, including for their reproduction, migration, growth and other critical functions, and for primary and secondary contact recreation." Anti-degradation provisions of these Standards require that "existing uses and the level of water quality necessary to protect the existing uses shall be maintained and protected."

This information is available in alternate format. Please contact Melixza Esenyie at 617-626-1282.
TTY# MassRelay Service 1-800-439-2370
MassDEP Website: www.mass.gov/dep

Printed on Recycled Paper

The proposed project consists of the removal of Little River Dam, and associated river restoration and recreational improvements located on the Little River in Haverhill, MA. The proposed project is intended to provide ecological and community benefits by allowing the river to revert to a natural unobstructed flow, while increasing climate resilience. The proposed removal of the Little River Dam includes demolition of 65 feet of the 75-foot-long dam, to be removed to a minimum of 2 feet below the proposed channel elevation. In addition to dam removal, site features will be installed to further promote an ecologically diverse habitat appropriate for fish migration and spawning, as well as terrestrial habitat.

A total of approximately 10,680 cubic yards of dredged material is anticipated to be generated from the Little River, with dredged material being managed the following ways: 1) beneficially reused within the existing river channel for creation of a new channel and banks, 2) removed for off-site disposal, 3) allowed to naturally migrate downstream.

Up to 8,000 cubic yard of contaminated sediment is anticipated to be generated and disposed of offsite.[1,2] Sediment from the following areas will not be reused onsite nor released downstream.

- **SED-19 sample area:** lead and PAHs-impacted sediment, landfill disposal, area to be delineated during restoration activities as further discussed in Condition #12
- **Transect #2 sample area:** PCB and PAHs-impacted sediment, disposal options not yet determined, limits as described and in accordance with the documents and plans cited in Condition #4
- **SED-4 sample area:** lead-impacted sediment, landfill disposal, area extending to nearest sample locations
- **Transect #7 sample area,** lead-impacted sediment, landfill disposal, area extending to nearest sample locations

Once removed, the dredged material will be placed at one of the following locations and allowed to dewater; the G&C Concrete Construction, Inc property located at 30 Stevens Street, on the Stevens Street Mill Property, or on City property at the back of Cashman's Field. Once the dredged material is sufficiently dewatered, the material will be transported offsite.

Approximately 2,320 cubic yards of the remaining dredged materials will be beneficially reused onsite as part of the ecological restoration for creation of a new channel and banks, and approximately 360 cubic yards of the remaining excess dredged materials which are not needed for onsite reuse is anticipated to be released and redistributed downstream.

Sediment Chemistry Results: Samples were collected from locations upstream of the project area, from within the project area, and downstream of project area above and below the confluence of the Merrimack River. The sediment sample analytical results were compared Reportable Concentration ("RC") S-1 and RCS-2 criteria of the

1 Letter from Fuss & O'Neill to Kenneth Alepidis of MassDEP, dated July 21, 2023
2 Email correspondence between Matthew Kissane of Fuss & O'Neill with Kenneth Alepidis of MassDEP, dated December 21, 2023.

Massachusetts Contingency Plan ("MCP") and compared to Background Levels of PAHs and Metals in Soil levels included in the 2002 MassDEP Technical Update.

Results of the sediment samples analyzed indicated the presence of polycyclic aromatic hydrocarbon (PAHs), metals, polychlorinated biphenyls (PCBs), and Extractable Hydrocarbons (EPHs) in concentrations above the RCS-1 criteria.

Public Notice: The Combined Permit Application public notice was published in the Eagle Tribune newspaper on Wednesday, April 14, 2022. No comments were received by MassDEP during the 21-day public comment period pursuant to 314 CMR 9.05(3)(e), which ended on May 5, 2023.

Section 61 Findings: Pursuant to M.G.L. Chapter 30, Sections 61 to 62H inclusive [the Massachusetts Environmental Policy Act ("MEPA")], the project, as referenced in the Water Quality Certification Application, #23-WW26-0006-APP, was required to file an Expanded Environmental Notification Form (EENF). The City of Haverhill (the City) filed the EENF for construction of the project under EEA #16601. The EENF was noticed in the Environmental Monitor on September 9, 2022. In the Certificate of the Secretary of Energy and Environmental Affairs on the Expanded Environmental Notification Form, issued on October 18, 2022, the Secretary of Energy and Environmental Affairs (the Secretary) indicated that based on review of the EENF and consultation with Agencies, the Proponent was allowed to submit a Single Environmental Impact Report (SEIR) in lieu of a Draft and Final EIR.

The City subsequently filed the SEIR for construction of the project, which was noticed in the Environmental Monitor on February 24, 2023. In the Certificate of the Secretary of Energy and Environmental Affairs on the Single Environmental Impact Report, issued on April 3, 2023, the Secretary determined that "the SEIR adequately and properly complies with MEPA and its implementing regulations."

Therefore, based on information currently in the record, MassDEP grants a Combined 401 WQC for this project subject to the following conditions to maintain or attain water quality, to minimize any damage to the environment that may result from the project, and to ensure compliance with appropriate provisions of state law. MassDEP certifies that there is reasonable assurance the project or activity, as conditioned herein, will be conducted in a manner which will not violate applicable water quality standards (314 CMR 4.00) and other appropriate requirements of state law.

1. Pursuant to 314 CMR 9.01(3), the Contractor shall take all steps necessary to assure that the proposed activities will be conducted in a manner that will avoid violations of the anti-degradation provisions of the Massachusetts Surface Water Quality Standards that protect all waters, including wetlands (314 CMR 4.00). This condition is necessary to assure that any discharge from the project complies with the Massachusetts Surface Water Quality Standards, as provided in 314 CMR 9.00,

to protect the public health and restore and maintain the chemical, physical, and biological integrity of the water resources of the Commonwealth.

2. Prior to the start of work, or for any portion of the work thereafter, MassDEP shall be notified of any change(s) in the proposed project or plans that may affect waters or wetlands. MassDEP will determine whether the change(s) requires a revision to this Certification. This condition, pursuant to 314 CMR 9.07(1) and 314 CMR 9.09(2), is necessary to protect the public health and restore and maintain the chemical, physical, and biological integrity of the water resources of the Commonwealth.

3. As provided by 314 CMR 9.09(1), dredging and filling in accordance with this Certification may begin following the 21-day appeal period and once all other permits have been received. This condition is necessary to protect the public health and restore and maintain the chemical, physical, and biological integrity of the water resources of the Commonwealth.

4. Pursuant to 314 CMR 9.05(1), all work shall be performed in accordance with the following documents and plans. This condition is necessary as these documents outline how the execution of the project will meet the criteria of 314 CMR 9.07 and thereby protecting water quality and preventing degradation to wetlands and waters.

    - Application for Combined Permit, Accela Application #23-WW26-0006-APP, dated April 11, 2023, with attachments.

    - Plans entitled “Preliminary Design Development Plans, Little River Dam Removal and River Restoration Project, Haverhill, Massachusetts,” consisting of 38 sheets, various scales, dated June 30, 2022, prepared by Fuss & O’Neill.

      MassDEP shall be notified if there are modifications and or deletions of work as specified in the plans. Depending on the nature and the scope of any change, approval by the Department may be required.

    - Letter from Fuss & O’Neill to Kenneth Alepidis of MassDEP, dated July 21, 2023, providing project review question responses and additional project details.

    - Email correspondence between Matthew Kissane of Fuss & O’Neill with Kenneth Alepidis of MassDEP, dated December 21, 2023, providing project review question responses and additional project details.

    - Letter from Forest Schenk of the Massachusetts Division of Marine Fisheries (DMF) to the Haverhill Conservation Commission, dated November 10, 2022, providing project review responses and recommendations.

5. As provided by 314 CMR 9.05(4), the Department shall be notified, attention Kenneth Alepidis (kenneth.alepidis@mass.gov), one week prior to the start of in-water work so that Department staff may inspect the work for compliance with the terms and conditions of this Certification. This condition is necessary to ensure that construction practices are implemented in such a manner as to prevent degradation to wetlands and waters of the Commonwealth.

6. Pursuant to 314 CMR 9.05(4), the applicant and its contractor shall allow agents of the Department to enter the project sites to verify compliance with the conditions of this Certification. This condition is necessary to ensure that construction practices are implemented in such a manner as to prevent degradation to wetlands and waters of the Commonwealth.

7. Pursuant to 314 CMR 9.09(1), the term of the 401 WQC remains in effect for the same duration as the federal permit that requires it. This condition is necessary to ensure that construction practices are implemented in such a manner as to prevent degradation to wetlands and waters of the Commonwealth.

8. Future maintenance dredging is not authorized under this Combined 401 WQC. Pursuant to 314 CMR 9.04(5), the project does not qualify for the routine maintenance exemption. This condition is necessary to ensure that the chemical, physical and biological integrity of wetlands and waters of the Commonwealth are protected.

9. In order to be compatible with the fish passage requirements of this fish run and to further minimize potential adverse effects of the project, the time-of-year (TOY) restrictions for dredging, dewatering and associated activities is summarized below.[3] This condition is necessary to protect water quality by ensuring that the project proponent is using planning and construction practices that will maintain the aquatic resource functions and values.

    - All in-water, silt-producing work shall occur outside of a time of year restriction period of March 1 to June 30 for the purpose of minimizing impacts to diadromous fish resources in the adjacent Merrimack River from sedimentation and turbidity.

    - All in-water work be sequenced to occur during periods of low flow stream conditions in the Little River (i.e. July 1 – October 31).

10. In accordance with 314 CMR 9.07(1) and 314 CMR9.07(3), Best Management Practices (BMPs) such a temporary cofferdam to be installed segregating the work area from the rest of the river, and such as a silt curtain to be deployed downstream

3 Letter from Forest Schenk of the Massachusetts Division of Marine Fisheries (DMF) to the Haverhill Conservation Commission, dated November 10, 2022.

of the proposed work area to minimize turbidity. At a minimum, the silt curtain shall be bottom weighted to minimize the degree of lifting/flailing or billowing and shall be of suitable material /grade appropriate based on the velocity of the current at the site. This condition is necessary to ensure that construction practices are implemented in such a manner as to prevent degradation to wetlands and waters. It is also necessary to minimize turbidity and sediment caused by construction activities, protecting water quality.

11. Best Management Practices (BMPs) shall be deployed to minimize turbidity during temporary cofferdam construction. At a minimum, silt curtain shall be used to control turbidity downstream of the proposed work area. Water quality nearby the construction areas such as turbidity (NTU) shall be monitored during before, during, and after cofferdam construction to ensure that water quality standards are met. Turbidity monitoring data shall be kept on site and available for MassDEP review upon request. This condition is necessary to minimize turbidity and sediment caused by construction activities. It is necessary to ensure that water quality is not degraded, and biology of the waters are not negatively impacted by potential discharges.

12. At the lead and PAH-impacted sediment area characterized by the SED-19 sample, additional sampling and characterization is required to delineate the limits of the impacted sediment. A minimum of two sediment samples shall be collected from in-situ sediment present at the SED-19 area for delineation: one upstream and one downstream of the original SED-19 sample location. Samples shall be collected to the depth of proposed sediment removal, for analysis of PAHs and lead. Additional samples may be collected to further refine the limits of the lead and PAHs-impacted sediment in that area.

    Sampling data including a plan of the sample locations, sampling methods and depths, and laboratory QA/QC data shall be provided to MassDEP, attention Kenneth Alepidis (kenneth.alepidis@mass.gov) within 48 hours once available from the analytical laboratory, for review. Results of the chemical analysis shall be compared to the reuse levels in Policy COMM-97-001- Reuse and Disposal of Contaminated Soil at Massachusetts Landfills for reuse as landfill daily cover and to the MCP RCS-1 criteria. MassDEP will review the data to determine limits of the lead and PAH-impacted sediment area at the SED-19 location which will require offsite disposal. Under no circumstances shall the SED-19 sample area material be dredged or transported until MassDEP has reviewed and approved the data and the disposal plan.

13. In accordance with 314 CMR 9.07(1), during dredging and filling operations, measures shall be made to avoid the potential spread of aquatic invasive species to other waterbodies. Appropriate invasive species decontamination protocols shall be reviewed and applied, as required. All vehicles, equipment and tools that have direct contact with invasive species shall be cleaned before leaving the project areas. Under no circumstances shall sediment with invasive species seeds or rhizomes be

reused or transported. This condition is necessary to prevent the spread or introduction of invasive species which would affect water quality and biological resources. It is necessary to sustain aquatic resource functions, as well as characteristics and health of the waters.

14. If invasive species along part of the project areas are found, they shall be removed and shall be replaced with native herbaceous and shrub vegetation. During replanting, precautions will be taken to minimize the introduction of invasive species, including requiring the use of certified clean, weed-free soils, and equipment to reduce the risk of introducing non-native invasive species at site. This condition is necessary to prevent the spread or introduction of invasive species which would affect water quality and biological resources. It is necessary to sustain aquatic resource functions, as well as characteristics and health of the waters.

15. In accordance with 314 CMR 9.06(6)(a)8., the Applicant shall utilize stabilized construction entrances, vehicle wash down pads, perimeter erosion controls, and re-vegetation of disturbed areas with native plantings and seed mixes in accordance with project plans to minimize potential water quality impact resulting from construction activities. This condition is necessary to ensure that construction practices are implemented in such a manner as to prevent degradation to wetlands and waters. It is also necessary to ensure that impacts to wetlands and waters are appropriately mitigated.

16. Best Management Practices shall be employed by the Contractor to protect resource areas located adjacent to the proposed staging/temporary dredged material stockpiling and dewatering areas. Sediment stockpiles shall be constructed in accordance with the MassDEP approved project plans, stabilized, bottom-lined and securely covered with wind tear resistance tarpaulin, polyethylene sheeting or similar impermeable material at all times, and properly labeled. Stockpile covers shall be securely weighed down. Stockpiles shall also be secured to restrict access by the public and shall be set back at least 10-feet from temporary construction access roads or other areas and activities which could disturb the stockpiles and associated erosion controls. Inspection of the sediment containment and dewatering location and associated erosion controls shall be conducted daily and more frequently immediately before, during and after all precipitation and storm events. Any observed deficiency shall be corrected or repaired in a timely manner.

17. Pursuant to 314 CMR 9.09(1), in case of a precipitation or storm event, the site shall be secured beforehand in such a way as to protect resource areas and waters on site and downstream of the site, including covering of stockpiles of dredged material; inspection of erosion and sedimentation controls and correction as needed; and removal of any debris, equipment, materials, etc. that could potentially enter the waters on-site. Sediment stockpile areas shall be inspected immediately prior to, during and immediately after all precipitation and storm events. Any observed deficiency shall be corrected or repaired in a timely manner to prevent discharge

from the stockpiled material. If stormwater runoff and erosion is observed from stockpiled dredged material, additional erosion and/or damage prevention controls measures shall be implemented. This condition is necessary to minimize stormwater runoff and erosion from impacting wetland resources.

18. Dredging, stockpiling of dredged material, and offsite transport of dredged material shall be sequenced and conducted in a manner to limit stockpiling time. Sediment characterized as having concentrations exceeding the RCS-1 criteria shall not be stockpiled at the site longer than 90-days from the date of generation.

19. All sedimentation barriers shall be maintained in good repair until all disturbed areas have been fully stabilized with vegetation or other means. At no time shall sediments be deposited in a wetland or water body, except as described in the documents and plans cited in Condition # 4. During construction, the applicant or his/her designee shall inspect the erosion controls on a daily basis and shall remove accumulated sediments as needed. The applicant shall immediately control any erosion problems that occur at the site and shall also immediately notify MassDEP, which reserves the right to require additional erosion and/or damage prevention controls it may deem necessary. Sedimentation barriers shall serve as the limit of work unless another limit of work line has been approved by MassDEP pursuant to this 401 WQC. Pursuant to 314 CMR 9.06(6)(a)8., this condition is necessary to avoid and minimize adverse construction impacts to wetlands and waters of the Commonwealth.

20. In accordance with 314 CMR 9.07(1), no later than 21 days prior to commencement of dredging activity, a dredged material dewatering plan shall be submitted to MassDEP for review and approval. At a minimum, the dewatering plan shall include but not be limited to the type of containment, method of dewatering (i.e. mechanical or by gravity), method of collecting the dewatered effluent and method of disposal.

21. No later than 21 days prior to commencement of dredging activity, a construction phase water control plan shall be submitted to MassDEP for review and written approval if it differs from the proposed plan referenced in Condition # 4. Pursuant to 314 CMR 9.06(1)(c)4.c. and 9.07(1)(b)4.c., this condition is necessary to avoid and minimize adverse construction impacts to wetlands and waters of the Commonwealth.

22. Flow to the downstream channel shall be maintained throughout construction of the project via cofferdam construction and phased approach as described in and in accordance with the documents and plans cited in Condition # 4. As provided by 314 CMR 9.09(1), this condition is necessary to protect the public health and restore and maintain the chemical, physical, and biological integrity of the water resources of the Commonwealth. Pursuant to 314 CMR 9.07(1)(c), this condition is necessary to ensure that construction will be conducted in a manner that will not reduce or alter the habitat functions of the affected wetlands and waters of the Commonwealth.

23. Any approved discharge of water shall be controlled so that no scouring shall occur. This condition is necessary to adequately minimize and contain runoff water and material from the dredged material dewatering process to protect the waters. It is also necessary to ensure that water quality is not degraded, and biological resources are not negatively impacted by potential discharges.

24. The wetland restoration areas shall be constructed and monitored as described in and in accordance with the documents and plans cited in Condition # 4. Pursuant to 314 CMR 9.06(2)(a), this condition is necessary to ensure that wetlands of the Commonwealth are restored.

25. All sediment management activities authorized by this Combined 401 WQC shall be conducted under the supervision of a Licensed Site Professional ("LSP"). Pursuant to 314 CMR 9.02, this condition is necessary to ensure that the management of the contaminated sediment is overseen by a Qualified Environmental Professional.

26. A Health & Safety Plan shall be required for handling of sediment which has been characterized as exceeding MCP RCS-1 criteria. A copy shall be provided to the Department within six weeks of the effective of this Certification or two weeks prior to the commencement of the dredging operation whichever comes first.

27. Pursuant to 314 CMR 9.07(1), 314CMR9.07(5), 9.07(9), and 314 CMR 9.07(13)(b), MassDEP shall be notified in writing of the name and location of the upland licensed facilities accepting the dredged material for disposal or reuse for review and approval. If the licensed facility is located out of state, documentation shall be provided to MassDEP that the dredged material disposal/reuse has been approved and will be accepted by the receiving State in accordance with 314 CMR 9.07(13)(b). The dredged material shall not be transported to the facility without concurrence of MassDEP.

28. Transportation and disposal of the dredged material shall be overseen by the LSP of record. In accordance with 314 CMR 9.07(5), a Bills-of-Lading (BOL) or a Material Shipping Record (MSR) shall be used to track the dredged material to the proposed intermediate (stockpiling /dewatering) facility. A fully executed copy of the BOL or MSR shall be provided to MassDEP within 30 days of final shipment to the reused location or facility. Pursuant to 314 CMR 9.07(5), this condition is necessary to maintain a record of the dredged material for reference and to ensure accountability in its transportation. This assists in the protection of health, safety, public welfare, and the environment from any potential hazards during transportation. This condition is necessary to maintain a record of the dredged material for to ensure that dredge material disposal will not adversely affect any wetlands or waters.

29. In accordance with 314 CMR 9.07(5), Best Management Practices (BMPs) shall be implemented during transportation of the dredged material to the licensed receiving facility. At a minimum, when transported upon public roadways, all dredged material

shall have no free liquid as determined by the Paint Filter Test or other suitably analogous methodology acceptable to MassDEP, and a tarpaulin or other means shall be used to cover the dredged material during transport. This condition is necessary to protect surrounding area water quality during transportation. These practices help to avoid fugitive dust and siltation into wetland resources and waters.

30. Pursuant to 314 CMR 9.06, disposal of any volume of dredged material at any location in tidal waters, other than as approved herein, is not authorized by this 401 Water Quality Certification, and would require a request for amendment that would be subject to approval by MassDEP and the Massachusetts Coastal Zone Management office. This condition is necessary to prevent any pollution of tidal water resources by discharge of dredged material.

31. All equipment/machinery shall be stored outside above the High Water Mark ("HWM") and any wetland resource areas when not in use. Pursuant to 314 CMR 9.06(6)(a)8. this condition is necessary to avoid and minimize adverse construction impacts to wetlands and waters of the Commonwealth.

32. Pursuant to 314 CMR 9.06(6)(a)8., storing, servicing, or cleaning of equipment, including but not limited to fueling, changing, adding, or applying lubricants or hydraulic fluids, or washing/rinsing of trucks or equipment, shall be performed outside wetland resource areas. This condition ensures that no hazardous materials from equipment are inadvertently discharged into the water resource area in which construction is occurring, which would otherwise degrade water quality.

33. Pursuant to 314 CMR 9.06(6)(a)8. during the project period, there shall be no discharge or spillage of fuel, oil, or other pollutants, including sediments, onto any part of the site. The applicant shall take all reasonable precautions to prevent the release of pollutants by ignorance, accident, or vandalism. This condition is necessary to ensure that construction practices are implemented in such a manner as to prevent degradation to wetlands and waters.

34. In accordance with 314 CMR 9.09(1) and 314 CMR 9.06(6)(a)8., no later than four weeks after issuance of this water quality certification, the applicant shall submit a notification procedure outlining the reporting process to MassDEP for incidents relating to dredging activities that impact surrounding resource areas and habitats including, but not limited to, observed dead or distressed fish or other aquatic organisms, observed oily sheen on the surface of the water, a sediment spill, a turbidity plume beyond the deployed BMPs, and a barge or equipment accident/spill. If at any time during implementation of the project such an incident occurs, the applicant shall immediately notify MassDEP and all site related activities impacting the water shall cease until the source of the problem is identified and adequate mitigating measures are deployed to the satisfaction of MassDEP. This condition is necessary to protect water quality because it ensures that the project proponent is

using proper monitoring and construction practices that will maintain the integrity of the site hydrology and maintain the aquatic resource functions and values.

35. Upon completion of the project, remnants of project debris such as dewatering structures, cofferdams, turbidity curtains, coir logs, coir matting, sediment control barrier components, sediment traps, etc. shall be removed and disposed of appropriately at an offsite facility. This condition is necessary to prevent degradation to wetlands and waters.

36. Pursuant to 314 CMR 9.07(1) within 30 days of completion of the dredging at Little River Dam Removal and River Restoration Project in Haverhill, the applicant shall provide a set of construction photographs depicting pre-, during, and post-dredging and filling activities to the Wetlands Program in the Boston Office, Attn: Kenneth Alepidis. The photographs shall be marked or labeled with the WQC transmittal number and wetlands file number of the project. This condition is necessary to ensure that water quality requirements are met. It is necessary to ensure the project proponent uses planning and construction practices that maintain the integrity of the site hydrology and maintain the aquatic resource functions and values.

Failure to comply with this Combined 401 WQC is grounds for enforcement, including civil and criminal penalties, under M.G.L. c. 21, § 42, 314 CMR 9.00, M.G.L. c. 21A, § 16, 310 CMR 5.00, or other possible actions/penalties as authorized by the General Laws of the Commonwealth.

This Combined 401 WQC does not relieve the applicant of the obligation to comply with other appropriate state or federal statutes or regulations. Any changes made to the project as described in the previously submitted Combined Permit Application or supplemental documents will require further notification to and, if an amendment is required, approval by MassDEP.

NOTICE OF APPEAL RIGHTS

Certain persons shall have a right to request an adjudicatory hearing concerning 401 WQCs by MassDEP when an application is required:

a. the applicant or property owner;
b. any person aggrieved by the decision who has submitted written comments during the public comment period;
c. any ten persons of the Commonwealth pursuant to M.G.L. c. 30A where a group member has submitted written comments during the public comment period; or
d. any governmental body or private organization with a mandate to protect the environment, which has submitted written comments during the public comment period.

Any person aggrieved, any ten (10) persons of the Commonwealth, or a governmental body or private organization with a mandate to protect the environment may appeal without having submitted written comments during the public comment period only when the claim is based on new substantive issues arising from material changes to the scope or impact of the activity and not apparent at the time of public notice. To request an adjudicatory hearing pursuant to M.G.L. c. 30A, § 10, a Notice of Claim must be made in writing, provided that the request is made by certified mail or hand delivery to MassDEP, with the appropriate filing fee specified within 310 CMR 4.10 along with a DEP Fee Transmittal Form within twenty-one 21 days from the date of issuance of this Certificate.

Case Administrator
Massachusetts Department of Environmental Protection
Office of Appeals and Dispute Resolution
100 Cambridge Street, Suite 900
Boston, MA 02114

A copy of the request shall at the same time be sent by certified mail or hand delivery to the issuing office of the Wetlands Program at:

Department of Environmental Protection
100 Cambridge Street, Suite 900
Boston, MA 02114

A Notice of Claim for Adjudicatory Hearing shall comply with MassDEP's Rules for Adjudicatory Proceedings, 310 CMR 1.01(6), and shall contain the following information pursuant to 314 CMR 9.10(3):

a. the Combined Permit Authorization Number;
b. the complete name of the applicant and address of the project;
c. the complete name, address, and fax and telephone numbers of the party filing the request, and, if represented by counsel or other representative, the name, fax and telephone numbers, and address of the attorney;
d. if claiming to be a party aggrieved, the specific facts that demonstrate that the party satisfies the definition of "aggrieved person" found at 314 CMR 9.02;
e. a clear and concise statement that an adjudicatory hearing is being requested;
f. a clear and concise statement of (1) the facts which are grounds for the proceedings, (2) the objections to this Certificate, including specifically the manner in which it is alleged to be inconsistent with the MassDEP's Water Quality Regulations, 314 CMR 9.00, and (3) the relief sought through the adjudicatory hearing, including specifically the changes desired in the final written 401 WQC; and
g. a statement that a copy of the request has been sent by certified mail or hand delivery to the applicant, the owner (if different from the applicant), the conservation commission of the city or town where the activity will occur, the

Department of Conservation and Recreation (when the certificate concerns projects in Areas of Critical Environmental Concern), the public or private water supplier where the project is located (when the certificate concerns projects in Outstanding Resource Waters), and any other entity with responsibility for the resource where the project is located.

The hearing request along with a DEP Fee Transmittal Form and a valid check or money order payable to the Commonwealth of Massachusetts in the amount of one hundred dollars ($100) must be mailed to:

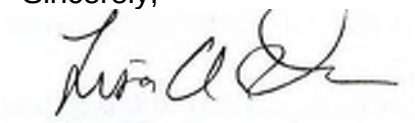
Commonwealth of Massachusetts
Department of Environmental Protection
Commonwealth Master Lockbox
PO Box 4062
Boston, MA 02211

The request will be dismissed if the filing fee is not paid, unless the appellant is exempt or granted a waiver. The filing fee is not required if the appellant is a city or town (or municipal agency), county, or district of the Commonwealth of Massachusetts, or a municipal housing authority. MassDEP may waive the adjudicatory hearing filing fee pursuant to 310 CMR 4.06(2) for a person who shows that paying the fee will create an undue financial hardship. A person seeking a waiver must file an affidavit setting forth the facts believed to support the claim of undue financial hardship together with the hearing request as provided above.

Failure to comply with this certification is grounds for enforcement, including civil and criminal penalties, under MGL c.21 §42, 314 CMR 9.00, MGL c. 21A §16, 310 CMR 5.00, or other possible actions/penalties as authorized by the General Laws of the Commonwealth.

Should you have any questions relative to this Combined 401 WQC, please contact Kenneth Alepidis at kenneth.alepidis@mass.gov.

Sincerely,

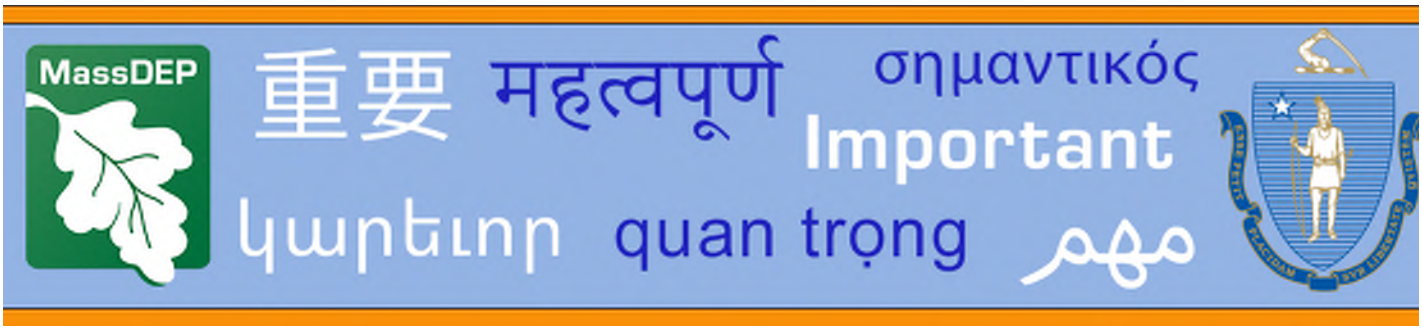


Lisa Rhodes
Wetlands Program Chief

ecc: Rober E. Moore, Jr., Haverhill Conservation Commission, City of Haverhill, 4 Summer St # 210, Haverhill, MA 01830, rmoore@cityofhaverhill.com
April Doroski, Fuss & O'Neill, 1550 Main Street, Springfield, MA, 01830

Kyle Lally, Jill Provencal, MassDEP Northeast Regional Office, 150 Presidential Way, Woburn, MA 01801
Paul Maniccia, Department of the Army, New England District, Corps of Engineers, 696 Virginia Road, Concord, MA 01742-2751
Forest Schenk, Massachusetts Division of Marine Fisheries, 30 Emerson Avenue, Gloucester, MA 01930
Edward Reiner and Rachel Croy, US EPA, 5 Post Office Square, Suite 100, Boston, MA 02109
Sean Duffey, Office of Coastal Zone 251 Causeway Street, Suite 800, Boston, MA 02114

attachments: Communication for Non-English Speaking Parties document
Plans of Record



Communication for Non-English-Speaking Parties

This document is important and should be translated immediately.

If you need this document translated, please contact MassDEP's Director of Environmental Justice at the telephone number listed below.

Español Spanish

Este documento es importante y debe ser traducido inmediatamente. Si necesita traducir este documento, póngase en contacto con el Director de Justicia Ambiental de MassDEP (*MassDEP's Director of Environmental Justice*) en el número de teléfono que figura más abajo.

Português Portuguese

Este documento é importante e deve ser traduzido imediatamente. Se você precisar traduzir este documento, entre em contato com o Diretor de Justiça Ambiental do MassDEP no número de telefone listado abaixo.

繁體中文 Chinese Traditional

本文檔很重要，需要即刻進行翻譯。
如需對本文檔進行翻譯，請透過如下列示電話號碼與 MassDEP 的環境司法總監聯絡。

简体中文 Chinese Simplified

这份文件非常重要，需要立即翻译。
如果您需要翻译这份文件，请通过下方电话与 MassDEP 环境司法主任联系。

Ayisyen Kreyòl Haitian Creole

Dokiman sa a enpòtan epi yo ta dwe tradui l imedyatman. Si w bezwen tradui dokiman sa a, tanpri kontakte Direktè. Jistis Anviwònmantal MassDEP a nan nimewo telefòn ki endike anba a.

Việt Vietnamese

Tài liệu này và quan trọng và phải được dịch ngay. Nếu quý vị cần bản dịch của tài liệu này, vui lòng liên hệ với Giám Đốc Phòng Công Lý Môi Trường của MassDEP theo số điện thoại được liệt kê bên dưới.

ប្រទេសកម្ពុជា Khmer/Cambodian

ឯកសារនេះមានសារៈសំខាន់
ហើយគប្បីតួរត្រូវបានបកប្រែភ្លាមៗ។
ប្រសិនបើអ្នកត្រូវការអោយឯកសារនេះបកប្រែ
សូមទាក់ទងនាយកផ្នែកយុត្តិធម៌បរិស្ថានរបស់
MassDEPតាមរយៈលេខទូរស័ព្ទដែលបានរាយដូចខាងក្រោម។

Kriolu Kabuverdianu Cape Verdean

Es dokumentu sta important i tenki ser tradusidu immediatamenti. Se nho ta presisa ke es dokumentu sta tradisidu, por favor kontata O Diretor di Justisia di Environman di DEP ku es numero di telifoni menxionadu di baixo.

Contact Deneen Simpson 857-406-0738
Massachusetts Department of Environmental Protection
100 Cambridge Street 9th Floor Boston, MA 02114
TTY# MassRelay Service 1-800-439-2370 • https://www.mass.gov/environmental-justice
(Version revised 8.2.2023) 310 CMR 1.03(5)(a)

Русский Russian

Это чрезвычайно важный документ, и он должен быть немедленно переведен. Если вам нужен перевод этого документа, обратитесь к директору Департамента экологического правосудия MassDEP (MassDEP's Director of Environmental Justice) по телефону, указанному ниже.

العربية Arabic

هذه الوثيقة مهمة وتجب ترجمتها على الفور.

إذا كنت بحاجة إلى ترجمة هذه الوثيقة، فيرجى الاتصال بمدير العدالة البيئية في MassDEP على رقم الهاتف المذكور أدناه.

한국어 Korean

이 문서는 중대하므로 즉시 번역되어야 합니다.
본 문서 번역이 필요하신 경우, 매사추세츠 환경보호부의 "환경정의" 담당자 분께 문의하십시오. 전화번호는 아래와 같습니다.

հայերեն Armenian

Այս փաստաթուղթը կարևոր է, և պետք է անհապաղ թարգմանել այն:
Եթե Ձեզ անհրաժեշտ է թարգմանել այս փաստաթուղթը, դիմեք Մասաչուսեթսի շրջակա միջավայրի պահպանության նախարարության (MassDEP) Բնապահպանական հարցերով արդարադատության ղեկավարին (Director of Environmental Justice)՝ ստորև նշված հեռախոսահամարով

فارسی Farsi Persian

این نوشتار بسیار مهمی است و باید فوراً ترجمه شود.
اگر نیاز به ترجمه این نوشتار دارید لطفاً با مدیر عدالت محیط زیستی MassDEP در شماره تلفن ذکر شده زیر تماس بگیرید.

Français French

Ce document est important et doit être traduit immédiatement. Si vous avez besoin d'une traduction de ce document, veuillez contacter le directeur de la justice environnementale du MassDEP au numéro de téléphone indiqué ci-dessous.

Deutsch German

Dieses Dokument ist wichtig und muss sofort übersetzt werden. Wenn Sie eine Übersetzung dieses Dokuments benötigen, wenden Sie sich bitte an MassDEP's Director of Environmental Justice *(Direktor für Umweltgerechtigkeit in Massachusetts)* unter der unten angegebenen Telefonnummer.

Ελληνική Greek

Το έγγραφο αυτό είναι πολύ σημαντικό και πρέπει να μεταφραστεί αμέσως. Αν χρειάζεστε μετάφραση του εγγράφου αυτού, παρακαλώ επικοινωνήστε με τον Διευθυντή του Τμήματος Περιβαλλοντικής Δικαιοσύνης της Μασαχουσέτης στον αριθμό τηλεφώνου που αναγράφεται παρακάτω

Italiano Italian

Questo documento è importante e deve essere tradotto immediatamente. Se hai bisogno di tradurre questo documento, contatta il Direttore della Giustizia Ambientale di MassDEP al numero di telefono sotto indicato.

Język Polski Polish

Ten dokument jest ważny i powinien zostać niezwłocznie przetłumaczony. Jeśli potrzebne jest tłumaczenie tego dokumentu, należy skontaktować się z dyrektorem ds. sprawiedliwości środowiskowej MassDEP pod numerem telefonu podanym poniżej.

हिन्दी Hindi

यह दस्तावेज महत्वपूर्ण है और इसका अनुवाद तुरंत किया जाना चाहिए। यदि आपको इस दस्तावेज का अनुवाद कराने की जरूरत है, तो कृपया नीचे दिए गए टेलीफोन नंबर पर MassDEP के पर्यावरणीय न्याय निदेशक से संपर्क करें।

Contact Deneen Simpson 857-406-0738
Massachusetts Department of Environmental Protection
100 Cambridge Street 9th Floor Boston, MA 02114
TTY# MassRelay Service 1-800-439-2370 • https://www.mass.gov/environmental-justice
(Version revised 8.2.2023) 310 CMR 1.03(5)(a)

LITTLE RIVER DAM REMOVAL AND RIVER RESTORATION

HAVERHILL · MASSACHUSETTS

PRELIMINARY DESIGN DEVELOPMENT PLANS

JUNE 30, 2022

PREPARED FOR

CITY OF HAVERHILL
DEPT. OF PUBLIC WORKS
500 PRIMROSE STREET
HAVERHILL, MA 01830-2660

PREPARED BY

FUSS & O'NEILL
1550 MAIN STREET, SUITE 400
SPRINGFIELD, MA 01103
413.452.0445
www.fando.com

SHEET INDEX

SHEET No.	SHEET TITLE
GI-001	COVER SHEET
GI-002	GENERAL NOTES AND LEGEND
GI-003	INDEX PLAN
CS-101 - CS-104	EXISTING CONDITIONS PLAN NOs. 1-4
CP-101 - CP-104	SITE PREPARATION AND EROSION CONTROL PLAN NOs. 1-4
CG-101 - CG-104	SITE LAYOUT AND GRADING PLAN NOs. 1-4
CX-301	TYPICAL CHANNEL CROSS SECTIONS
CR-101 - CR-104	RIVER RESTORATION PLAN NOs. 1-4
CW-101 - CW-102	CONSTRUCTION SEQUENCING PLAN NOs. 1-2
CD-501 - CD-508	CONSTRUCTION DETAILS
LA-101 - LA-104	LANDSCAPE AND PLANTING PLAN NOs. 1-4
LA-105	SITE PLAN ENLARGEMENTS
LA-106	PLANTING PLAN ENLARGEMENTS
S-101	RETAINING WALL DETAILS
S-102	PEDESTRIAN BRIDGE DETAILS

PROJECT TEAM

MUNICIPAL VULNERABILITY PREPAREDNESS PROGRAM (MVP)
MASSACHUSETTS EXECUTIVE OFFICE OF ENERGY AND ENVIRONMENTAL AFFAIRS
SALTONSTALL BUILDING
100 CAMBRIDGE STREET SUITE 900
BOSTON, MA 02114
617.626.1000

O'REILLY, TALBOT & OKUN ENGINEERING ASSOCIATES
293 BRIDGE STREET SUITE 500
SPRINGFIELD, MA 01103
413.788.6222

TG & B MARINE SERVICES, INC.
P.O. BOX 767
NORTH FALMOUTH, MA 02556-0767
508.326.3685

LOCATION MAP
SCALE: 1" = 2,000'

PROJ. No.: 20170390.U30
DATE: JUNE 2022

GI-001

File: J:\DWG\P20170390\U30\Civil\Plan\20170390U30_COV01.dwg Layout: 11X17 GI-001 Plotted: 2022-12-08 3:12 PM Saved: 2022-12-08 1:38 PM User: CNauman

LEGEND

EXIST	PROP	
		PROPERTY LINE/RIGHT-OF-WAY
		CENTERLINE
LOD	LOD	LIMIT OF DISTURBANCE
		EASEMENT
10+00	10+00	BASELINE
		GRAVEL ROAD
		EDGE OF PAVEMENT
		VERT. GRAN. CURB
		SAW CUT
MATCHLINE SEE SHEET EP-2	MATCHLINE SEE SHEET EP-2	MATCH LINE
		FEMA FLOODWAY
		100-YEAR FLOOD ELEVATION
		500-YEAR FLOOD ELEVATION
▲A100		WETLAND DELINEATION FLAG
		BANK/MEAN ANNUAL HIGH WATER
		BORDERING VEGETATED WETLANDS
		25' NO DISTURBANCE ZONE
		50' NO BUILD ZONE
		100' BUFFER ZONE
		200' RIVERFRONT AREA
		BASE CONDITION FLOW LIMITS / MEAN ANNUAL LOW WATER
		LITTLE RIVER DAM
		EDGE OF WATER
		BUFFER ZONE
		GUARD RAIL
		STOCKADE FENCE
		WIRE FENCE
		CHAIN LINK FENCE
		TREE LINE
		SHRUB LINE
		STONE WALL
		RETAINING WALL
2 4	2 4	MINOR CONTOUR
10 20	10 20	MAJOR CONTOUR
		BUILDING
		BOLLARD
		SIGN
		CONC. PAVEMENT
		NORMAL PAVEMENT
		HEAVY DUTY PAVEMENT
		ADA OR ACCESSIBLE RAMP
		HANDICAP PARKING
VAN	VAN	VAN-ACCESSIBLE HANDICAP PARKING
x 21.25* (XX')		TOP OF SEDIMENT ELEVATION (DEPTH OF SEDIMENT) - APPROXIMATE FROM BOAT DEPTH MEASUREMENTS
x 21.25		TOP OF SEDIMENT ELEVATION (FROM FIELD SURVEY)
x 21.25 B		BOTTOM OF SEDIMENT ELEVATION (FROM FIELD SURVEY)
x 21.25	x21.25	GROUND OR BOTTOM OF RIVER SPOT ELEVATION (FROM FIELD SURVEY)
21.25	21.25 w/LEADER	SPOT ELEVATION w/LEADER
		IRON PIPE
		DRILL HOLE
		IRON PIN
		MONUMENT
		CONTROL POINT
		WETLAND SEED MIX
		WETLAND SEED MIX AND LIVE STAKES
		CONSERVATION SEED MIX
		SEMI-SHADE SEED MIX
		SHOWY WILDFLOWER SEED MIX
		UPLAND/PARK SEED MIX

EXIST	PROP	
D	D	DRAIN/CSO LINE
S	S	SEWER LINE
E	E	OVERHEAD ELECTRIC, TELEPHONE & FIRE ALARM
W	W	WATER LINE
G	G	GAS LINE
E	E	UNDERGROUND ELECTRIC
T	T	TELEPHONE LINE
C	C	CABLE TV
E/T/C	E/T/C	ELECTRIC, TELEPHONE & CABLE TV LINES
CB	CB	CATCH BASIN
DCB	DCB	DOUBLE CATCH BASIN
DI	DI	DRAIN INLET
DMH	DMH	DRAIN MANHOLE
		HEADWALL
SMH	SMH	SEWER MANHOLE
CO	CO	CLEAN OUT
WG	WG	WATER MANHOLE
WG	WG	WATER GATE
		FIRE HYDRANT
WM	WM	WATER METER
PIV	PIV	POST INDICATOR VALVE
W	W	WELL
GG	GG	GAS GATE
GM	GM	GAS METER
E	E	ELECTRIC MANHOLE
		ELECTRIC BOX
EM	EM	ELECTRIC METER
M	M	TRANSFORMER
		LIGHT POST
T	T	TELEPHONE MANHOLE
TS	TS	TRAFFIC SIGNAL
SB	SB	SIGNAL BOX
FACP	FACP	FIRE ALARM CONTROL PANEL
FB	FB	FIRE ALARM BOX
		UTILITY POLE
		GUY POLE
		HAND HOLE
		PULL BOX
SF	SF	SILT FENCE
		BIODEGRADABLE COIR ROLLS
		TEMPORARY COFFERDAM
		CONSTRUCTION ENTRANCE/ TEMPORARY HAUL ROAD
		STAGING AREA
		TEMPORARY GRAVEL WALKWAY
		BASE CONDITION WATER LEVEL
		LOWER RIVER STABILIZATION
		UPPER RIVERBANK STABILIZATION
		GRAVEL WALKING TRAIL
		SCOUR POOL

LEGEND NOTE

SYMBOLS AND LEGENDS OF PROJECT FEATURES ARE GRAPHIC REPRESENTATIONS AND ARE NOT NECESSARILY SHOWN ON THE DRAWINGS TO SCALE OR TO THEIR ACTUAL DIMENSION OR LOCATION. COORDINATE DETAIL SHEET DIMENSIONS, MANUFACTURERS' LITERATURE, SHOP DRAWINGS, AND FIELD MEASUREMENTS OF SUPPLIED PRODUCTS FOR LAYOUT OF THE PROJECT FEATURES.

ABBREVIATIONS

GENERAL

APPROX	APPROXIMATE
BIT	BITUMINOUS PAVEMENT
BW	BOTTOM OF WALL
CC	CONCRETE CURB
COB	CAPE CODE BERM
ELEV	ELEVATION
EXIST	EXISTING
GC	GRANITE CURB
MAX	MAXIMUM
MIN	MINIMUM
NTS	NOT TO SCALE
PCC	PRECAST CONCRETE CURB
PROP	PROPOSED
R&D	REMOVE AND DISPOSE
R&R	REMOVE AND RESET
R&S	REMOVE AND STACK
TOS	TOP OF SLOPE
TW	TOP OF WALL
TYP	TYPICAL
VGC	VERTICAL GRANITE CURB

UTILITY

CB	CATCH BASIN
CMP	CORRUGATED METAL PIPE
CPP	CORRUGATED POLYETHYLENE PIPE
DCB	DOUBLE CATCH BASIN
DI	DUCTILE IRON PIPE
F&G	FRAME AND GRATE
F&C	FRAME AND COVER
HDPE	HIGH DENSITY POLYETHYLENE
HYD	HYDRANT
INV	INVERT ELEVATION
PVC	POLYVINYL CHLORIDE PIPE
RCP	REINFORCED CONCRETE PIPE
RD	ROOF DRAIN
SMH	SEWER MANHOLE
TSV	TAPPING SLEEVE, VALVE AND BOX
UP	UTILITY POLE

MAP NOTES AND REFERENCES

1. REFERENCES:
   A. COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF TRANSPORTATION STANDARD SPECIFICATIONS FOR HIGHWAY AND BRIDGES, 2022 EDITION, REVISIONS AND ALL CURRENT ADDENDA, ARE MADE A PART HEREOF, AS IF ATTACHED HERETO. ALL REFERENCES TO "STATE STANDARD SPECIFICATIONS" SHALL REFER TO THE LATEST EDITION OF THE COMMONWEALTH OF MASSACHUSETTS DEPARTMENT OF TRANSPORTATION STANDARD SPECIFICATIONS FOR HIGHWAYS AND BRIDGES CONSTRUCTION.
   B. THE MASSACHUSETTS DEPARTMENT OF TRANSPORTATION CONSTRUCTION STANDARD DETAILS, 2017 EDITION, AND ALL CURRENT REVISIONS, ARE MADE A PART HEREOF, AS IF ATTACHED HERETO.
   C. THE MASSACHUSETTS EROSION AND SEDIMENT CONTROL GUIDELINES FOR URBAN AND SUBURBAN AREAS, 2013 EDITION, REVISIONS AND ALL CURRENT ADDENDA, ARE MADE A PART HEREOF, AS IF ATTACHED HERETO. ALL REFERENCES TO "SOIL EROSION AND SEDIMENT CONTROL HANDBOOK" SHALL REFER TO THE LATEST EDITION OF THE MASSACHUSETTS EROSION AND SEDIMENT CONTROL GUIDELINES FOR URBAN AND SUBURBAN AREAS.

2. EXISTING CONDITIONS:
   A. SURVEY: CONTOURS SHOWN ON THIS PLAN THAT ARE OUTSIDE OF THE RIVER AND CASHMAN PARK AREA ARE APPROXIMATE ONLY AND WERE OBTAINED FROM 2013-2014 USGS LIDAR DATA OBTAINED FROM NOAA'S ONLINE DATA ACCESS VIEWER. TOPOGRAPHY WITHIN CASHMAN PARK, BATHYMETRIC SPOT ELEVATIONS (WITHIN THE RIVER), AND SEDIMENT DEPTHS (WITHIN THE RIVER) WERE OBTAINED FROM THE FOLLOWING COMBINATION OF FIELD INVESTIGATIONS AND RESEARCH:
      A.A. ELEVATIONS SHOWN WITHIN RIVER WITH ASTERISKS ARE APPROXIMATE AND WERE OBTAINED ON NOVEMBER 6, 2020 AND ON NOVEMBER 17, 2020 FROM DEPTH MEASUREMENTS TAKEN BY BOAT BY FUSS & O'NEILL AND TG&B MARINE SERVICES, INC.
      A.B. ELEVATIONS IN RIVER AND AT WINTER STREET THAT DO NOT INCLUDE ASTERISKS WERE OBTAINED FROM ACTUAL FIELD SURVEY PERFORMED BY FUSS & O'NEILL IN FALL OF 2021 AND WINTER OF 2022. ELEVATION WITH "I" DESIGNATION REFERS TO TOP OF SEDIMENT ELEVATION; ELEVATION WITH "B" DESIGNATION REFERS TO BOTTOM OF SEDIMENT. ELEVATIONS THAT DO NOT HAVE ASTERISKS OR "I" OR "B" DESIGNATION WERE ALSO OBTAINED FROM ACTUAL FIELD SURVEY.
      A.C. ELEVATION AND WETLANDS DATA WITHIN CASHMAN PARK WAS OBTAINED FROM AN EXISTING CONDITIONS SURVEY PLAN OF CASHMAN PARK, DATED JUNE 1, 2017, AND PREPARED BY SMC SURVEYING AND MAPPING CONSULTANTS.
   B. TOPOGRAPHIC INFORMATION (CONTOURS), BUILDING FOOTPRINTS, EXISTING FEATURES SHOWN OUTSIDE OF THE PROJECT'S RIGHTS OF WAY ARE APPROXIMATE ONLY AND WERE OBTAINED FROM A COMBINATION OF 2013-2014 USGS CMGP LIDAR DATA (OBTAINED FROM NOAA'S ONLINE DATA ACCESS VIEWER) AND MASSGIS DATA LAYER.
   C. WETLAND FLAGGING ALONG LITTLE RIVER WITHIN THE DIRECT PROJECT LIMITS WAS PERFORMED BY FUSS & O'NEILL, INC. (MICHAEL SOARES, WETLAND SCIENTIST) ON SEPTEMBER 27, 2021 AND APRIL 29, 2022. THE WETLAND FLAGS WERE THEN LOCATED VIA SUB-METER GPS. DUE TO SPECIFIC SITE RESTRICTIONS OR SAFETY CONCERNS, IT WAS NOT POSSIBLE TO ACCESS AND FIELD-DELINEATE SOME SEGMENTS OF RIVERBANK AND BORDERING WETLANDS. IN LOCATIONS WHERE A TYPICAL FIELD DELINEATION OF THE BANK, LUWW, AND/OR BVW WAS NOT PRACTICABLE, BOUNDARIES OF RESOURCE AREAS BETWEEN FIELD DELINEATED SEGMENTS WERE COMPLETED IN GIS THROUGH A REVIEW OF AERIAL IMAGERY (2014-2021, SPRING AND SUMMER), FEDERAL AND STATE WETLANDS MAPPING (NATIONAL WETLANDS INVENTORY AND MASS DEP, RESPECTIVELY), AND 1-FOOT CONTOURS (DERIVED FROM 2013-2014 LIDAR). STATE-REGULATED RIVERFRONT AREA IS MEASURED HORIZONTALLY FROM BANK OF LITTLE RIVER, AND STATE-REGULATED BUFFER ZONE IS MEASURED HORIZONTALLY FROM THE BOUNDARIES OF BVW IDENTIFIED AT THE SITE.
   D. ASSESSOR'S PARCELS, WETLAND BOUNDARIES (UPSTREAM OF THE MBTA BRIDGE AND THE PROJECT'S LIMIT OF DIRECT IMPACTS), POTENTIAL & CERTIFIED VERNAL POOLS, SHOWN ON THESE PLANS ARE APPROXIMATE AND WERE OBTAINED FROM MASSACHUSETTS GEOGRAPHIC INFORMATION SYSTEM (MASSGIS).

3. FLOOD ZONE:
   A. SPECIAL FLOOD HAZARD AREAS (SFHAS), INCLUDING FLOODWAY INFORMATION, SHOWN ON THIS PLAN WERE INITIALLY OBTAINED FROM FEMA FLOOD INSURANCE RATE MAP (FIRM) PANEL NUMBER 25009C0089G WITH AN EFFECTIVE DATE OF JULY 19, 2018 AND FIRM PANEL NUMBERS 25009C0087F, 25009C0086F, AND 25009C0078F WITH AN EFFECTIVE DATE OF JULY 3, 2012 FOR ESSEX COUNTY, MASSACHUSETTS. THESE FLOOD HAZARD AREAS WERE THEN MODIFIED BASED ON THE RESULTS OF MORE DETAILED TOPOGRAPHY AND A PRE-CONDITIONS (OR PRE-DAM REMOVAL) HYDRAULIC ANALYSIS PERFORMED BY FUSS & O'NEILL USING HEC-RAS. IN ORDER TO ASSESS ANTICIPATED HYDRAULIC IMPACTS AS A RESULT OF THE PROPOSED REMOVAL OF THE DAM, A POST-CONDITIONS (OR POST-DAM REMOVAL) HYDRAULIC ANALYSIS WAS ALSO PERFORMED BY FUSS & O'NEILL USING HEC-RAS. THE MODIFIED PRE-CONDITIONS SPECIAL FLOOD AREA BOUNDARIES ARE REFLECTED ON THE EXISTING CONDITIONS PLANS. THE POST-CONDITIONS (OR POST-DAM REMOVAL) SPECIAL FLOOD AREA BOUNDARIES ARE REFLECTED ON THE SITE LAYOUT AND GRADING PLANS.

4. NATURAL HERITAGE DATA:
   THERE ARE NO NHESP PRIORITY HABITATS OF RARE SPECIES, ESTIMATED HABITATS OF RARE WILDLIFE, OR NATURAL COMMUNITIES LOCATED ALONG THE LITTLE RIVER. THERE ARE ALSO NO AREAS OF CRITICAL ENVIRONMENTAL CONCERN ALONG LITTLE RIVER. THERE ONE, HOWEVER, POTENTIAL VERNAL POOLS LOCATED ALONG LITTLE RIVER TO THE SOUTH OF THE RIVER'S CROSSING WITH I-495 AND NORTH OF THE RIVER'S RAILROAD BRIDGE CROSSING. THESE POTENTIAL VERNAL POOLS WERE OBTAINED FROM MASSGIS.

5. UTILITIES:
   UTILITIES SHOWN ON THIS PLAN WERE APPROXIMATED FROM FIELD OBSERVATIONS AND A COLLECTIVE REVIEW OF THE FOLLOWING DOCUMENTS: (1) WINTER STREET AND HALE STREET SEWER DIVERSION PLAN PREPARED BY METCALF & EDDY (DATED JULY 1937), (2) FLOOD PROTECTION SYSTEM IMPROVEMENT PLANS (CWSRF-3862, IFB020-13) PREPARED BY AECOM (DATED JANUARY 14, 2013), AND (3) INTERSTATE FINAL CONTRACTOR SEWER OVERFLOW LONG-TERM CONTROL PLAN AND SUPPLEMENTAL ENVIRONMENTAL IMPACT REPORT PREPARED BY CDM SMITH (DATED FEBRUARY 2017).

6. ACTIVITY AND USE LIMITATION AREAS AND UNDERGROUND STORAGE TANKS:
   ALL PROPERTIES WHERE WORK IS PROPOSED DO NOT HAVE UNDERGROUND STORAGE TANKS. HOWEVER, PARCEL 518-304-1 (93 LAFAYETTE SQUARE) IS CONSIDERED AN AUL (ACTIVITY AND USE LIMITATION) PROPERTY.

GENERAL CONSTRUCTION AND COORDINATION REQUIREMENTS

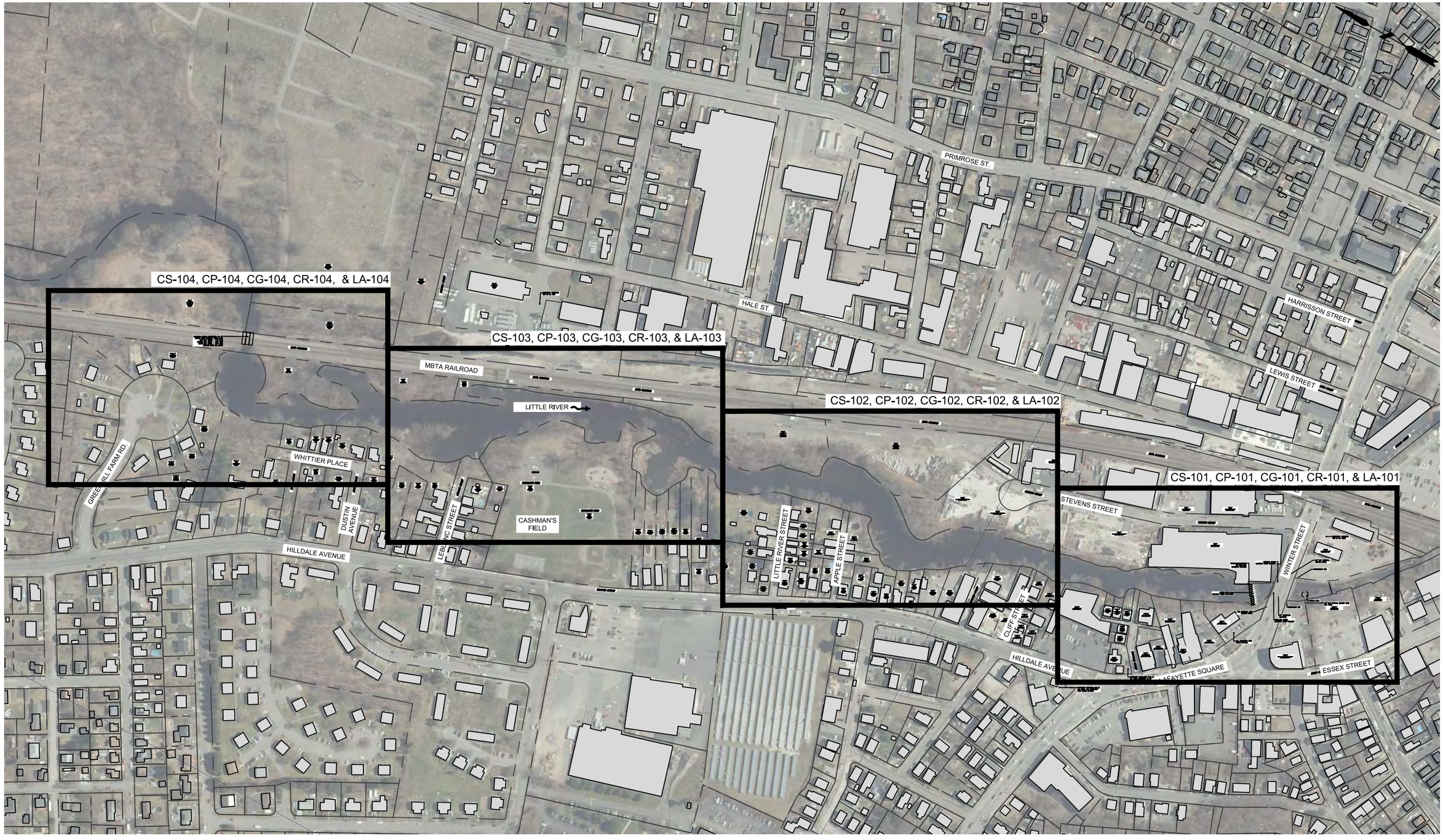
1. THE CONTRACTOR SHALL VERIFY THE LOCATION OF THE EXISTING DAM TO BE REMOVED, EXISTING ADJACENT STRUCTURES, AND THE PROPOSED LAYOUT OF THE RIVER CHANNEL IMPROVEMENTS WITH ITS RELATIONSHIP TO THE EXISTING SITE SURVEY. THE CONTRACTOR SHALL ALSO VERIFY ALL DIMENSIONS, SITE CONDITIONS, AND MATERIAL SPECIFICATIONS AND SHALL NOTIFY THE OWNER AND ENGINEER OF ANY ERRORS, OMISSIONS OR DISCREPANCIES BEFORE COMMENCING OR PROCEEDING WITH WORK.
2. THE CONTRACTOR SHALL TAKE FIELD MEASUREMENTS AS REQUIRED TO FIT THE WORK PROPERLY. RECHECK MEASUREMENTS BEFORE CONSTRUCTING EACH WORK ITEM. WHERE PORTIONS OF THE WORK ARE INDICATED TO FIT TO OTHER CONSTRUCTION, VERIFY DIMENSIONS OF OTHER CONSTRUCTION BY FIELD MEASUREMENTS BEFORE FABRICATION. COORDINATE FABRICATION SCHEDULE WITH CONSTRUCTION PROGRESS TO AVOID DELAYING THE WORK.
3. THE LOCATION OF EXISTING UTILITIES ARE APPROXIMATE, HAVE BEEN PLOTTED FROM THE LATEST AVAILABLE INFORMATION, AND MAY NOT BE ALL INCLUSIVE. THE CONTRACTOR SHALL CHECK AND VERIFY THE LOCATIONS OF ALL EXISTING UTILITIES, BOTH OVERHEAD AND UNDERGROUND, AND "DIG-SAFE" MUST BE NOTIFIED PRIOR TO COMMENCING ANY CONSTRUCTION OPERATIONS. RESTORATION AND REPAIR OF DAMAGE TO EXISTING UTILITIES SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR WITH NO ADDITIONAL COST TO THE OWNER. NO EXCAVATION SHALL COMMENCE UNTIL ALL INVOLVED UTILITY COMPANIES AND/OR TOWN WHOSE FACILITIES MIGHT BE AFFECTED BY ANY WORK TO BE PERFORMED BY THE CONTRACTOR ARE NOTIFIED AT LEAST 72 HOURS IN ADVANCE. RELOCATION OF ANY UTILITIES SHALL BE AT THE OWNERS EXPENSE AND COMPLETED WITH THE UTILITY WORK. THE OWNER SHALL BE NOTIFIED AS TO THE RELOCATIONS REQUIRED PRIOR TO THE START OF CONSTRUCTION.
4. DEVIATIONS OR CHANGES FROM THESE PLANS WILL NOT BE ALLOWED UNLESS APPROVED BY THE ENGINEER/CONTRACT OWNER.
5. THE CONTRACTOR SHALL MAKE EXPLORATORY EXCAVATIONS AND LOCATE ANY EXISTING UTILITIES SUFFICIENTLY AHEAD OF CONSTRUCTION TO PERMIT REVISIONS TO PLANS IF NECESSARY. HOWEVER, EXPLORATORY EXCAVATIONS AND OTHER ACTIVITIES INVOLVING SOIL DISTURBANCES WITHIN THE RIVER OR OTHER ADJACENT WATERCOURSES SHALL BE LIMITED TO THE LOW-FLOW PERIOD (I.E. THE PERIOD FROM JULY 1 TO OCTOBER 31 OF ANY CALENDAR YEAR).
6. THE EXISTENCE AND/OR LOCATION OF UTILITIES SHOWN ON THESE PLANS MAY BE ONLY APPROXIMATELY CORRECT AND THE CONTRACTOR IS REQUIRED TO TAKE PRECAUTIONARY MEASURES TO PROTECT THE UTILITIES SHOWN HEREON AND ANY OTHER EXISTING UTILITIES NOT OF RECORD OR NOT SHOWN ON THESE PLANS. THE CONTRACTOR SHALL BE RESPONSIBLE FOR REMOVING, AT HIS/HER EXPENSE, ANY EXISTING UTILITIES DAMAGED DURING CONSTRUCTION.
7. THE CONTRACTOR SHALL BE RESPONSIBLE FOR REPLACING, WITH MATCHING MATERIALS, ANY PAVEMENT, WALKS, CURBS, WALLS, FENCES, ETC., THAT MUST BE CUT OR THAT ARE DAMAGED DURING CONSTRUCTION.
8. THE CONTRACTOR SHALL BE RESPONSIBLE FOR OBTAINING ALL REMAINING NECESSARY PERMITS, INSPECTIONS, BONDS, ETC. AND OTHER APPROVAL RELATED ITEMS WITH THE LOCAL AND STATE/FEDERAL MUNICIPALITIES. NO CONSTRUCTION SHALL COMMENCE UNTIL SUCH PERMITS HAVE BEEN SECURED AND THE CONTRACTOR HAS RECEIVED THE REQUIRED NOTICES.
9. WORK ON MBTA PROPERTY CAN ONLY BE UNDERTAKEN UPON RECEIPT OF A LICENSE FROM MBTA.
10. AN APPROVED SET OF PLANS AND ALL APPLICABLE PERMITS MUST BE AVAILABLE AT THE SITE THROUGH THE ENTIRE PERIOD OF CONSTRUCTION WHEN WORK IS ACTIVELY OCCURING.
11. CONTRACTOR AGREES THAT HE/SHE SHALL ASSUME SOLE AND COMPLETE RESPONSIBILITY FOR JOB SITE CONDITIONS DURING THE COURSE OF CONSTRUCTION OF THIS PROJECT, INCLUDING SAFETY OF ALL PERSONS AND PROPERTY; THAT THIS REQUIREMENT SHALL APPLY CONTINUOUSLY AND NOT BE LIMITED TO NORMAL WORKING HOURS; AND THAT THE CONTRACTOR SHALL DEFEND, INDEMNIFY AND HOLD THE CONTRACT OWNER (CITY OF HAVERHILL), PROPERTY OWNERS AND THE ENGINEER HARMLESS FROM ANY AND ALL LIABILITY, REAL AND ALLEGED, IN CONNECTION WITH THE PERFORMANCE OF WORK ON THIS PROJECT, EXCEPTING FOR LIABILITY ARISING FROM "THE SOLE NEGLIGENCE OF THE CONTRACT OWNER, PROPERTY OWNER OR THE ENGINEER."
12. PHOTOGRAPHS, VIDEOTAPING, AND SKETCHES (AS NECESSARY) MUST BE TAKEN OF ADJOINING CONSTRUCTION AND SITE IMPROVEMENTS WITHIN 200 FEET OF EXCAVATION LIMITS ASSOCIATED WITH THE DAM REMOVAL AND RIVER CHANNEL IMPROVEMENTS PRIOR TO EXCAVATION AND THE INSTALLATION OF EXCAVATION SUPPORT SYSTEMS. SUCH DOCUMENTATION SHALL ILLUSTRATE EXISTING SURFACES THAT MAY BE MISCONSTRUED AS DAMAGE CAUSED BY THIS PROJECT CONSTRUCTION OPERATIONS.
13. METHODS AND MATERIALS USED IN THE CONSTRUCTION OF IMPROVEMENTS FOR THIS PROJECT SHALL CONFORM TO THE CURRENT CONSTRUCTION STANDARDS AND SPECIFICATIONS OF THE CITY OF HAVERHILL AND THE MASSACHUSETTS DEPARTMENT OF TRANSPORTATION.
14. VERIFY SPACE REQUIREMENTS AND DIMENSIONS OF ITEMS SHOWN ON DRAWINGS. CHECK THE LOCATION, LEVEL AND GRADE, OF EVERY MAJOR ELEMENT AS THE WORK PROGRESSES.
15. ESTABLISH BENCHMARKS AND CONTROL POINTS IN ADDITION TO THOSE INDICATED TO SET LINES, GRADES, AND LEVELS AT EACH STAGE OF CONSTRUCTION. LOCATE THE WORK AND COMPONENTS OF THE WORK ACCURATELY, IN CORRECT ALIGNMENT AND ELEVATION, AS INDICATED BOUNDS OR MONUMENTATION DISTURBED DURING CONSTRUCTION SHALL BE SET OR RESET BY A PROFESSIONAL LICENSED SURVEYOR AT NO COST TO THE OWNER.
16. COMPLY WITH MANUFACTURERS' WRITTEN INSTRUCTIONS AND RECOMMENDATIONS FOR INSTALLING MATERIALS AND PRODUCTS. INSTALL PRODUCTS AT THE TIME AND UNDER CONDITIONS THAT WILL ENSURE THE BEST POSSIBLE RESULTS. MAINTAIN CONDITIONS REQUIRED FOR PRODUCT PERFORMANCE UNTIL SUBSTANTIAL COMPLETION.
17. USE PRODUCTS, CLEANERS, AND INSTALLATION MATERIALS THAT ARE NOT CONSIDERED HAZARDOUS.
18. CONTRACTOR SHALL IDENTIFY TREES TO BE REMOVED PRIOR TO CONSTRUCTION AND MARK THEM WITH CONSTRUCTION TAPE FOR REVIEW BY THE OWNER/ENGINEER. TREES AND OTHER EXISTING VEGETATION SHALL BE RETAINED WHEREVER FEASIBLE. CONTRACTOR SHALL NOT REMOVE TREES UNTIL REVIEWED AND APPROVED BY THE OWNER/ENGINEER.
19. THE CONTRACTOR SHALL RESTORE DISTURBED LANDSCAPE AREAS TO ORIGINAL CONDITION (I.E. SEEDED, SODDED, PLANTED), UNLESS OTHERWISE DIRECTED WITHIN CONTRACT DOCUMENTS.
20. ALL EXCESS EXCAVATED MATERIALS, EXCESS FILL, EXCESS CONSTRUCTION MATERIALS, DEBRIS, AND WASTE (INCLUDING IDENTIFIED CONTAMINATED SOILS WITHIN RIVER) SHALL BE REMOVED FROM THE SITE AND SHALL BE DISPOSED OF IN ACCORDANCE WITH APPLICABLE LAWS.
21. DO NOT CLOSE OR OBSTRUCT ROADWAYS, SIDEWALKS, FIRE HYDRANTS, AND UTILITIES WITHOUT APPROPRIATE PERMITS.
22. WORK IS RESTRICTED TO THE HOURS OF 7 AM TO 5 PM ON MONDAY THROUGH FRIDAY, EXCLUDING HOLIDAYS, UNLESS OTHERWISE APPROVED BY THE OWNER.
23. PRIOR TO CONSTRUCTION, ADDITIONAL CONSTRUCTION ACCESSES AND/OR CONSTRUCTION EASEMENTS NOT SHOWN ON THIS PLAN (AGREED UPON THROUGH COORDINATION BETWEEN CONTRACTOR AND PROPERTY OWNER) MUST BE GRANTED IN WRITING BY PROPERTY OWNERS.
24. STOP WORK IN THE VICINITY OF SUSPECTED CONTAMINATED SOIL, GROUNDWATER, OR OTHER MEDIA OUTSIDE OF THE AREA OF CONTAMINATED SOIL AREA IDENTIFIED WITHIN. IMMEDIATELY NOTIFY THE ENGINEER AND OWNER SO THAT APPROPRIATE TESTING AND SUBSEQUENT ACTION CAN BE TAKEN. RESUME WORK IN THE IMMEDIATE VICINITY ONLY UPON DIRECTION BY THE OWNER.

PROTECTION OF WORK REQUIREMENTS

1. THE WORK AND SITE SHALL BE PROTECTED AT ALL TIMES UNTIL FINAL ACCEPTANCE BY THE OWNER. CARE SHALL BE EXERCISED WHILE OPERATING EQUIPMENT ON, AND ADJACENT TO, THE WORK AREA. THE CONTRACTOR SHALL BE RESPONSIBLE TO ASSURE THE UTILIZED EQUIPMENT DOES NOT CAUSE DAMAGE TO EXISTING AND ADJACENT FEATURES NOT SCHEDULED FOR DEMOLITION OR REMOVAL.
2. ACCESS TO VARIOUS PORTIONS OF THE SITE SHALL BE UNDERTAKEN IN SUCH A MANNER THAT THE WORK AND SITE ARE PROTECTED AT ALL TIMES. ACCESS WAYS SHALL BE CONSTRUCTED, MAINTAINED, AND PROTECTED WITH SEDIMENT CONTROLS TO PREVENT DAMAGE FROM EROSION DURING MAJOR STORM EVENTS.
3. PLACEMENT AND COMPACTION OF FILL MATERIALS SHALL BE COMPLETED IN ACCORDANCE WITH THE PROJECT MANUAL AND IN SUCH A MANNER THAT THE WORK AND ADJACENT PROPERTIES ARE PROTECTED FROM DAMAGE AT ALL TIMES.
4. CONSTRUCT IN-RIVER IMPROVEMENTS AND MAINTAIN IN-RIVER WORK AREAS IN ACCORDANCE WITH THE PROJECT'S APPROVED WATER CONTROL & CONSTRUCTION SEQUENCING PLANS. IN THE EVENT THAT FLOOD FLOWS ARE EXPECTED TO EXCEED THE ELEVATIONS OF THE PROPOSED TEMPORARY RIVER CROSSING AND COFFERDAM SYSTEMS; PROTECT ANY NON-STABLE OR ERODIBLE IMPROVEMENTS USING APPROPRIATELY SIZED STONE RIPRAP MATERIAL (OR SIMILAR) AND REMOVE ALL EQUIPMENT AND PERSONNEL FROM IN-RIVER LOCATIONS.

EROSION AND SEDIMENT CONTROL

1. PRIOR TO THE COMMENCEMENT OF CONSTRUCTION ACTIVITIES, INSTALL ALL EROSION AND SEDIMENT CONTROL DEVICES AS SHOWN ON THE PLAN OR AS REQUIRED BY SITE CONDITIONS. ALL EROSION CONTROL DEVICES WILL BE MAINTAINED THROUGHOUT CONSTRUCTION.
2. DISTURBANCE OF SOIL SURFACES IS REGULATED BY STATE LAW AND LOCAL ORDINANCE. ALL WORK SHALL COMPLY WITH THESE EROSION AND SEDIMENT CONTROL NOTES AND OTHER PERMIT CONDITIONS TO PREVENT OR MINIMIZE SOIL EROSION AND SEDIMENTATION TO OFF-SITE AREAS.
3. THE CONTRACTOR SHALL COMPLY WITH THE LATEST EDITION OF THE "MASSACHUSETTS EROSION AND SEDIMENT CONTROL GUIDELINES FOR URBAN AND SUBURBAN AREAS" IN CONSTRUCTING THE EROSION AND SEDIMENT CONTROLS INDICATED ON THE PLANS. ALL EROSION AND SEDIMENT CONTROL MEASURES OR WORKS AND REHABILITATION MEASURES MUST CONFORM TO OR EXCEED THE SPECIFICATIONS OR STANDARDS SET OUT IN THIS DOCUMENT.
4. THE CONTRACTOR IS RESPONSIBLE FOR THE TIMELY INSTALLATION, INSPECTION, MAINTENANCE, AND/OR REPLACEMENT OF ALL TEMPORARY AND PERMANENT EROSION CONTROL DEVICES SHOWN ON THESE PLANS TO ENSURE PROPER OPERATION THROUGHOUT THE LIFE OF THE PROJECT. REMOVE EROSION AND SEDIMENTATION CONTROLS AFTER STABLE VEGETATIVE GROWTH IS ESTABLISHED BY THE OWNER, ENGINEER OR LANDSCAPE ARCHITECT.
5. THE CONTRACTOR SHALL INSPECT EROSION AND SEDIMENT CONTROL DEVICES ON A WEEKLY BASIS, AFTER EACH STORM EVENT, AND AT LEAST DAILY DURING PROLONGED RAINFALL. CLEAN OUT ACCUMULATED SEDIMENT BEHIND CONTROLS. REPAIR OR REPLACE CONTROLS PROMPTLY AS NEEDED. REMOVE ACCUMULATED SEDIMENT FROM BEHIND PERIMETER CONTROLS (I.E. BIODEGRADABLE COIR ROLLS AND SILT FENCING) WHEN ONE-THIRD OF THE ORIGINAL HEIGHT OF THE CONTROLS BECOME FILLED WITH SEDIMENT. DISPOSE OF REMOVED SEDIMENT IN ON-SITE FILL AREAS OR LAWFULLY OFF-SITE.
6. TREES AND OTHER EXISTING VEGETATION NOT WITHIN THE LIMITS OF DISTURBANCE SHALL BE PROTECTED FROM DAMAGE. VEGETATED AREAS AND/OR TREES DAMAGED THAT ARE NOT PLANNED FOR REMOVAL SHALL BE RESTORED TO THEIR ORIGINAL CONDITION OR BETTER TO THE SATISFACTION OF THE CITY.
7. IT SHALL BE THE CONTRACTOR'S RESPONSIBILITY TO CLEAN ROADS, CONTROL DUST, AND TAKE ALL NECESSARY MEASURES TO ENSURE THAT THE SITE AND ALL ADJACENT AREAS SHALL BE KEPT FREE OF MUD IN A MUD- AND DUST-FREE CONDITION AT ALL TIMES THROUGHOUT THE LIFE OF THE CONTRACT. DUST CONTROL SHALL INCLUDE, BUT IS NOT LIMITED TO, WATER AND/OR CRUSHED STONE OR COARSE GRAVEL.
8. ALL PROPOSED TEMPORARY STONE CONSTRUCTION ENTRANCES SHALL BE CONSTRUCTED AS SHOWN ON THE PLANS AND DETAILS. ALL VEHICLE TRAFFIC ENTERING OR EXITING THE PROJECT SITE SHALL PASS OVER THE CONSTRUCTION ENTRANCES TO REDUCE THE TRACKING OR FLOWING OF SEDIMENT ONTO THE SURROUNDING ROADWAYS. ENTRANCES SHALL BE MAINTAINED IN A CONDITION THAT WILL PREVENT TRACKING OR FLOWING OF SEDIMENT ONTO THE SURROUNDING ROADWAYS. THIS WILL REQUIRE PERIODIC TOP DRESSING WITH ADDITIONAL STONE OR ADDITIONAL LENGTH AS CONDITIONS DEMAND AND REPAIR AND/OR CLEANOUT OF ANY MEASURES USED TO TRAP SEDIMENT. ALL SEDIMENT SPILLED, DROPPED, WASHED, OR TRACKED ONTO THE SURROUNDING ROADWAYS AND PARKING AREAS MUST BE REMOVED IMMEDIATELY. ADDITIONAL ENTRANCES FOR CONSTRUCTION PHASING SHALL BE INSTALLED AS REQUIRED TO PREVENT TRACKING OR FLOWING OF SEDIMENT ONTO ROADWAYS.
9. THE CONTRACTOR SHALL INSTALL ALL PERIMETER SEDIMENT CONTROL BARRIERS (I.E. SILT FENCE) AS SHOWN ON THE PLANS. A SILT FENCE SHALL ALSO BE INSTALLED AROUND ANY SOIL STOCKPILE AREAS.
10. TEMPORARY VEGETATION COVER SHALL BE ESTABLISHED IMMEDIATELY IN ANY DISTURBED AREAS THAT HAVE NOT YET REACHED FINISHED GRADE AND CONSTRUCTION IS NOT EXPECTED TO RESUME FOR MORE THAN 14 DAYS. TEMPORARY VEGETATIVE COVER SHALL CONSIST OF SHORT-TERM EROSION CONTROL SEED (SUBSECTION M6.03.1 OF THE MASSDOT STANDARD SPECIFICATIONS) FROM APRIL 1 TO JUNE 1 AND AUGUST 15 TO OCTOBER 15. MAY ALSO BE INSTALLED BETWEEN OCTOBER 15 TO MARCH 31 IF COVERED WITH TEMPORARY MULCHING. SEED AT A RATE OF 75 LBS/ACRE BY HAND.
11. PERMANENT VEGETATIVE COVER SHALL BE ESTABLISHED TO ALL DISTURBED AREAS THAT HAVE REACHED FINISHED GRADE AS SOON AS POSSIBLE, BUT NOT MORE THAN 14 DAYS AFTER THE CONSTRUCTION ACTIVITY IN THAT AREA HAS PERMANENTLY CEASED. RECOMMENDED PERMANENT SEEDING DATES ARE APRIL 1 TO JUNE 1 AND AUGUST 15 TO OCTOBER 15. REFER TO RESTORATION PLANS FOR PERMANENT VEGETATIVE COVER SEED MIXTURES AND APPLICATION RATES. ALL PLANTINGS AND SEED SHALL BE COVERED BY A ONE-YEAR WARRANTY PERIOD; RESEEDING/RE-PLANTING SHALL BE COMPLETED TO ENSURE STABLE VEGETATIVE COVER IS ESTABLISHED OVER ALL DISTURBED AREAS.
12. IF PERMANENT SEEDING CANNOT BE COMPLETED WITHIN 14 DAYS OF THE COMPLETION OF CONSTRUCTION OR WITHIN THE RECOMMENDED SEEDING DATES, TE



No.	DATE	DESCRIPTION	DESIGNER	REVIEWER

SCALE:
HORZ.: 1" = 300'
VERT.:
DATUM:
HORZ.: NAD83
VERT.: NAVD88
0 150 300
GRAPHIC SCALE

FUSS & O'NEILL
1550 MAIN STREET, SUITE 400
SPRINGFIELD, MA 01103
413.452.0445
www.fando.com

CITY OF HAVERHILL

INDEX PLAN

LITTLE RIVER DAM REMOVAL AND RESTORATION

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

GI-003

File: J:\DWG\P20170390\U30\Civil\Plan\20170390U30_IND01.dwg Layout: 11X17-GI-003 Plotted: 2022-12-08 3:13 PM Saved: 2022-12-08 1:46 PM User: CNauman
MS VIEW: LAYER STATE:
PC3: AUTOCAD PDF (GENERAL DOCUMENTATION).PC3 STB/CTB: FO HALF.STB

MATCH LINE SEE SHEET CS-102

STEVENS STREET

WINTER STREET

MBTA RAILROAD

LITTLE RIVER

LITTLE RIVER DAM
SPILLWAY CREST EL.=18.6±

FORMER/ABANDONED
12' WIDE MILL
RACEWAY CHANNEL

16'Wx8'H STONE
MASONRY ARCH CULVERT

30'Wx14'H STONE
MASONRY ARCH CULVERT

54" RCP OUTFALL
(NPDES 021H)

42" RCP OUTFALL (NPDES 038)
INV. 11.39

PROPERTY CONTAINS
UST ID No. 5252

BENCHMARK 302

BENCHMARK 301

SCOUR HOLE

21" OVERFLOW
(LR0934)

BIT. SIDEWALK AND
GRANITE CURB

AUL PROPERTY WITH
CLASS B2 RAO

200' RIVERFRONT AREA

100' BUFFER ZONE

50' NO BUILD ZONE

25' NO DISTURBANCE ZONE

LAFAYETTE SQUARE

ESSEX STREET

LEGEND:

FLOODWAY	FEMA FLOODWAY
100YR	100-YEAR FLOOD ELEVATION
500YR	500-YEAR FLOOD ELEVATION
▲A100	WETLAND DELINEATION FLAG
	BANK/MEAN ANNUAL HIGH WATER
	BORDERING VEGETATED WETLANDS
	25' NO DISTURBANCE ZONE
	50' NO BUILD ZONE
	100' BUFFER ZONE
	200' RIVERFRONT AREA
	BASE CONDITION FLOW LIMITS / MEAN ANNUAL LOW WATER
	PARCEL BOUNDARY
D	DRAIN/CSO LINE
W	WATER LINE
G	GAS LINE
E/T	ELECTRIC/TELEPHONE LINE
	CATCH BASIN
2	EXISTING GROUND OR BOTTOM OF RIVER CHANNEL CONTOUR
WG/GG	WATER GATE / GAS GATE
	TREE LINE

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER

SCALE:
HORZ.: 1" = 70'
VERT.:
DATUM:
HORZ.: NAD83
VERT.: NAVD88
0 35 70
GRAPHIC SCALE

FUSS&O'NEILL
1550 MAIN STREET, SUITE 400
SPRINGFIELD, MA 01103
413.452.0445
www.fando.com

CITY OF HAVERHILL

EXISTING CONDITIONS PLAN NO. 1

LITTLE RIVER DAM REMOVAL AND RESTORATION

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

CS-101

File: J:\DWG\P2017\0390\U30\CivilPlan\20170390U30_EXC01.dwg Layout: 11X17-CS-101 Plotted: 2022-12-08 3:14 PM Saved: 2022-11-29 3:18 PM User: CNauman
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LAYER STATE:
MS VIEW:

MATCH LINE SEE SHEET CS-103

MATCH LINE SEE SHEET CS-101

MBTA RAILROAD

50' NO BUILD ZONE

25' NO DISTURBANCE ZONE

100' BUFFER ZONE

200' RIVERFRONT AREA

LITTLE RIVER

LITTLE RIVER STREET

APPLE STREET

STEVENS STREET

BENJAMIN STREET

CLIFF STREET

FLOODWAY

100YR

500YR

LEGEND:

FLOODWAY	FEMA FLOODWAY
100YR	100-YEAR FLOOD ELEVATION
500YR	500-YEAR FLOOD ELEVATION
▲A100	WETLAND DELINEATION FLAG
	BANK/MEAN ANNUAL HIGH WATER
	BORDERING VEGETATED WETLANDS
	25' NO DISTURBANCE ZONE
	50' NO BUILD ZONE
	100' BUFFER ZONE
	200' RIVERFRONT AREA
	BASE CONDITION FLOW LIMITS / MEAN ANNUAL LOW WATER
	PARCEL BOUNDARY
D	DRAIN/CSO LINE
W	WATER LINE
G	GAS LINE
E/T	ELECTRIC/TELEPHONE LINE
	CATCH BASIN
2	EXISTING GROUND OR BOTTOM OF RIVER CHANNEL CONTOUR
WG / GG	WATER GATE / GAS GATE
	TREE LINE

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CITY OF HAVERHILL

EXISTING CONDITIONS PLAN NO. 2

LITTLE RIVER DAM REMOVAL AND RESTORATION

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

CS-102

File: J:\DWG\P20\170390\U30\CivilPlan\20170390U30_EXC01.dwg Layout: 11X17-CS-102 Plotted: 2022-12-08 3:14 PM Saved: 2022-11-29 3:18 PM User: CNauman
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MS VIEW: LAYER STATE:

MATCH LINE SEE SHEET CS-104

MATCH LINE SEE SHEET CS-102

LITTLE RIVER

MBTA RAILROAD

MBTA RAILROAD

100' BUFFER ZONE

50' NO BUILD ZONE

25' NO DISTURBANCE ZONE

200' RIVERFRONT AREA

SKATE PARK

100' BUFFER ZONE

CASHMAN'S FIELD

CASHMAN'S FIELD

LEBLANC STREET

25' NO DISTURBANCE ZONE

50' NO BUILD ZONE

BUILDING NOT PRESENT DURING WETLAND DELINEATION ON 9/27/21

LEGEND:

FLOODWAY	FEMA FLOODWAY
100YR	100-YEAR FLOOD ELEVATION
500YR	500-YEAR FLOOD ELEVATION
▲A100	WETLAND DELINEATION FLAG
	BANK/MEAN ANNUAL HIGH WATER
	BORDERING VEGETATED WETLANDS
	25' NO DISTURBANCE ZONE
	50' NO BUILD ZONE
	100' BUFFER ZONE
	200' RIVERFRONT AREA
	BASE CONDITION FLOW LIMITS / MEAN ANNUAL LOW WATER
	PARCEL BOUNDARY
D	DRAIN/CSO LINE
W	WATER LINE
G	GAS LINE
E/T	ELECTRIC/TELEPHONE LINE
	CATCH BASIN
2	EXISTING GROUND OR BOTTOM OF RIVER CHANNEL CONTOUR
WG	WATER GATE / GAS GATE
	TREE LINE

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CITY OF HAVERHILL

EXISTING CONDITIONS PLAN NO. 3

LITTLE RIVER DAM REMOVAL AND RESTORATION

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

CS-103

File: J:\DWG\P2017\0390\U30\Civil\Plan\20170390U30_EXC01.dwg Layout: 11X17-CS-103 Plotted: 2022-12-08 3:14 PM Saved: 2022-11-29 3:18 PM User: CNauman
PC3: AUTOCAD PDF (GENERAL DOCUMENTATION).PC3 STB/CTB: FO HALF STB
LAYER STATE:
MS VIEW:

RAILROAD BRIDGE SUPPORTED ON 12" TIMBER PIERS FORMING THREE BAYS
LEFT BAY WIDTH – 11.0' WIDE
CENTER BAY WIDTH – 12.0' WIDE
RIGHT BAY WIDTH – 10.9' WIDE
BOTTOM BEAM EL.=22.7±

POTENTIAL ELECTRIC CABLE IN RIVER (REPORTED BY LITTLE RIVER NEIGHBORHOOD RESIDENTS)

MBTA RAILROAD

50' NO BUILD ZONE
25' NO DISTURBANCE ZONE
100' BUFFER ZONE
200' RIVERFRONT AREA

WHITTIER PLACE

MATCH LINE SEE SHEET CS-103

LEGEND:

- FLOODWAY — FEMA FLOODWAY
- 100YR — 100-YEAR FLOOD ELEVATION
- 500YR — 500-YEAR FLOOD ELEVATION
- ▲A100 — WETLAND DELINEATION FLAG
- BANK/MEAN ANNUAL HIGH WATER
- BORDERING VEGETATED WETLANDS
- 25' NO DISTURBANCE ZONE
- 50' NO BUILD ZONE
- 100' BUFFER ZONE
- 200' RIVERFRONT AREA
- BASE CONDITION FLOW LIMITS / MEAN ANNUAL LOW WATER
- PARCEL BOUNDARY
- D — DRAIN/CSO LINE
- W — WATER LINE
- G — GAS LINE
- E/T — ELECTRIC/TELEPHONE LINE
- CATCH BASIN
- 2 — EXISTING GROUND OR BOTTOM OF RIVER CHANNEL CONTOUR
- WG / GG — WATER GATE / GAS GATE
- TREE LINE

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CITY OF HAVERHILL

EXISTING CONDITIONS PLAN NO. 4

LITTLE RIVER DAM REMOVAL AND RESTORATION

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

CS-104

File: J:\DWG\P2017\0390\U30\Civil\Plan\20170390U30_EXC01.dwg Layout: 11X17-CS-104 Plotted: 2022-12-08 3:14 PM Saved: 2022-11-29 3:18 PM User: CNauman
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LAYER STATE:
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MATCH LINE SEE SHEET CP-102

LIMIT OF DISTURBANCE (TYP.)

TEMPORARY COFFERDAM (TYP.)

CLEARING LIMIT (TYP.)

UPPER RIVERBANK STABILIZATION AND FLOODPLAIN RESTORATION AREA (TYP.)

12" DIA. BIODEGRADABLE FIBER ROLL/VEGETATED COIR FASCINE (TYP.)

LOWER RIVER SLOPE STABILIZATION (TYP.)

TEMPORARY HAUL ROAD (TYP.)

TEMPORARY RIVER CROSSING (TYP.)

STEVENS STREET

MBTA RAILROAD

WINTER STREET

GRANVILLE STREET

LAFAYETTE SQUARE

ESSEX STREET

REMOVE AND DISPOSE OF DAM

FORMER/ABANDONED 12' WIDE MILL RACEWAY CHANNEL

16'Wx8'H STONE MASONRY ARCH CULVERT

54" RCP OUTFALL (NPDES 021H)

42" RCP OUTFALL (NPDES 038) INV. 11.39

PROPERTY CONTAINS UST ID No. 5252

BENCHMARK 302

BENCHMARK 301

SCOUR HOLE

FLOATING TYPE 3 PERMEABLE TURBIDITY BARRIER

RESTORE SIDEWALK AND GRANITE CURB TO PREVIOUS CONDITION OR BETTER. RE-USE GRANITE CURB IF POSSIBLE.

CONSTRUCTION EQUIPMENT AND STAGING AREA

AUL PROPERTY WITH CLASS B2 RAO

SILT FENCE FOR TEMPORARY STONE CONSTRUCTION ACCESS ROUTE AND STAGING AREA. RESTORE EXISTING FENCE TO PREVIOUS CONDITION OF BETTER.

PROPERTY CONTAINED USTs ID No. 5235 (REMOVED AS OF 7/30/20); FORMER AUL

NOTES:

1. IMPLEMENT AND MAINTAIN CONSTRUCTION ACCESS STABILIZATION MEASURES THROUGHOUT CONSTRUCTION. REMOVE ALL SUCH MEASURES AND STABLIZE/RESTORE ALL DISTURBED AREAS FOLLOWING CONSTRUCTION.
2. SUCH MEASURES SHALL BE COMPLETED BY THE CONTRACTOR AND ACCEPTED BY THE ENGINEER PRIOR TO INITIATION OF CONSTRUCTION ACTIVITIES.
3. REFER TO RIVER RESTORATION PLAN AND LANDSCAPE AND PLANTING PLAN FOR POST-CONSTRUCTION RESTORATION MEASURES (SEEDING AND PLANTING).
4. REFER TO WATER CONTROL AND CONSTRUCTION SEQUENCING PLAN FOR INSTALLATION OF HAUL ROADS, TEMPORARY COFFERDAMS AND FLOATING TURBIDITY CURTAIN(S).

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER

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HORZ.: 1" = 70'
VERT.:
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0 35 70
GRAPHIC SCALE

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www.fando.com

CITY OF HAVERHILL

SITE PREPARATION AND EROSION CONTROL PLAN NO. 1

LITTLE RIVER DAM REMOVAL AND RESTORATION

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

CP-101

File: J:\DWG\P2017\0390\U30\Civil\Plan\20170390U30_ERO01.dwg Layout: 11X17-CP-101 Plotted: 2022-12-08 3:15 PM Saved: 2022-12-07 1:56 PM User: CNauman
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LAYER STATE:
MS VIEW:

MATCH LINE SEE SHEET CP-103

MATCH LINE SEE SHEET CP-101

MBTA RAILROAD

AREA OF CONTAMINATED SEDIMENT TO BE REMOVED

TEMPORARY HAUL ROAD (TYP.)

TEMPORARY HAUL ROAD BUMP OUTS (TYP.)

TEMPORARY RIVER CROSSING (TYP.)

UPPER RIVERBANK STABILIZATION AND FLOODPLAIN RESTORATION AREA (TYP.)

12" DIA. BIODEGRADABLE FIBER ROLL/VEGETATED COIR FASCINE (TYP.)

LOWER RIVER SLOPE STABILIZATION (TYP.)

TEMPORARY COFFERDAM (TYP.)

CLEARING LIMIT (TYP.)

LIMIT OF DISTURBANCE (TYP.)

STONE PROTECTION AT EXISTING OUTFALL

LOD

LITTLE RIVER STREET

APPLE STREET

STEVENS STREET

BENJAMIN STREET

CLIFF STREET

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER

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CITY OF HAVERHILL

SITE PREPARATION AND EROSION CONTROL PLAN NO. 2

LITTLE RIVER DAM REMOVAL AND RESTORATION

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

CP-102

File: J:\DWG\P20170390\U30\CivilPlan\20170390U30_ERO01.dwg Layout: 11X17-CP-102 Plotted: 2022-12-08 3:15 PM Saved: 2022-12-07 1:56 PM User: CNauman
MS VIEW: LAYER STATE: PC3: AUTOCAD PDF (GENERAL DOCUMENTATION).PC3 STB/CTB: FO HALF.STB

TEMPORARY COFFERDAM (TYP.)

TEMPORARY HAUL ROAD (TYP.)

MBTA RAILROAD

TEMPORARY HAUL ROAD BUMP OUTS (TYP.)

TEMPORARY RIVER CROSSING (TYP.)

UPPER RIVERBANK STABILIZATION AND FLOODPLAIN RESTORATION AREA (TYP.)

12" DIA. BIODEGRADABLE FIBER ROLL/VEGETATED COIR FASCINE (TYP.)

LOWER RIVER SLOPE STABILIZATION (TYP.)

MBTA RAILROAD

CLEARING LIMIT (TYP.)

LIMIT OF DISTURBANCE (TYP.)

MATCH LINE SEE SHEET CP-104

MATCH LINE SEE SHEET CP-102

SKATE PARK

LEBLANC STREET

CASHMAN'S FIELD

HILLDALE AVENUE

TEMPORARY 5' WIDE COMPACTED GRAVEL PEDESTRIAN WALKWAY (FOR SKATE PARK ACCESS)

REMOVE SECTION OF WOOD GUARDRAIL AND CONNECT TEMPORARY GRAVEL PEDESTRIAN WALKWAY TO EXIST. BITUMINOUS SIDEWALK; FOLLOWING CONSTRUCTION, REMOVE WALKWAY AND RESTORE DISTURBED LAWN AREAS

INSET 2

TEMPORARY 5' WIDE COMPACTED GRAVEL PEDESTRIAN WALKWAY (FOR SKATE PARK ACCESS)

MATCH LINE SEE INSET 2

SILT FENCE AND 6' HIGH TEMPORARY CHAINLINK CONSTRUCTION FENCE TO ENCOMPASS TEMPORARY STONE CONSTRUCTION ACCESS ROUTE AND STAGING AREA (TYP.)

RESTORE CHAIN LINK FENCE TO PREVIOUS CONDITION OR BETTER

CONSTRUCTION EQUIPMENT, STAGING, AND SOIL STORAGE AREAS (TYP.)

PLACE SILT FENCE AND CONSTRUCTION FENCE AROUND KAYAK/CANOE LAUNCH PATH ONLY DURING THAT PHASE OF WORK TO PRESERVE PEDESTRIAN ACCESS TO PLAYGROUNG

MATCH LINE SEE INSET 1

SILT FENCE AND 6' HIGH TEMPORARY CHAINLINK CONSTRUCTION FENCING TO SURROUND TEMPORARY STONE CONSTRUCTION ACCESS ROUTE (TYP.)

TEMPORARY 5' WIDE COMPACTED GRAVEL PEDESTRIAN WALKWAY (FOR PLAYGROUND ACCESS)

GATED ENTRANCE TO CONSTRUCTION ACCESS ROUTE; SECURE/LOCK GATES AT END OF WORK DAY

FOLLOWING CONSTRUCTION; RESTORE SIDEWALK, CURBING, GATE, WOODEN GUARDRAIL, GRAVEL WALKWAY AND DRIVEWAY TO PREVIOUS CONDITION OR BETTER

TEMPORARY STONE CONSTRUCTION ACCESS

INSET 1

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER

SCALE:
HORZ.: 1" = 70'
VERT.:
DATUM:
HORZ.: NAD83
VERT.: NAVD88
0 35 70
GRAPHIC SCALE

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www.fando.com

CITY OF HAVERHILL

SITE PREPARATION AND EROSION CONTROL PLAN NO. 3

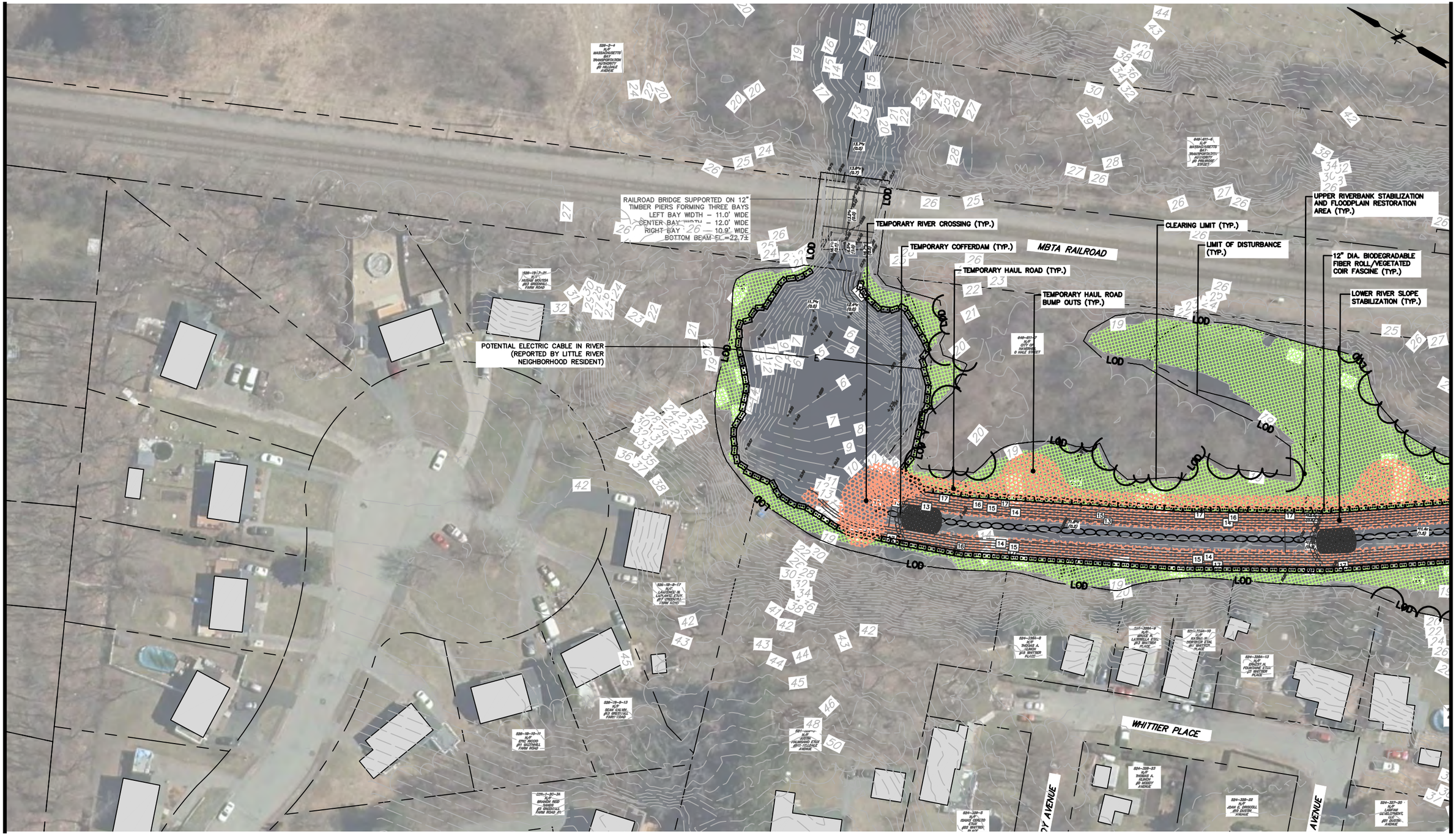
LITTLE RIVER DAM REMOVAL AND RESTORATION

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

CP-103

File: J:\DWG\P2017\0390\U30\Civil\Plan\20170390U30_ERO01.dwg Layout: 11X17-CP-103 Plotted: 2022-12-08 3:16 PM Saved: 2022-12-07 1:56 PM User: CNauman
PC3: AUTOCAD PDF (GENERAL DOCUMENTATION).PC3 STB/CTB: FO HALF.STB
LAYER STATE:
MS VIEW:



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CITY OF HAVERHILL

SITE PREPARATION AND EROSION CONTROL PLAN NO. 4

LITTLE RIVER DAM REMOVAL AND RESTORATION

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

CP-104

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MATCH LINE SEE SHEET CG-102

COMPACTED GRAVEL WALKING TRAIL EL. 23.0±

UPPER RIVERBANK STABILIZATION AND FLOODPLAIN RESTORATION AREA (TYP.)

PROPOSED 100 YEAR WATER SURFACE ELEVATION (TYP.)

12" DIA. BIODEGRADABLE FIBER ROLL/VEGETATED COIR FASCINE (TYP.)

APPROXIMATE LOCATION OF PORTAGE ACCESS FOR KAYAK/CANOE

LOWER RIVER SLOPE STABILIZATION (TYP.) CHOICE OF NATURAL OR STONE TO BE DETERMINED IN THE FIELD BY THE ENGINEER, SEE CONSTRUCTION DETAILS SHEET CD-502

SIGNAGE TO PROTECT PUBLIC FROM PADDLING FURTHER DOWNSTREAM

POOL BOTTOMS AND BANKS FORMED WITH NATIVE STABLE STONE/COBBLES INFILLED WITH NATIVE SEDIMENT AND INTERSPERSED SMALL/MEDIUM BOULDERS (TYP.)

SLOPE PROTECTION RETAINING WALL (SEE STRUCTURAL PLANS AND DETAILS) TOP EL. VARIES BETWEEN EL. 18.5 TO EL 15.0 BOTTOM EL. VARIES BETWEEN EL. 14.0 TO EL 9.0

SLOPE PROTECTION RETAINING WALL (SEE STRUCTURAL PLANS AND DETAILS) TOP EL. VARIES BETWEEN EL. 25.0 TO EL 22.0 BOTTOM EL. VARIES BETWEEN EL. 17.0 TO EL. 11.5

PROPERTY CONTAINS UST ID No. 5252

PROPERTY CONTAINED USTs ID No. 5235 (REMOVED AS OF 7/30/20); FORMER AUL

54" RCP OUTFALL (NPDES 021H)

42" RCP OUTFALL (NPDES 038) INV. 11.39

BENCHMARK 302

BENCHMARK 301

MASONRY ARCH CULVERT

RACEWAY CHANNEL

BIT. SIDEWALK AND GRANITE CURB

STEVENS STREET

WINTER STREET

GRANVILLE STREET

LAFAYETTE SQUARE

ESSEX STREET

MBTA RAILROAD

LOD

100YR

E/T

G

SCALE:
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0 35 70
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No.	DATE	DESCRIPTION	DESIGNER	REVIEWER

CITY OF HAVERHILL

SITE LAYOUT AND GRADING PLAN NO. 1

LITTLE RIVER DAM REMOVAL AND RESTORATION

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

CG-101

File: J:\DWG\P2017\0390\U30\Civil\Plan\20170390U30_STP01.dwg Layout: 11X17-CG-101 Plotted: 2022-12-08 3:17 PM Saved: 2022-12-08 3:11 PM User: CNauman
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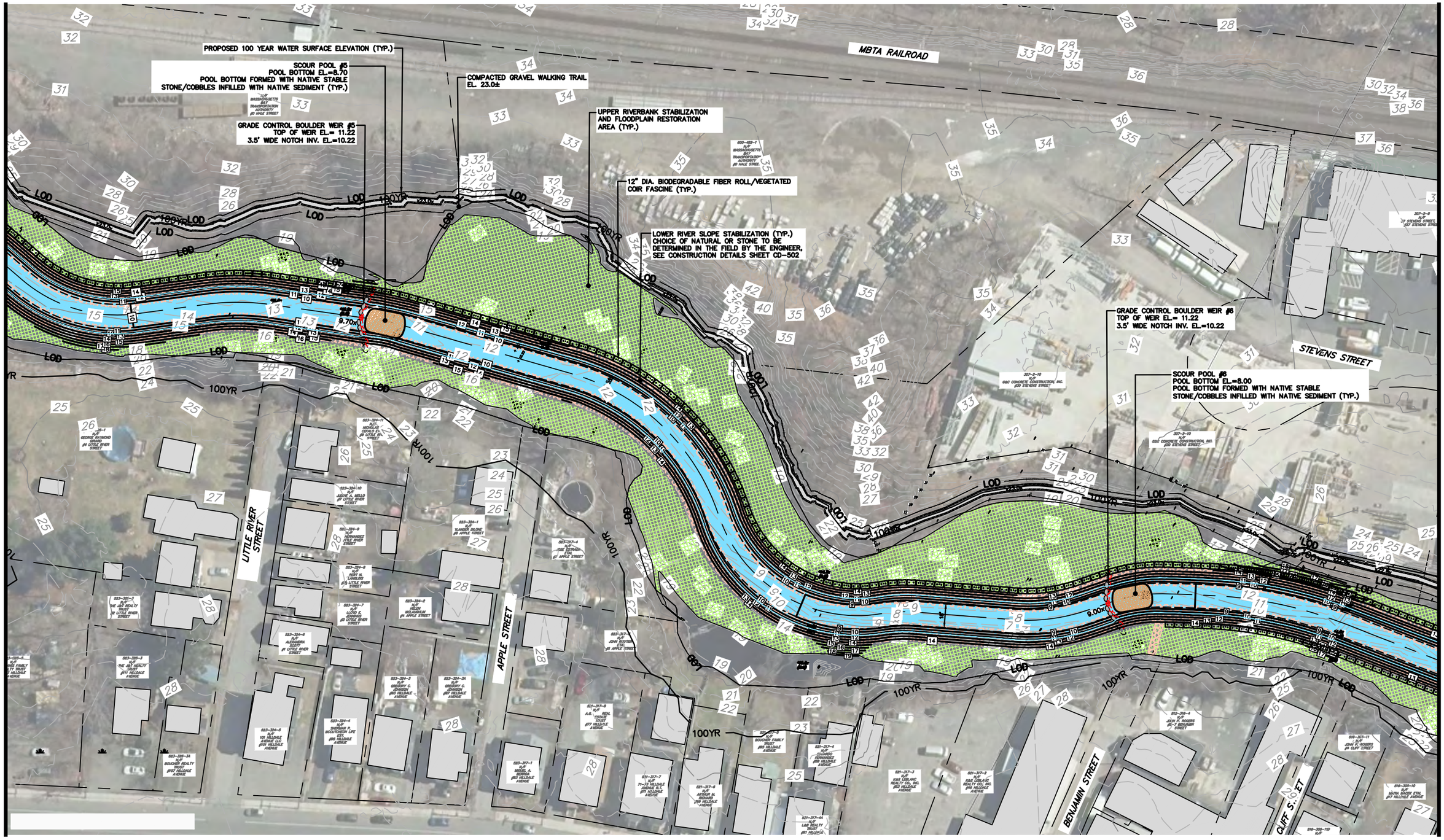

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MS VIEW:

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CITY OF HAVERHILL

SITE LAYOUT AND GRADING PLAN NO. 2

LITTLE RIVER DAM REMOVAL AND RESTORATION

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

CG-102

AFTER INCREMENTAL DAM REMOVAL AND THE LOWERING OF THE IMPOUNDMENT, THE CONTRACTOR SHALL PERFORM CONFIRMATORY EXPLORATION BELOW THE MBTA BRIDGE TO DETERMINE THE EXISTING SIZE OF SCOUR-RESISTANT MATERIALS BENEATH THE BRIDGE AND EXTENT OF UNDERMINING OF THE BRIDGE'S SOUTHWEST WINGWALL; INSTALL SCOUR COUNTERMEASURES AS DIRECTED BY ENGINEER BASED ON RESULTS OF INVESTIGATION IF IT IS DETERMINED THAT EXISTING CHANNEL BOTTOM MATERIAL DOES NOT RANGE IN SIZE BETWEEN 14 TO 34 INCHES (WITH A D50 OF 18 INCHES)

RAILROAD BRIDGE SUPPORTED ON 12" TIMBER PIERS FORMING THREE BAYS
LEFT BAY WIDTH – 11.0' WIDE
CENTER BAY WIDTH – 12.0' WIDE
RIGHT BAY – 10.9' WIDE
BOTTOM BEAM EL=22.7±

POTENTIAL ELECTRIC CABLE IN RIVER (REPORTED BY LITTLE RIVER NEIGHBORHOOD RESIDENT)

PROPOSED 100 YEAR WATER SURFACE ELEVATION (TYP.)

UPPER RIVERBANK STABILIZATION AND FLOODPLAIN RESTORATION AREA (TYP.)

MBTA RAILROAD

12" DIA. BIODEGRADABLE FIBER ROLL/VEGETATED COIR FASCINE (TYP.)

LOWER RIVER SLOPE STABILIZATION (TYP.) CHOICE OF NATURAL OR STONE TO BE DETERMINED IN THE FIELD BY THE ENGINEER, SEE CONSTRUCTION DETAILS SHEET CD-502

GRADE CONTROL BOULDER WEIR #1
TOP OF WEIR EL.= 15.00
3.5' WIDE NOTCH INV. EL.=14.00

SCOUR POOL #1
POOL BOTTOM EL.=11.75
POOL BOTTOM FORMED WITH NATIVE STABLE STONE/COBBLES INFILLED WITH NATIVE SEDIMENT (TYP.)

SCOUR POOL #2
POOL BOTTOM EL.=11.2
POOL BOTTOM FORMED
STONE/COBBLES INFILL

GRADE CONTROL BOULDER WEIR #2
TOP OF WEIR EL.= 14.25
3.5' WIDE NOTCH INV. EL.=13.25

WHITTIER PLACE

MATCH LINE SEE SHEET CG-103

100YR
LOD

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CITY OF HAVERHILL

SITE LAYOUT AND GRADING PLAN NO. 4

LITTLE RIVER DAM REMOVAL AND RESTORATION

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

CG-104

MATCH LINE SEE SHEET CG-104

MATCH LINE SEE SHEET CG-102

PROPOSED 100 YEAR WATER SURFACE ELEVATION (TYP.)

PEDESTRIAN BRIDGE
TOP OF BRIDGE EL.=26.5±
BOTTOM OF BRIDGE EL.=25.0±(MIN.)

FISHING AREA AND ACCESS WITH STEPS/TERRACES TO PROVIDE ACCESS TO RIVER AT VARYING WATER LEVELS (SEE LANDSCAPE PLAN FOR DETAILS); TOP OF PLATFORM EL.= 19.00

GRADE CONTROL BOULDER WEIR #4
TOP OF WEIR EL.= 12.80
3.5' WIDE NOTCH INV. EL.=11.80

SCOUR POOL #4
POOL BOTTOM EL.=9.70
POOL BOTTOM FORMED WITH NATIVE STABLE STONE/COBBLES INFILLED WITH NATIVE SEDIMENT (TYP.)

GRADE CONTROL BOULDER WEIR #3
TOP OF WEIR EL.= 13.59
3.5' WIDE NOTCH INV. EL.=12.59

COMPACTED GRAVEL WALKING TRAIL
EL. 23.0±

MBTA RAILROAD

MBTA RAILROAD

100YR

LOD

WET

LEBLANC STREET

SKATE PARK

REINFORCED GRAVEL ACCESS/WALKWAY TO FISHING AREA ACCESS

REINFORCED GRAVEL KAYAK/CANOE LAUNCH ACCESS (MAX. SLOPE 15%) WITH

CASHMAN'S FIELD

CASHMAN'S FIELD

WITH NATIVE STABLE
D WITH NATIVE SEDIMENT (TYP.)

524-327-2
N/F
LAURENCE
ETAL
#41 HILLDALE AVENUE

524-327-6
N/F
LLOYD W
BROWN
2007 HILLDALE AVENUE

524-327-1
N/F
LAURENCE L
#43 LEBLANC STREET

524-327-3
N/F
JAMES A
CHRISTOFERSON
#42 LEBLANC STREET

524-326-A
N/F
JUNE M. CHALIS
#1 LEBLANC STREET

523-339-1
N/F
CITY OF
HAVERHILL
#175 HILLDALE AVENUE

523-339-11
N/F
JANICE E.
MACKINNON
#49 HILLDALE AVENUE

523-339-10
N/F
CLAIRE
SERRO
#49 HILLDALE AVENUE

523-339-9
N/F
JOHN
ETAL
RISSET
#49 HILLDALE AVENUE

523-339-8
N/F
135 HILLDALE
AVENUE REALTY
TRUST
#135 HILLDALE AVENUE

523-339-7A
N/F
CAROLE A
HOLLAND
#131 HILLDALE AVENUE

523-339-6
N/F
BOSTON GAS CO.
#129 HILLDALE AVENUE

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No.	DATE	DESCRIPTION	DESIGNER	REVIEWER

SCALE:
HORZ.: 1" = 70'
VERT.:
DATUM:
HORZ.: NAD83
VERT.: NAVD88
0 35 70
GRAPHIC SCALE

CITY OF HAVERHILL

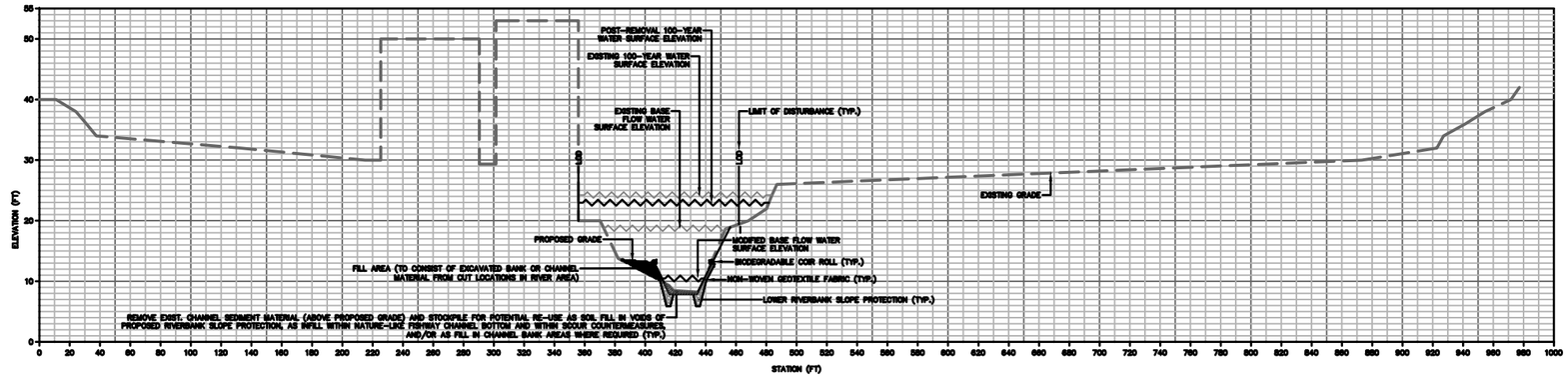
SITE LAYOUT AND GRADING PLAN NO. 3

LITTLE RIVER DAM REMOVAL AND RESTORATION

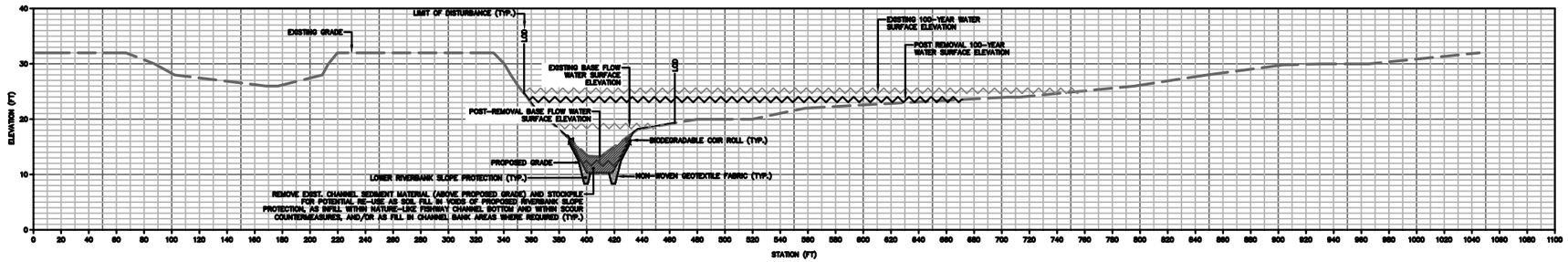
HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

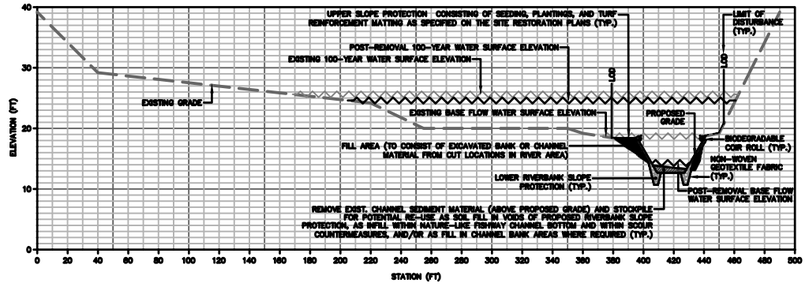
CG-103



SECTION A



SECTION B



SECTION C

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER

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DATUM:
HORZ.: NAD83
VERT.: NAVD88
0 35 70
GRAPHIC SCALE

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413.452.0445
www.fando.com

CITY OF HAVERHILL

TYPICAL CHANNEL CROSS SECTIONS

LITTLE RIVER DAM REMOVAL AND RESTORATION

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

CX-301

File: J:\DWG\P2017\0390\U30\Civil\Plan\20170390U30_XCS01.dwg Layout: 11X17-CX-301 Plotted: 2022-12-08 3:18 PM Saved: 2022-11-29 5:07 PM User: CNauman
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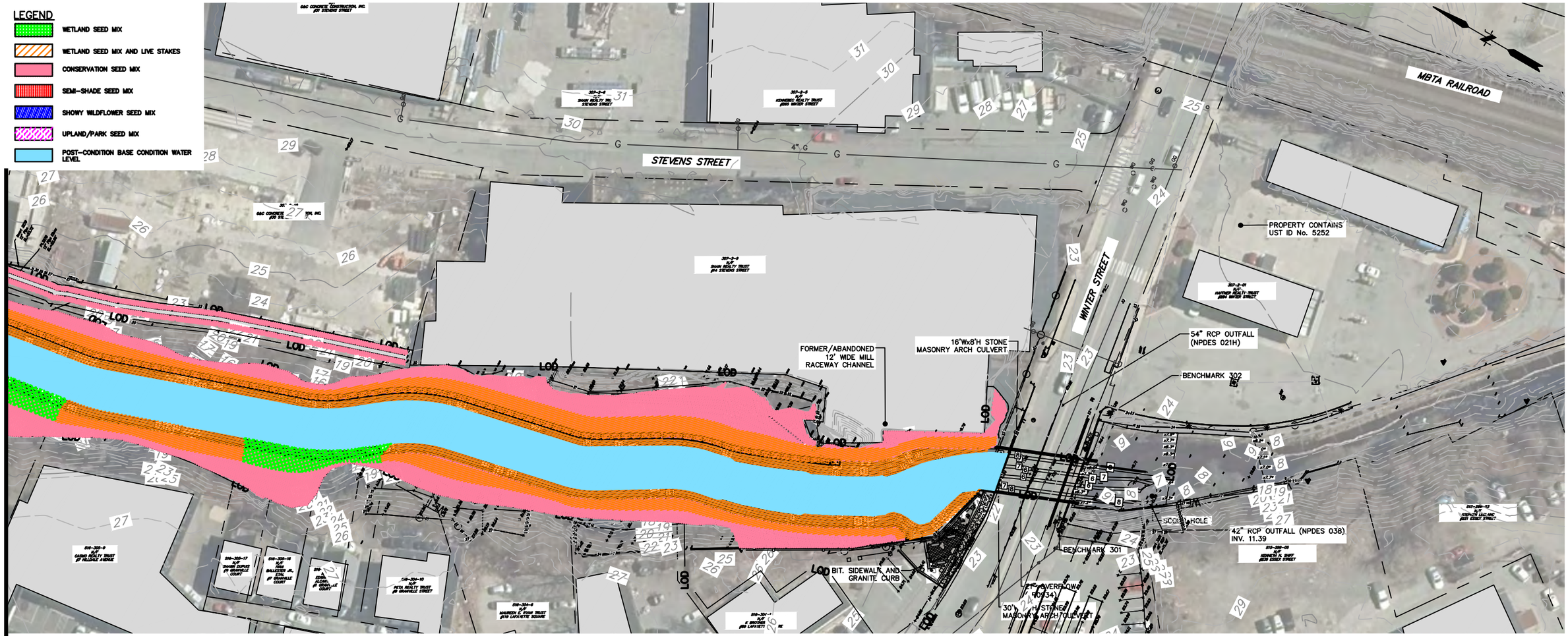

NEW ENGLAND WETMIX (WETLAND SEED MIX)

BOTANICAL NAME	COMMON NAME	IND.
CAREX VULPINOIDEA	FOX SEDGE	OBL
CAREX LURIDA	LURID SEDGE	OBL
CAREX SCOPARIA	BLUNT BROOM SEDGE	FACW
SCIRPUS ATROVIRENS	GREEN BULRUSH	OBL
POA PALUSTRIS	FOWL BLUEGRASS	FACW
CAREX LUPULINA	HOP SEDGE	OBL
BIDENS FRONDOSA	BEGGAR TICKS	FACW
VERNONIA NOVEBORACENSIS	NEW YORK IRONWEED	FACW
CAREX CRINITA	FRINGED SEDGE	OBL
JUNCUS EFFUSUS	SOFT RUSH	FACW
GLYCERIA GRANDIS	AMERICAN MANNAGRASS	OBL
EUPATORIUM MACULATUM	SPOTTED JOE PYE WEED	FACW
ASTER LATERIFLORUS	STARRED/CALICO ASTER	FACW
ASCLEPIAS INCARNATA	SWAMP MILKWEED	OBL
MIMULUS RINGENS	SQUARE STEMMED MONKEY FLOWER	OBL
IRIS VERSICOLOR	BLUE FLAG	OBL

WETLAND SEED MIX
MIXTURE: WETLAND SEED MIX
ANNUAL RYEGRASS (TEMPORARY COVER)
APPLICATION RATE: ANNUAL RYEGRASS = 25 LBS/ACRE
WETLAND SEED MIX = 18 LBS/ACRE

NEW ENGLAND CONSERVATION/WILDLIFE MIX (CONSERVATION SEED MIX)

BOTANICAL NAME	COMMON NAME	IND.
ELYMUS VIRGINICUS	VIRGINIA WILD RYE	FACW
SCHIZACHYRIUM SCOPARIUM	LITTLE BLUESTEM	FACU
ANDROPOGON GERARDII	BIG BLUESTEM	FAC
FESTUCA RUBRA	RED FESCUE	FACU
PANICUM VIRGATUM	SWITCH GRASS	FAC
CHAMAECRISTA FASCICULATA	PARTRIDGE PEA	FACU
DESMODIUM CANADENSE	SHOWY TICK TREFOIL	FAC
SORGHASTRUM NUTANS	INDIAN GRASS	UPL
ASCLEPIAS TUBEROSA	BUTTERFLY MILKWEED	NI
BIDENS FRONDOSA	BEGGAR TICKS	FACW
RUDBECKIA HIRTA	BLACK EYED SUSAN	FACU
EUPATORIUM PURPUREUM	PURPLE JOE PYE WEED	FAC
ASTER PILOSUS	HEATH OR HAIRY ASTER	UPL
SOLIDAGO JUNCEA	EARLY GOLDENROD	NI

CONSERVATION SEED MIX
MIXTURE: CONSERVATION MIX
ANNUAL RYEGRASS (TEMPORARY COVER)
APPLICATION RATE: ANNUAL RYEGRASS = 25 LBS/ACRE
CONSERVATION SEED MIX = 25 LBS/ACRE

NEW ENGLAND SEMI-SHADE GRASS AND FORBS MIX (SEMI-SHADE SEED MIX)

BOTANICAL NAME	COMMON NAME	IND.
ELYMUS VIRGINICUS	VIRGINIA WILD RYE	FACW
ELYMUS CANADENSIS	CANADA WILD RYE	FACU
FESTUCA RUBRA	RED FESCUE	FACU
CHAMAECRISTA FASCICULATA	PARTRIDGE PEA	FACU
LIATRIS SPICATA	SPIKED GAYFEATHER/MARSH BLAZING STAR	FAC
ONOCLEA SENSIBILIS	SENSITIVE FERN	FACW
ASTER PRENANTHOIDES	CROOKED ASTER	FAC
EUPATORIUM FISTULOSUM	HOLLOW-STEM JOE PYE WEED	FACW
EUPATORIUM PERFOLIATUM	BONESET	FACW
JUNCUS TENUIS	PATH RUSH	FAC

SEMI-SHADE SEED MIX
APPLICATION RATE: SEMI-SHADE SEED MIX = 30 LBS/ACRE

NEW ENGLAND SHOWY WILDFLOWER MIX (SHOWY WILDFLOWER SEED MIX)

BOTANICAL NAME	COMMON NAME	IND.
SCHIZACHYRIUM SCOPARIUM	LITTLE BLUESTEM	FACU
CHAMAECRISTA FASCICULATA	PARTRIDGE PEA	FACU
SORGHASTRUM NUTANS	INDIAN GRASS	UPL
FESTUCA RUBRA	RED FESCUE	FACU
ELYMUS CANADENSIS	CANADA WILD RYE	FACU
ELYMUS RIPARIUS	RIVERBANK WILD RYE	FACW
HELIOPSIS HELIANTHOIDES	OX EYE SUNFLOWER	UPL
COREOPSIS LANCEOLATA	LANCE LEAVED COREOPSIS	FACU
RUDBEKIA HIRTA	BLACK EYED SUSAN	FACU
LIATRIS SPICATA	SPIKED GAYFEATHER/MARSH BALZING STAR	FAC
ASCLEPIAS SYRIACA	COMMON MILKWEED	FACU
VERONIA NOVEBORACENSIS	NEW YORK IRONWEED	FACW
ASTER NOVAE-ANGLIAE	NEW ENGLAND ASTER	FACW
EUPATORIUM PURPUREUM	PURPLE JOE PYE WEED	FAC
ASCLEPIAS TUBEROSA	BUTTERFLY MILKWEED	NI
SOLIDAGO JUNCEA	EARLY GOLDENROD	
EUPATORIUM PERFOLIATUM	BONESET	FACW

SHOW WILDFLOWER SEED MIX
APPLICATION RATE: SHOWY WILDFLOWER SEED MIX = 23 LBS/ACRE

UPLAND/PARK SEED MIX
MIXTURE: SHALL BE IN ACCORDANCE WITH SECTION M.6.03.0-1 OF THE MASSDOT STANDARD SPECIFICATIONS FOR FLAT LAWN GRASS AREAS AND M6.03.0-2 FOR SLOPED LAWN GRASS AREAS.
APPLICATION RATE: 25 LBS/ACRE

RESTORATION NOTES:

1. CONSTRUCTION ACCESS ROUTES AND STAGING AREAS WITHIN CASHMAN'S PARK AREA THAT WERE PREVIOUSLY MAINTAINED AS LAWN AREA SHALL BE COVERED WITH TOPSOIL PRIOR TO SEEDING. ALL SEED MIXES SHALL BE FREE OF INVASIVE NON-NATIVE PLANT SPECIES.
2. AREAS TO BE STABILIZED BETWEEN SEPTEMBER THROUGH NOVEMBER SHALL BE OVERSEEDED WITH WINTER RYE (SECALE CEREALE).
3. STABILIZATION OF DISTURBED AREAS SHALL BE IMPLEMENTED WITHIN 14 DAYS AFTER GRADING OR CONSTRUCTION ACTIVITIES HAVE TEMPORARILY OR PERMANENTLY CEASED.
4. RESTORATION AREAS SHALL BE MULCHED WITH STRAW FOLLOWING SEEDING.

LIVE STAKE SPECIES

Select at least 4 of the following species in equal quantities

Black Willow (Salix nigra; OBL)
Silky Willow (Salix sericea; OBL)
Bebb's Willow (Salix bebbiana; FACW)
Pussy Willow (Salix discolor; FACW)
Speckled Alder (Alnus incana; FACW)
Silky Dogwood (Cornus amomum; FACW)
Red-osier Dogwood (Cornus sericea; NI)

Planting Density: 1 live stake every 3' on center.

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0 35 70
GRAPHIC SCALE

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CITY OF HAVERHILL

RIVER RESTORATION PLAN NO. 1

LITTLE RIVER DAM REMOVAL AND RESTORATION

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

CR-101

File: J:\DWG\P2017\0390\U30\Civil\Plan\20170390U30_RES01.dwg Layout: 11X17-CR-101 Plotted: 2022-12-08 3:19 PM Saved: 2022-12-07 4:02 PM User: CNauman
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LAYER STATE:
MS VIEW:

MATCH LINE SEE SHEET CR-103

MATCH LINE SEE SHEET CR-101

MBTA RAILROAD

LITTLE RIVER STREET

APPLE STREET

STEVENS STREET

BENJAMIN STREET

CLIFF STREET

LOD

FLOODWAY

100YR

500YR

A100

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CITY OF HAVERHILL

RIVER RESTORATION PLAN NO. 2

LITTLE RIVER DAM REMOVAL AND RESTORATION

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

CR-102

File: J:\DWG\P2017\0390\U30\Civil\Plan\20170390U30_RES01.dwg Layout: 11X17-CR-102 Plotted: 2022-12-08 3:19 PM Saved: 2022-12-07 4:02 PM User: CNauman
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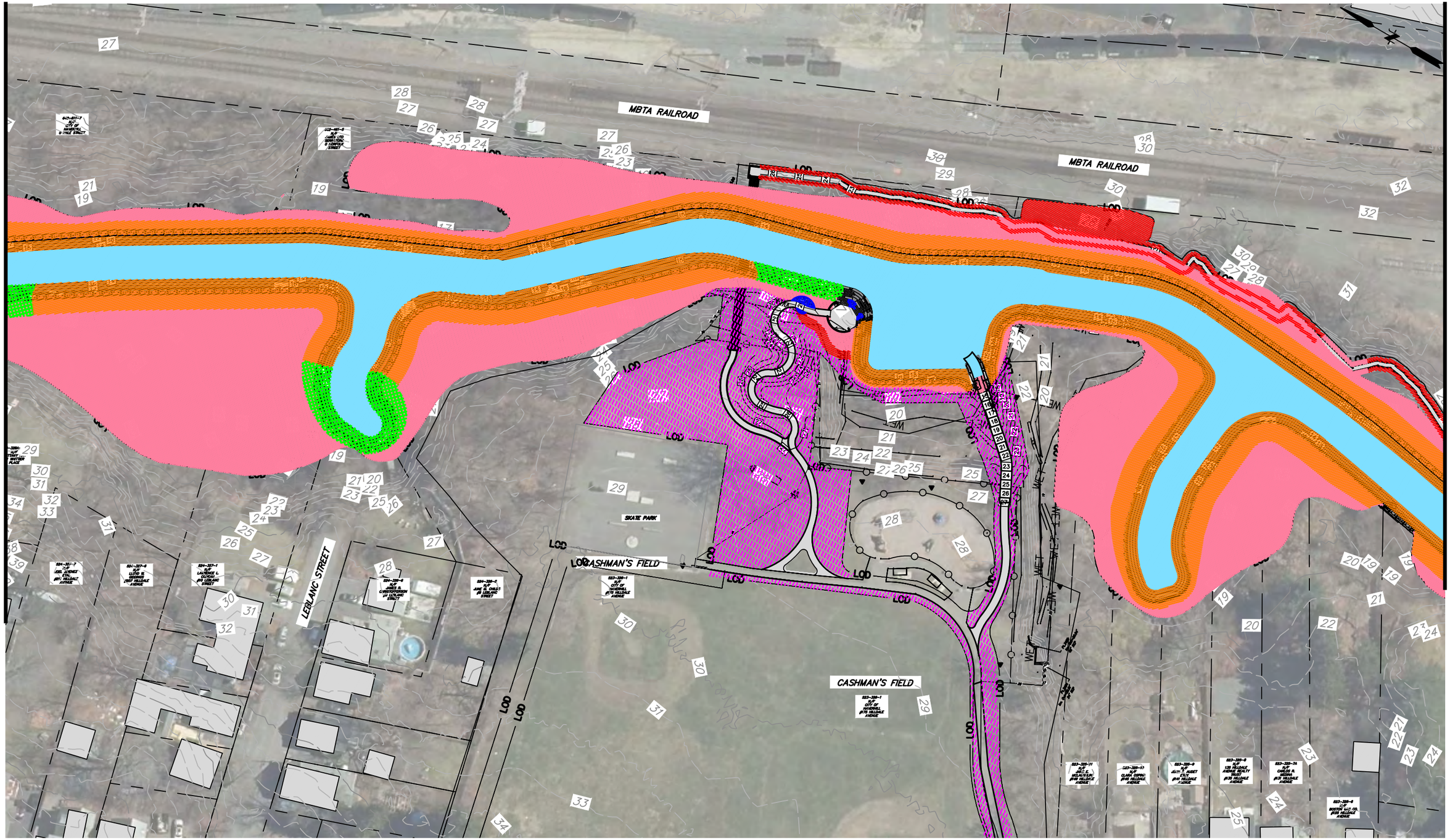

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CITY OF HAVERHILL

RIVER RESTORATION PLAN NO. 3

LITTLE RIVER DAM REMOVAL AND RESTORATION

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

CR-103

RAILROAD BRIDGE SUPPORTED ON 12" TIMBER PIERS FORMING THREE BAYS
LEFT BAY WIDTH – 11.0' WIDE
CENTER BAY WIDTH – 12.0' WIDE
RIGHT BAY WIDTH – 10.9' WIDE
BOTTOM BEAM EL.=22.7±

POTENTIAL ELECTRIC CABLE IN RIVER (REPORTED BY LITTLE RIVER NEIGHBORHOOD RESIDENT)

MBTA RAILROAD

WHITTIER PLACE

MATCH LINE SEE SHEET CR-103

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DATUM:
HORZ.: NAD83
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0 35 70
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CITY OF HAVERHILL

RIVER RESTORATION PLAN NO. 4

LITTLE RIVER DAM REMOVAL AND RESTORATION

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

CR-104

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MS VIEW:

GENERAL WATER CONTROL SYSTEM NOTES:

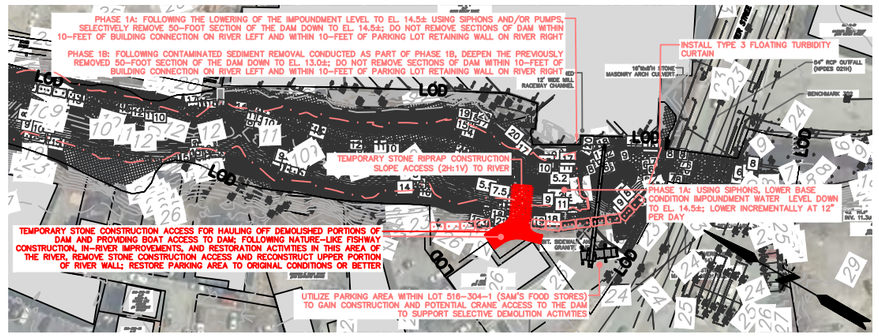
1. PRIOR TO ANY LAND DISTURBANCE ACTIVITIES, THE CONTRACTOR MUST PHYSICALLY MARK THE LIMITS OF DISTURBANCE IN ACCORDANCE WITH THE APPROVED PLANS.
2. THE TEMPORARY COFFERDAMS, RIVER CROSSINGS, AND HAUL ROADS MUST BE INSTALLED DURING THE LOW FLOW PERIOD (I.E., THE PERIOD BETWEEN JULY 1 THROUGH OCTOBER 31). COFFERDAMMED AREAS, WHERE APPLICABLE, SHALL BE MAINTAINED TO ALLOW A DRY WORKING CONDITION (NO SEDIMENT PLUME) IN THE WATERCOURSE. SOIL DISTURBANCE IN COFFERDAMMED AREAS OR THE WATERCOURSE MUST TEMPORARILY CEASE IN THE EVENT OF ANY ABNORMALLY HIGH STORMWATER RUNOFF EVENT THAT OVERTOPS THE COFFERDAMS OR TEMPORARY RIVER CROSSINGS.
3. SELECTIVE DEMOLITION/REMOVAL OF THE DAM MUST BE CONDUCTED SEQUENTIALLY TO CONTROL UPSTREAM DRAWDOWN TO NO MORE THAN TWELVE (12) INCHES PER DAY.
4. OBTAIN CONFIRMATORY ELEVATIONS OF THE RIVER CHANNEL BOTTOM ALONG THE PROPOSED ALIGNMENTS OF THE TEMPORARY COFFERDAMS AND RIVER CROSSINGS TO VERIFY EXISTING CONDITIONS AND ACTUAL COFFERDAM HEIGHTS PRIOR TO INSTALLATION.
5. THIS PLAN ILLUSTRATES ONE CONCEPTUAL APPROACH TO WATER CONTROL FOR THE PROJECT. THE CONTRACTOR SHALL SUBMIT A FINAL WATER CONTROL PLAN TO FUSS & O'NEILL AND THE MASSDEP FOR REVIEW WITH ADEQUATE TIME FOR THEIR REVIEW AND ACCEPTANCE PRIOR TO THE INITIATION OF CONSTRUCTION.
6. TEMPORARY HAUL ROADS, COFFERDAMS, TEMPORARY RIVER CROSSINGS, AND BYPASS PROVISIONS SHALL BE MAINTAINED THROUGHOUT THE CONSTRUCTION PERIOD TO ENSURE RESPECTIVE COMPONENTS FUNCTION AS INTENDED TO PROTECT ADJACENT PROPERTIES, WETLAND RESOURCES AND DOWNSTREAM WORK AREAS.

PHASE 1A:

1. AFTER MOBILIZING AT CASHMAN PARK AND INSTALLING TEMPORARY EROSION CONTROL MEASURES AT THE PORTION OF THE PARKING LOT OF PARCEL 516-304-1 (SAM'S FOOD STORE PROPERTY) AND CASHMAN PARK AREA WITHIN THE LIMIT OF DISTURBANCE, THE CONTRACTOR SHALL INSTALL FLOATING TURBIDITY BARRIER JUST UPSTREAM OF THE WINTER STREET BRIDGE OPENING. THE FLOATING TURBIDITY BARRIER MUST BE A TYPE III BARRIER CAPABLE OF PASSING FLOW VELOCITIES UP TO 5 FEET PER SECOND.
2. THE CONTRACTOR SHALL THEN INSTALL THE TEMPORARY CONSTRUCTION ACCESS TO THE RIVER AT PARCEL 516-304-1, REMOVE 20-FOOT SECTION OF THE FREESTANDING PORTION OF THE PARKING LOT RETAINING WALL BEHIND THE SAM'S STORE BUILDING STRUCTURE (OR AS REQUIRED AND APPROVED BY OWNER TO FACILITATE ACCESS), AND CONSTRUCT TEMPORARY STONE RIPRAP ACCESS DOWN THE SLOPE (AT NO STEEPER THAN 2H:1V) IN ORDER TO GAIN ACCESS TO THE IMPOUNDMENT JUST UPSTREAM OF THE DAM FROM PARCEL 516-304-1 FOR CONSTRUCTION EQUIPMENT AND/OR BARGE ACCESS TO DAM. THE STONE RIPRAP USED TO CONSTRUCT THE TEMPORARY STONE RIPRAP ACCESS SHALL BE CONSTRUCTED OF SAME STONE MATERIAL USED TO PERMANENTLY STABILIZE THE LOWER SLOPE OF THE PROPOSED RIVER CHANNEL SIDESLOPES. THIS STONE IS TO REMAIN STABLE DURING FLOOD FLOWS.
3. USING SIPHONS AND/OR PUMPS, INCREMENTALLY LOWER THE IMPOUNDMENT BY 12-INCHES PER DAY TO DOWN TO EL. 14.5 FEET. THIS SHOULD TAKE APPROXIMATELY 4 WORK DAYS ASSUMING NO SUBSTANTIAL RAINFALL EVENTS OCCUR. THIS WILL ALSO ALLOW THE NEWLY EXPOSED AREAS ALONG THE RIVER BANK TIME TO BEGIN TO DRAIN AND STABILIZE.
4. ONCE THE BASE CONDITION WATER SURFACE WITHIN THE IMPOUNDMENT HAS BEEN LOWERED TO EL. 14.5 FEET, REMOVE A 50-FOOT SECTION OF THE UPPER PORTION OF THE DAM USING BARGE MOUNTED EQUIPMENT OR BY CRANE FROM ADJACENT PARKING LOT (ON PARCEL 516-304-1) DOWN TO EL. 14.50 FEET, DO NOT DISTURB SECTION OF DAM WITHIN 10-FEET OF ITS CONNECTION TO BUILDING ON RIVER LEFT AND WITHIN 10-FEET OF ITS CONNECTION TO RIVER WALL ON RIVER RIGHT. THIS WILL BE CONSIDERED THE FIRST PHASE OF THE INCREMENTAL REMOVAL OF THE DAM. REMOVING THE DAM INCREMENTALLY WILL MINIMIZE THE POTENTIAL FOR SEDIMENT TO MOBILIZE DOWNSTREAM, ALLOW THE BED AND NEWLY EXPOSED BANKS OF THE IMPOUNDMENT AND STREAM TO DRAIN AND STABILIZE, AND PREVENT A SUDDEN RELEASE OF WATER WHICH COULD UNNECESSARILY DAMAGE DOWNSTREAM INFRASTRUCTURE AND/OR HABITAT.

PHASE 1B:

1. ONCE THE BASE FLOW CONDITION WATER SURFACE ELEVATION IS LOWERED TO APPROXIMATELY EL. 15.0 WITHIN THE ENTIRE IMPOUNDMENT FROM THE DAM UP TO THE MBTA BRIDGE, CONSTRUCT TEMPORARY RIVER CROSSING AT CASHMAN'S PARK (WITH A TOP WIDTH OF 12 FEET). THIS RIVER CROSSING WILL BE CONSTRUCTED OF STONE RIPRAP EQUIVALENT IN SIZE TO THAT USED TO STABILIZE THE LOWER SIDESLOPES OF THE PROPOSED RIVER CHANNEL. THE CROSSING WILL BE CONSTRUCTED WITH (4) 48-INCH CULVERTS THAT WILL PASS APPROXIMATELY 380 CFS AT FULL CAPACITY. THIS FLOW IS EQUIVALENT TO THE BANKFULL FLOW. BANKFULL FLOW CONDITIONS ARE APPROXIMATELY EQUIVALENT TO THE 1.5-YEAR RECURRENCE INTERVAL FLOOD EVENT. INLET CONTROL DEVICES SHALL BE INSTALLED ON UPSTREAM ENDS OF CULVERTS TO ALLOW FOR THE REGULATION OF FLOW THROUGH CULVERTS.
2. ONCE CONSTRUCTION OF THE TEMPORARY RIVER CROSSING IS COMPLETE, CONTINUE CONSTRUCTION OF A STONE ACCESS/HAUL ROAD (WITH A 10-FOOT MINIMUM TOP WIDTH) BETWEEN THE TEMPORARY RIVER CROSSING AND THE AREA OF SEDIMENT CONTAMINATION. THE TEMPORARY HAUL ROAD WILL FOLLOW THE ALIGNMENT OF THE TOP OF LEFT BANK OF THE PROPOSED RIVER CHANNEL. AS A RESULT, CONSTRUCTING THIS HAUL ROAD WILL ALSO ASSIST IN FORMING A STABLE LEFT BANK FOR THE PROPOSED RIVER CHANNEL.
3. ONCE THE HAUL ROAD HAS BEEN BUILT TO THE APPROXIMATE AREA OF SEDIMENT CONTAMINATION, CONSTRUCT A TEMPORARY RIVER CROSSING (WITH A 12-FOOT TOP WIDTH) JUST UPSTREAM OF THE AREA NEAR LITTLE RIVER STREET. THE ROAD SHALL BE CONSTRUCTED FROM THE TEMPORARY HAUL ROAD AS OPPOSED TO CONSTRUCTING FROM LITTLE RIVER STREET. THIS TEMPORARY RIVER CROSSING WILL BE CONSTRUCTED OF STONE RIPRAP EQUIVALENT IN SIZE TO THAT USED TO STABILIZE THE LOWER SIDESLOPES OF THE PROPOSED RIVER CHANNEL. THE CROSSING WILL BE CONSTRUCTED WITH (4) 48-INCH CULVERTS THAT WILL PASS APPROXIMATELY 380 CFS AT FULL CAPACITY. THE PURPOSE OF THIS CROSSING WILL BE TO GAIN ACCESS TO BOTH SIDES OF THE RIVER CHANNEL FOR SEDIMENT REMOVAL AND TO CONSTRUCT IN-CHANNEL RIVER IMPROVEMENTS.
4. USING LARGE SANDBAGS OR EQUAL, CONSTRUCT A TEMPORARY COFFERDAM DOWN THE APPROXIMATE CENTER OF THE RIVER CHANNEL BETWEEN THE TEMPORARY RIVER CROSSING AND DOWNSTREAM LIMIT OF CONTAMINATED SEDIMENT AREA. CAP/BLOCK THE INLET TO THE EASTERN CULVERTS AND ISOLATE THE EASTERN HALF OF THE RIVER USING COFFERDAM SYSTEM. ONLY ALLOW FLOW THROUGH THE WESTERN CULVERTS. INSTALL TEMPORARY DEWATERING AREA ATOP THE WESTERN HALF OF THE TEMPORARY RIVER CROSSING AND UTILIZE CONSTRUCTION DEWATERING PUMPS TO CREATE A DRY WORKING AREA WITHIN THE LIMITS OF THE COFFERDAM. PERFORM SEDIMENT REMOVAL OPERATIONS. HAUL SEDIMENT TO CASHMAN PARK TEMPORARY SOIL STORAGE AREA FOR DEWATERING AND ULTIMATE TRANSPORT OFF-SITE. THE TOP OF THE COFFERDAM SYSTEM SHALL BE SET TO PROTECT WORK AREA FOR MAXIMUM RIVER FLOWS OF UP TO APPROXIMATELY 100 CFS (OR 3-FEET FLOW DEPTH THROUGH DIVERTED HALF OF RIVER CHANNEL) AT MINIMUM WITHOUT OVERTOPPING.
5. ONCE CONTAMINATED SEDIMENT HAS BEEN REMOVED IN THE EASTERN HALF OF THE RIVER, ROUGH GRADE LEFT BANK AND CHANNEL BOTTOM IN THIS LOCATION TO PROPOSED GRADE AND STABILIZE WITH LOWER SLOPE PROTECTION AND CHANNEL BOTTOM STABILIZATION MEASURES.
6. REMOVE TEMPORARY DEWATERING AREA ON THE RIVER CROSSING AND SHIFT TO THE UPPER LEFT BANK OF RIVER AT EL. 17.5± OR ABOVE. ADJUST TEMPORARY COFFERDAM SYSTEM TO ISOLATE THE WESTERN SIDE OF RIVER. SLOWLY ALLOW FLOW THROUGH THE EASTERN CULVERTS AND CAP/BLOCK WESTERN CULVERTS. UTILIZE CONSTRUCTION DEWATERING PUMPS TO CREATE A DRY WORKING AREA WITHIN WESTERN COFFERDAMMED AREA. PERFORM SEDIMENT REMOVAL OPERATIONS IN WESTERN HALF OF RIVER. HAUL SEDIMENT TO CASHMAN PARK TEMPORARY SOIL STORAGE AREA FOR DEWATERING AND ULTIMATE TRANSPORT OFF-SITE. ONCE CONTAIMINATED SEDIMENT HAS BEEN REMOVED, ROUGH GRADE RIGHT BANK AND CHANNEL BOTTOM TO PROPOSED GRADE AND STABILIZE WITH LOWER SLOPE PROTECTION AND CHANNEL BOTTOM STABILIZATION MEASURES.
7. ONCE IN-RIVER IMPROVEMENTS ARE COMPLETE IN THIS LOCATION, REMOVE TEMPORARY COFFERDAM SYSTEM AND TEMPORARY RIVER CROSSING (WITH CULVERTS) AT LITTLE RIVER STREET AREA. STONE RIPRAP USED TO CONSTRUCT TEMPORARY RIVER CROSSING CAN BE USED ELSEWHERE AS STABILIZATION FOR LOWER RIVER CHANNEL SLOPE AND CHANNEL BOTTOM PROTECTION OF RIVER CHANNEL.



WATER CONTROL – PHASE 1A & 1B (INCREMENTAL REMOVAL OF DAM AND LOWERING OF HEADPOND)

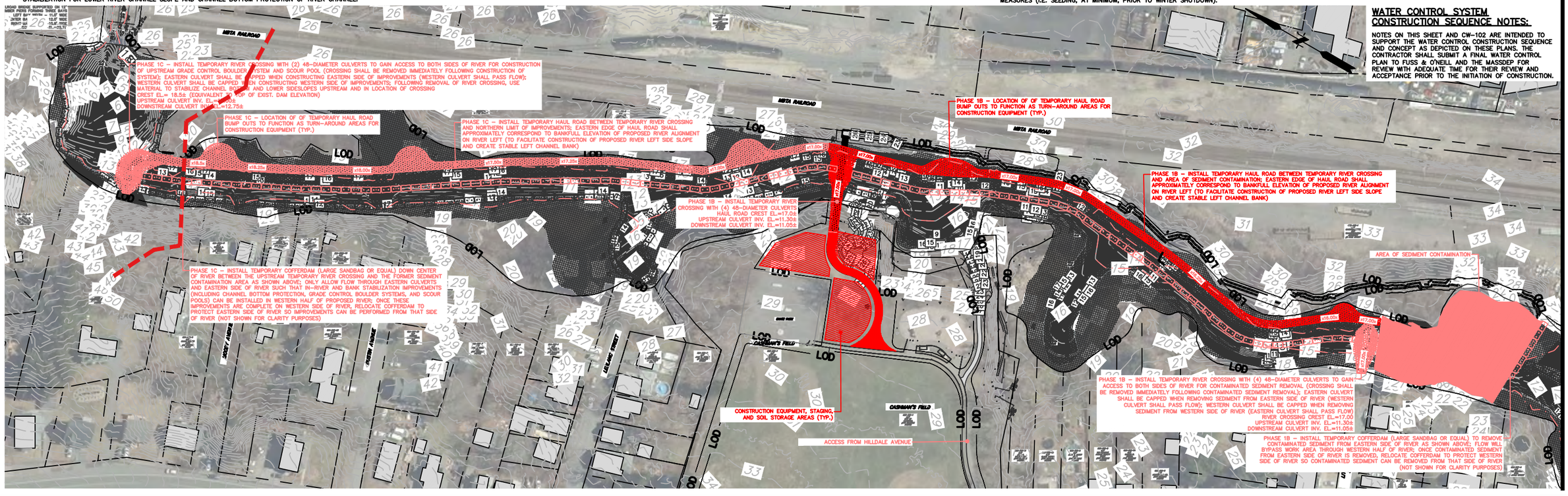
SCALE: 1"= 140'

PHASE 1C:

1. ONCE CONTAMINATED SEDIMENT HAS BEEN FULLY REMOVED, CONTINUE CONSTRUCTION OF STONE ACCESS/HAUL ROAD (WITH A 10-FOOT TOP WIDTH) BETWEEN THE TEMPORARY RIVER CROSSING AT CASHMAN PARK AND THE UPSTREAM LIMIT OF PROPOSED CONSTRUCTION. THIS PORTION OF THE TEMPORARY HAUL ROAD WILL ALSO FOLLOW THE ALIGNMENT OF THE TOP OF LEFT BANK OF THE PROPOSED RIVER CHANNEL. AS A RESULT, CONSTRUCTING THIS HAUL ROAD WILL ALSO ASSIST IN FORMING A STABLE LEFT BANK FOR THE PROPOSED RIVER CHANNEL. CONSTRUCT TEMPORARY RIVER CROSSING WITH A 12-FOOT TOP WIDTH AND WITH (4) 48-INCH CULVERTS JUST UPSTREAM OF PROPOSED UPSTREAM GRADE CONTROL BOULDER SYSTEM AND SCOUR POOL. INSTALL CULVERTS WITH INLET AND/OR OUTLET CONTROL DEVICES THAT WILL ALLOW FLOW TO BE REGULATED. CONSTRUCTING THIS SYSTEM WILL ASSIST IN MINIMIZING UPSTREAM IMPACTS DURING THIS PHASE OF CONSTRUCTION.
2. FOLLOWING CONSTRUCTION OF THE UPSTREAM TEMPORARY RIVER CROSSING, PERFORM THE SECOND PHASE OF INCREMENTAL DAM REMOVAL. LOWER THE DAM CREST FROM EL. 14.5± FEET DOWN TO EL. 12.0±. THIS WILL LOWER THE BASE FLOW CONDITION WATER SURFACE ELEVATION TO BETWEEN APPROXIMATELY EL. 12.0± AND EL. 13.5± WITHIN THE ENTIRE IMPOUNDMENT FROM THE DAM UP TO THE UPSTREAM RIVER CROSSING.
3. CONSTRUCT LARGE SANDBAG OR SIMILAR COFFERDAM SYSTEM DOWN THE APPROXIMATE CENTER OF THE RIVER CHANNEL BETWEEN THE UPSTREAM TEMPORARY RIVER CROSSING AND THE TEMPOORARY RIVER CROSSING AT CASHMAN PARK. CAP/BLOCK THE INLET TO THE EASTERN CULVERTS AND ISOLATE THE EASTERN HALF OF THE RIVER USING COFFERDAM SYSTEM. ONLY ALLOW FLOW THROUGH THE WESTERN CULVERTS. CONSTRUCT IN-RIVER IMPROVEMENTS AND LOWER BANK STABILIZATION MEASURES. CONSTRUCTING THIS SYSTEM WILL ASSIST IN MINIMIZING TEMPORARY UPSTREAM IMPACTS THROUGHOUT THE REMAINDER OF CONSTRUCTION. THE TOP OF THE COFFERDAM SYSTEM SHALL BE SET TO PROTECT WORK AREA FOR MAXIMUM RIVER FLOWS OF UP TO APPROXIMATELY 100 CFS (OR 3-FEET FLOW DEPTH THROUGH DIVERTED HALF OF RIVER CHANNEL) AT MINIMUM WITHOUT OVERTOPPING.
4. PERFORM RIVER CHANNEL IMPROVEMENTS BETWEEN THE UPSTREAM RIVER CROSSING AND THE FORMER AREA OF SEDIMENT CONTAMINATION AS INDICATED IN THE CONTRACT DOCUMENTS INCLUDING CHANNEL REALIGNMENT (INCLUDING SEDIMENT EXCAVATION AND RELOCATION), INSTALL GRADE CONTROL BOULDER WEIR NOS. 1 THRU 5, SCOUR POOL NOS. 1 THRU 5, LOWER AND UPPER SLOPE STABILIZATION MEASURES, FISHING PLATFORM AT CASHMAN PARK BELOW THE BANKFULL ELEVATION, AND VEGETATIVE RESTORATION MEASURES (I.E. SEEDING, AT MINIMUM, PRIOR TO WINTER SHUTDOWN).

WATER CONTROL SYSTEM CONSTRUCTION SEQUENCE NOTES:

NOTES ON THIS SHEET AND CW-102 ARE INTENDED TO SUPPORT THE WATER CONTROL CONSTRUCTION SEQUENCE AND CONCEPT AS DEPICTED ON THESE PLANS. THE CONTRACTOR SHALL SUBMIT A FINAL WATER CONTROL PLAN TO FUSS & O'NEILL AND THE MASSDEP FOR REVIEW WITH ADEQUATE TIME FOR THEIR REVIEW AND ACCEPTANCE PRIOR TO THE INITIATION OF CONSTRUCTION.



MATCH LINE SEE SHEET CW-102

LAYER STATE:

MS VIEW:

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER

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DATUM:
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GRAPHIC SCALE

CITY OF HAVERHILL

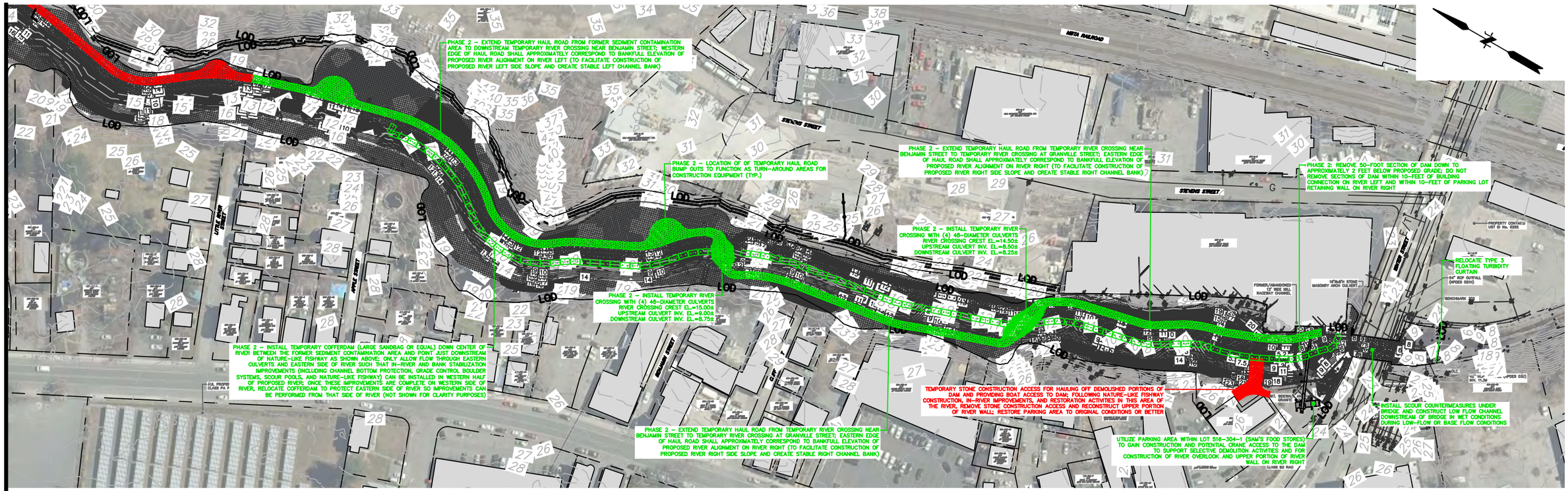
WATER CONTROL & CONSTRUCTION SEQUENCING PLAN NO. 1

LITTLE RIVER DAM REMOVAL AND RESTORATION

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

CW-101


PHASE 2 – EXTEND TEMPORARY HAUL ROAD FROM FORMER SEDIMENT CONTAMINATION AREA TO DOWNSTREAM TEMPORARY RIVER CROSSING NEAR BENJAMIN STREET; WESTERN EDGE OF HAUL ROAD SHALL APPROXIMATELY CORRESPOND TO BANKFULL ELEVATION OF PROPOSED RIVER ALIGNMENT ON RIVER LEFT (TO FACILITATE CONSTRUCTION OF PROPOSED RIVER LEFT SIDE SLOPE AND CREATE STABLE LEFT CHANNEL BANK)
PHASE 2 – LOCATION OF OF TEMPORARY HAUL ROAD BUMP OUTS TO FUNCTION AS TURN-AROUND AREAS FOR CONSTRUCTION EQUIPMENT (TYP.)
PHASE 2 – EXTEND TEMPORARY HAUL ROAD FROM TEMPORARY RIVER CROSSING NEAR BENJAMIN STREET TO TEMPORARY RIVER CROSSING AT GRANVILLE STREET; EASTERN EDGE OF HAUL ROAD SHALL APPROXIMATELY CORRESPOND TO BANKFULL ELEVATION OF PROPOSED RIVER ALIGNMENT ON RIVER RIGHT (TO FACILITATE CONSTRUCTION OF PROPOSED RIVER RIGHT SIDE SLOPE AND CREATE STABLE RIGHT CHANNEL BANK)
PHASE 2 – INSTALL TEMPORARY RIVER CROSSING WITH (4) 48-DIAMETER CULVERTS RIVER CROSSING CREST EL.=14.50± UPSTREAM CULVERT INV. EL.=8.50± DOWNSTREAM CULVERT INV. EL.=8.25±
PHASE 2: REMOVE 50-FOOT SECTION OF DAM DOWN TO APPROXIMATELY 2 FEET BELOW PROPOSED GRADE; DO NOT REMOVE SECTIONS OF DAM WITHIN 10-FEET OF BUILDING CONNECTION ON RIVER LEFT AND WITHIN 10-FEET OF PARKING LOT RETAINING WALL ON RIVER RIGHT
PHASE 2 – INSTALL TEMPORARY RIVER CROSSING WITH (4) 48-DIAMETER CULVERTS RIVER CROSSING CREST EL.=15.00± UPSTREAM CULVERT INV. EL.=9.00± DOWNSTREAM CULVERT INV. EL.=8.75±
PHASE 2 – INSTALL TEMPORARY COFFERDAM (LARGE SANDBAG OR EQUAL) DOWN CENTER OF RIVER BETWEEN THE FORMER SEDIMENT CONTAMINATION AREA AND POINT JUST DOWNSTREAM OF NATURE-LIKE FISHWAY AS SHOWN ABOVE; ONLY ALLOW FLOW THROUGH EASTERN CULVERTS AND EASTERN SIDE OF RIVER SUCH THAT IN-RIVER AND BANK STABILIZATION IMPROVEMENTS (INCLUDING CHANNEL BOTTOM PROTECTION, GRADE CONTROL BOULDER SYSTEMS, SCOUR POOLS, AND NATURE-LIKE FISHWAY) CAN BE INSTALLED IN WESTERN HALF OF PROPOSED RIVER; ONCE THESE IMPROVEMENTS ARE COMPLETE ON WESTERN SIDE OF RIVER, RELOCATE COFFERDAM TO PROTECT EASTERN SIDE OF RIVER SO IMPROVEMENTS CAN BE PERFORMED FROM THAT SIDE OF RIVER (NOT SHOWN FOR CLARITY PURPOSES)
PHASE 2 – EXTEND TEMPORARY HAUL ROAD FROM TEMPORARY RIVER CROSSING NEAR BENJAMIN STREET TO TEMPORARY RIVER CROSSING AT GRANVILLE STREET; EASTERN EDGE OF HAUL ROAD SHALL APPROXIMATELY CORRESPOND TO BANKFULL ELEVATION OF PROPOSED RIVER ALIGNMENT ON RIVER RIGHT (TO FACILITATE CONSTRUCTION OF PROPOSED RIVER RIGHT SIDE SLOPE AND CREATE STABLE RIGHT CHANNEL BANK)
TEMPORARY STONE CONSTRUCTION ACCESS FOR HAULING OFF DEMOLISHED PORTIONS OF DAM AND PROVIDING BOAT ACCESS TO DAM; FOLLOWING NATURE-LIKE FISHWAY CONSTRUCTION, IN-RIVER IMPROVEMENTS, AND RESTORATION ACTIVITIES IN THIS AREA OF THE RIVER, REMOVE STONE CONSTRUCTION ACCESS AND RECONSTRUCT UPPER PORTION OF RIVER WALL; RESTORE PARKING AREA TO ORIGINAL CONDITIONS OR BETTER
UTILIZE PARKING AREA WITHIN LOT 516-304-1 (SAM'S FOOD STORES) TO GAIN CONSTRUCTION AND POTENTIAL CRANE ACCESS TO THE DAM TO SUPPORT SELECTIVE DEMOLITION ACTIVITIES AND FOR CONSTRUCTION OF RIVER OVERLOOK AND UPPER PORTION OF RIVER WALL ON RIVER RIGHT
RELOCATE TYPE 3 FLOATING TURBIDITY CURTAIN
INSTALL SCOUR COUNTERMEASURES UNDER BRIDGE AND CONSTRUCT LOW FLOW CHANNEL DOWNSTREAM OF BRIDGE IN WET CONDITIONS DURING LOW-FLOW OR BASE FLOW CONDITIONS
MBTA RAILROAD
STENSIG STREET
GRANVILLE STREET
WINTER STREET
LITTLE RIVER
LOD
LOD1
LOD2
LOD3
LOD4
LOD5
LOD6
LOD7
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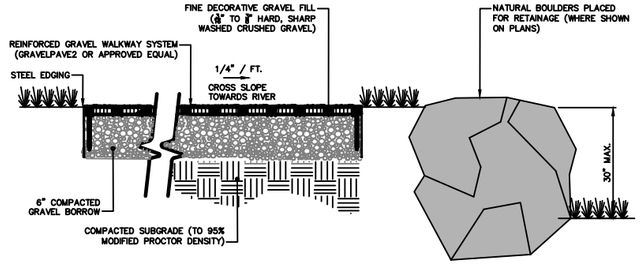
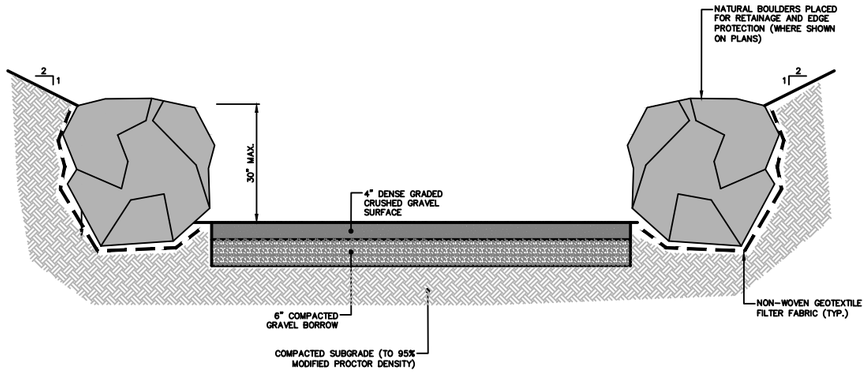


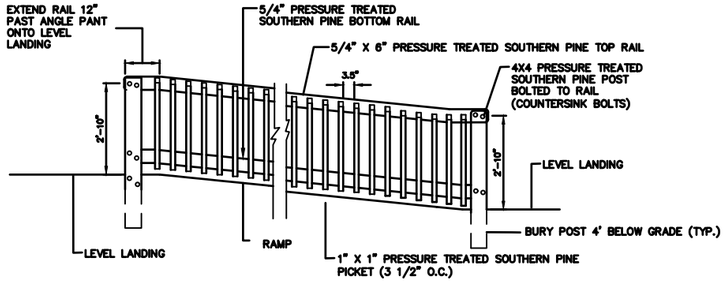
GRAVEL WALKWAY/ACCESS PATH (AT CASHMAN PARK)

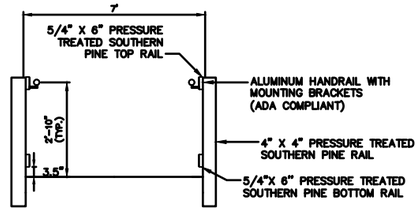
NOT TO SCALE



KAYAK/CANOE ACCESS PATH (AT CASHMAN PARK)

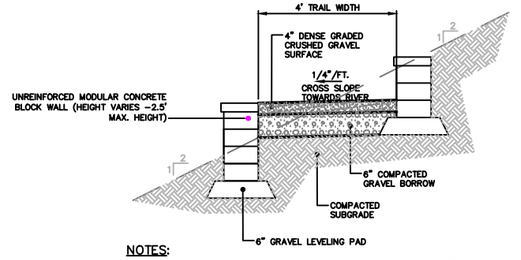
NOT TO SCALE





TIMBER HANDRAIL (AT KAYAK/CANOE ACCESS)

NOT TO SCALE

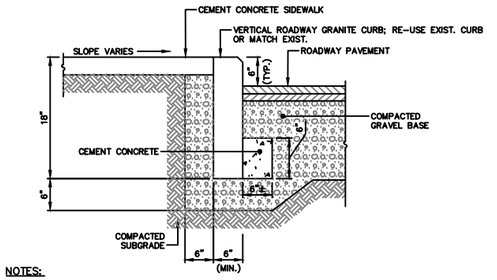


NOTES:

1. GRAVEL BORROW BASE COURSE SHALL CONSIST OF REUSED ON-SITE GRAVEL OR IMPORTED GRAVEL MEETING THE GRADATION REQUIREMENTS OF M.1.03 OF THE MASSDOT STANDARD SPECIFICATIONS.
2. DENSE GRADED CRUSHED GRAVEL SURFACE SHALL CONSIST OF GRAVEL SURFACE MATERIAL MEETING THE REQUIREMENTS OF M2.05.0 OF THE MASSDOT STANDARD SPECIFICATIONS.
3. ALIGNMENT OF TRAIL MAY VARY SLIGHTLY WITHIN LIMIT OF DISTURBANCE (AS FIELD DIRECTED BY ENGINEER) IN ORDER TO MINIMIZE TREE AND VEGETATION REMOVAL.

COMPACTED GRAVEL WALKING TRAIL

NOT TO SCALE

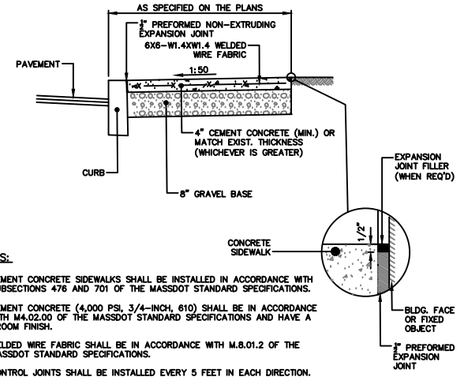


NOTES:

1. CURBING SHALL BE INSTALLED IN ACCORDANCE WITH SUBSECTION 501 OF THE MASSDOT STANDARD SPECIFICATIONS.
2. GRANITE CURB, GRANITE CURB INLETS, AND GRANITE CURB CORNERS SHALL BE IN ACCORDANCE WITH M9.04.1, M9.04.5, AND M9.04.6 OF THE MASSDOT STANDARD SPECIFICATIONS, RESPECTIVELY.
3. CEMENT CONCRETE (3,000 PSI, 3/4-INCH, 520) SHALL BE IN ACCORDANCE WITH M4.02.00 OF THE MASSDOT STANDARD SPECIFICATIONS AND INSTALLED IN ACCORDANCE WITH SUBSECTION 476 OF THE MASSDOT STANDARD SPECIFICATIONS.
4. MORTAR FOR CURBING JOINTS SHALL BE IN ACCORDANCE WITH M4.02.15 OF THE MASSDOT STANDARD SPECIFICATIONS.

VERTICAL ROADWAY GRANITE CURB

NOT TO SCALE

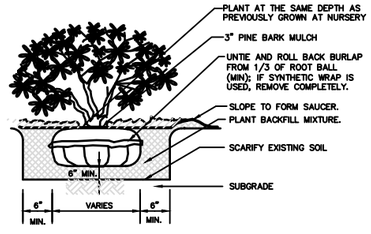


NOTES:

1. CEMENT CONCRETE SIDEWALKS SHALL BE INSTALLED IN ACCORDANCE WITH SUBSECTIONS 476 AND 701 OF THE MASSDOT STANDARD SPECIFICATIONS.
2. CEMENT CONCRETE (4,000 PSI, 3/4-INCH, 610) SHALL BE IN ACCORDANCE WITH M4.02.00 OF THE MASSDOT STANDARD SPECIFICATIONS AND HAVE A BROOM FINISH.
3. WELDED WIRE FABRIC SHALL BE IN ACCORDANCE WITH M.8.01.2 OF THE MASSDOT STANDARD SPECIFICATIONS.
4. CONTROL JOINTS SHALL BE INSTALLED EVERY 5 FEET IN EACH DIRECTION.
5. EXPANSION JOINTS SHALL BE INSTALLED EVERY 20 FEET IN EACH DIRECTION AT FOUNDATIONS AND WALLS IN IN A SQUARE PATTERN AROUND MANHOLE COVERS, HYDRANTS, SIGN POSTS AND UTILITY POLES. THE EXPANSION JOINT SHALL BE THE FULL DEPTH OF THE SIDEWALK AND FILLED WITH AN APPROVED TYPE OF PREMOLDED EXPANSION JOINT FILLER IN ACCORDANCE WITH M.9.14.0 OF THE MASSDOT STANDARD SPECIFICATIONS.

CEMENT CONCRETE SIDEWALK

NOT TO SCALE



SHRUB PLANTING

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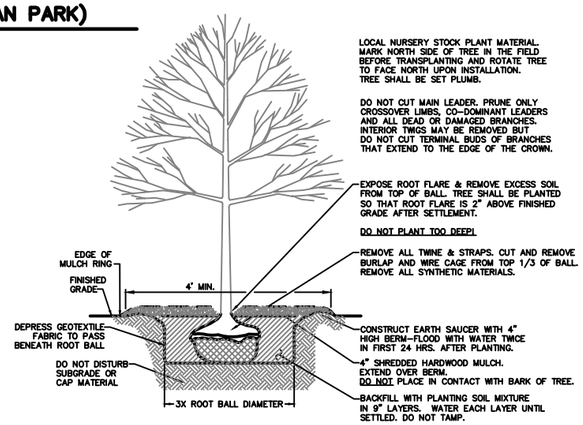
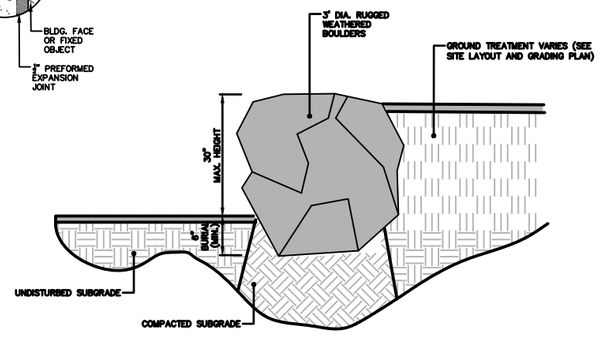


NOTES:
1. STAKES & GUYS SHALL NOT BE USED.
2. SPRAY WITH ANTIDESICCANT IN ACCORDANCE WITH MFG'S INSTRUCTIONS IF FOLIGAE IS PRESENT.

TREE PLANTING DETAIL

NOT TO SCALE



NATURAL BOULDER PLACEMENT (FOR RETAINAGE)

NOT TO SCALE

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER

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HORZ.: AS NOTED
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DATUM:
HORZ.: NAD83
VERT.: NAVD88
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GRAPHIC SCALE

CITY OF HAVERHILL

CONSTRUCTION DETAILS

LITTLE RIVER DAM REMOVAL AND RESTORATION

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

CD-501

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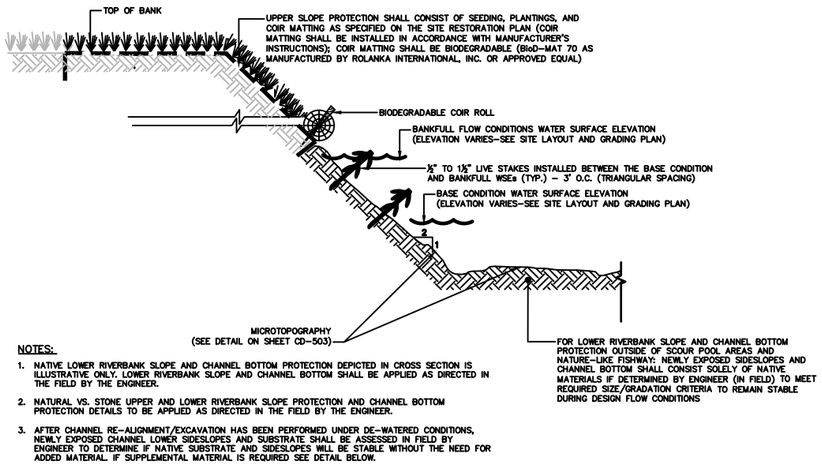
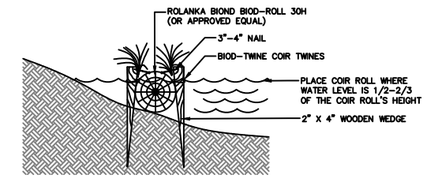
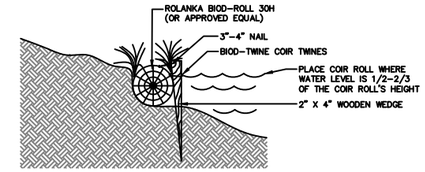


NOTES:

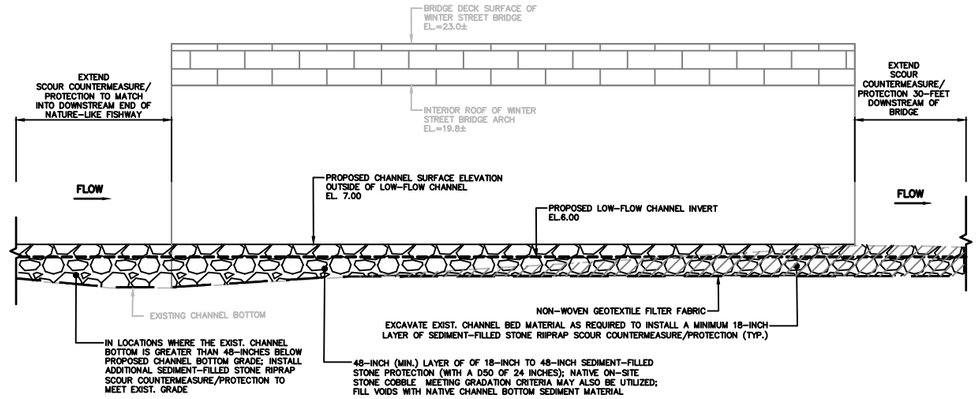
1. NATIVE LOWER RIVERBANK SLOPE AND CHANNEL BOTTOM PROTECTION DEPICTED IN CROSS SECTION IS ILLUSTRATIVE ONLY. LOWER RIVERBANK SLOPE AND CHANNEL BOTTOM SHALL BE APPLIED AS DIRECTED IN THE FIELD BY THE ENGINEER.
2. NATURAL VS. STONE UPPER AND LOWER RIVERBANK SLOPE PROTECTION AND CHANNEL BOTTOM PROTECTION DETAILS TO BE APPLIED AS DIRECTED IN THE FIELD BY THE ENGINEER.
3. AFTER CHANNEL RE-ALIGNMENT/EXCAVATION HAS BEEN PERFORMED UNDER DE-WATERED CONDITIONS, NEWLY EXPOSED CHANNEL LOWER SIDESLOPES AND SUBSTRATE SHALL BE ASSESSED IN FIELD BY ENGINEER TO DETERMINE IF NATIVE SUBSTRATE AND SIDESLOPES WILL BE STABLE WITHOUT THE NEED FOR ADDED MATERIAL. IF SUPPLEMENTAL MATERIAL IS REQUIRED SEE DETAIL BELOW.



COIR ROLL PLACEMENT OPTION 1 – WITHOUT BANK SUPPORT



COIR ROLL PLACEMENT OPTION 2 – WITH BANK SUPPORT

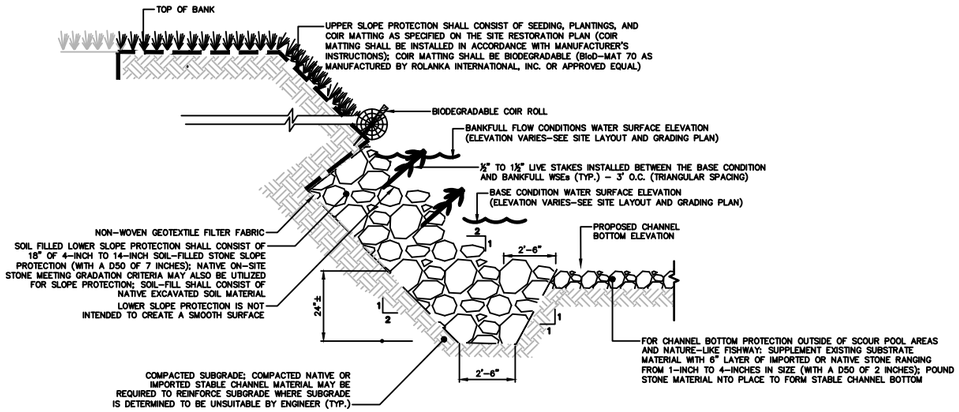


WINTER STREET BRIDGE SCOUR COUNTERMEASURE/PROTECTION

NOT TO SCALE

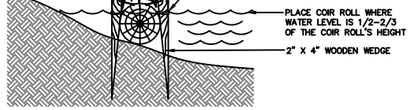
NATURAL UPPER AND LOWER RIVERBANK SLOPE PROTECTION AND CHANNEL BOTTOM PROTECTION (OUTSIDE OF NATURE-LIKE FISHWAY, SCOUR HOLE, AND SCOUR COUNTERMEASURE LOCATIONS)

NOT TO SCALE

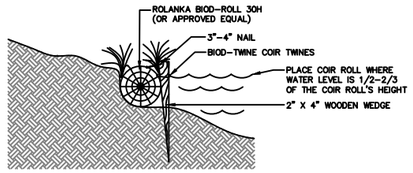


NOTE:

IMPORTED LOWER RIVERBANK SLOPE AND CHANNEL BOTTOM PROTECTION DEPICTED IN CROSS SECTION IS ILLUSTRATIVE ONLY. LOWER RIVERBANK SLOPE AND CHANNEL BOTTOM SHALL BE APPLIED AS DIRECTED IN THE FIELD BY THE ENGINEER.



COIR ROLL PLACEMENT OPTION 1 – WITHOUT BANK SUPPORT



COIR ROLL PLACEMENT OPTION 2 – WITH BANK SUPPORT

STONE UPPER AND LOWER RIVERBANK SLOPE PROTECTION AND CHANNEL BOTTOM PROTECTION (OUTSIDE OF NATURE-LIKE FISHWAY, SCOUR HOLE, AND SCOUR COUNTERMEASURE LOCATIONS)

NOT TO SCALE

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HORZ.: AS NOTED
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GRAPHIC SCALE

CITY OF HAVERHILL

CONSTRUCTION DETAILS

LITTLE RIVER DAM REMOVAL AND RESTORATION

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

CD-502

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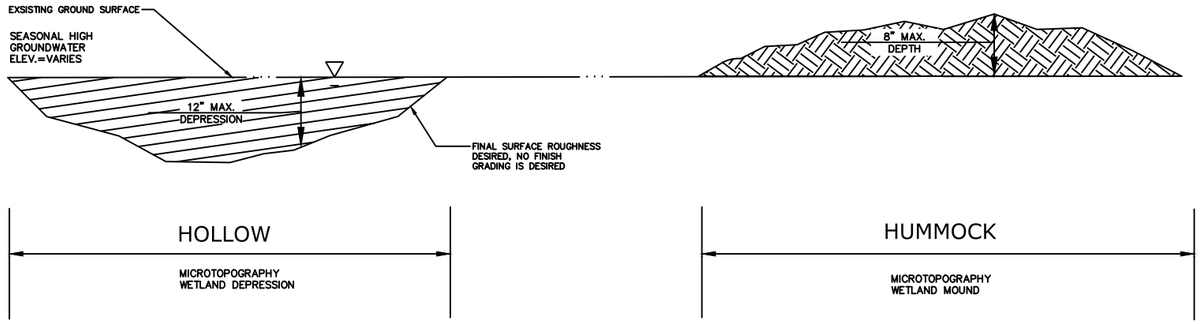

MICROTOPOGRAPHY CROSS SECTION

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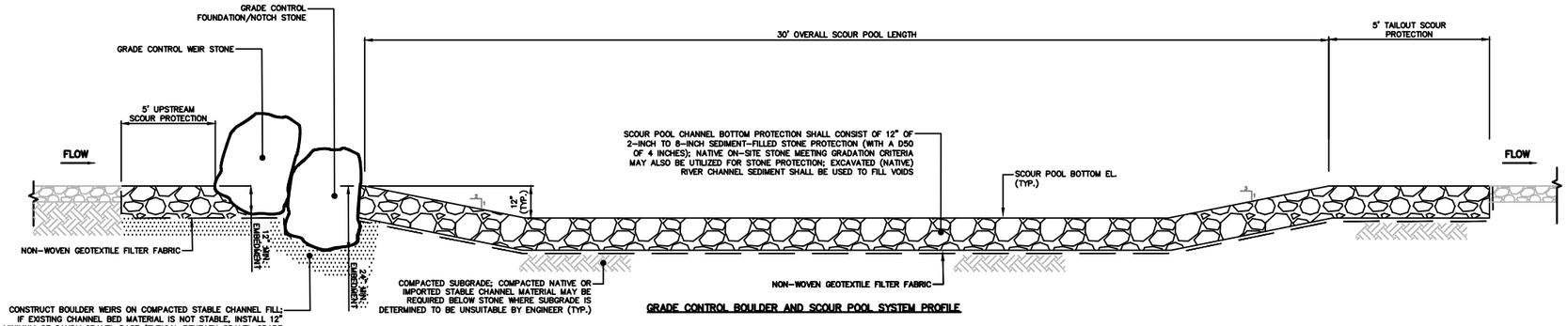


GRADE CONTROL BOULDER AND SCOUR POOL SYSTEM PROFILE

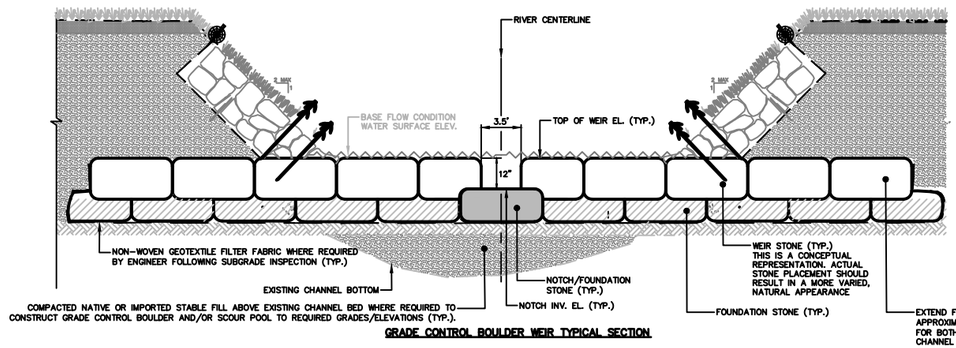
GRADE CONTROL WEIR

STONE TYPE	STONE LENGTH (A)*	STONE WIDTH (B)	STONE HEIGHT (C)
FOUNDATION/NOTCH STONE	3.0'-4.0'	2.0'-3.0'	3.0'-3.5'
WEIR STONE	3.0'-4.0'	2.0'-3.0'	3.0'-3.5'

* 'A' DIMENSION REFERS TO LENGTH OF STONE PERPENDICULAR TO FLOW; 'C' DIMENSION REFERS TO WIDTH OF STONE PARALLEL TO FLOW.

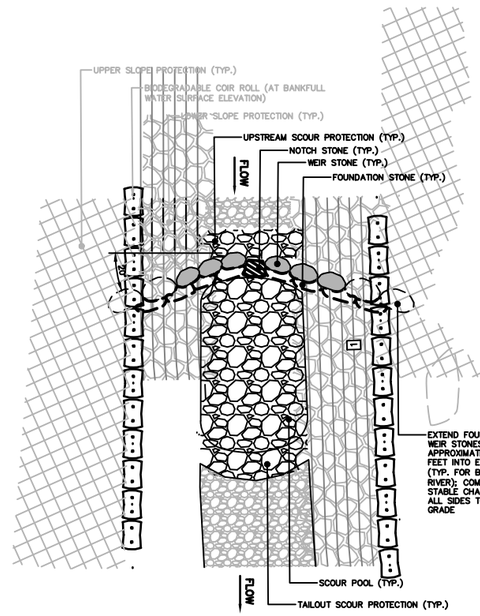
** ADDITIONAL WEIR STONE MAY BE PLACED BEHIND & ABUTTING THE NOTCH STONES AS DIRECTED BY THE ENGINEER TO OBTAIN REQUIRED NOTCH WIDTH.

*** DIMENSIONS SELECTED FOR ANY FOUNDATION/NOTCH AND WEIR STONES SHALL RESULT IN A MINIMUM WEIGHT OF 2,200 LBS ASSUMING THE STONE HAS AN APPROXIMATE UNIT WEIGHT OF 160 LBS/CF.



GRADE CONTROL BOULDER WEIR TYPICAL SECTION

NOTE:
REFER TO THE SITE GRADING AND LAYOUT PLANS FOR TOP OF GRADE CONTROL BOULDER WEIR AND NOTCH INVERT ELEVATION INFORMATION.



TYPICAL PLAN VIEW

TYPICAL GRADE CONTROL BOULDER AND SCOUR POOL SYSTEM

NOT TO SCALE

File: J:\DWG\P20170390\U30\CivilPlan\20170390U30_DET01.dwg Layout: 11X17-CD-503 Plotted: 2022-12-08 3:21 PM Saved: 2022-12-08 2:44 PM User: CNauman
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No.	DATE	DESCRIPTION	DESIGNER	REVIEWER

SCALE:
HORZ.: AS NOTED
VERT.:
DATUM:
HORZ.: NAD83
VERT.: NAVD88
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GRAPHIC SCALE

CITY OF HAVERHILL

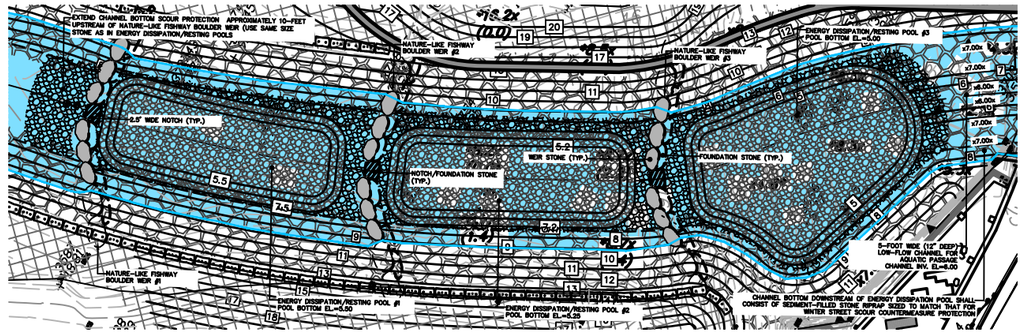
CONSTRUCTION DETAILS

LITTLE RIVER DAM REMOVAL AND RESTORATION

HAVERHILL MASSACHUSETTS

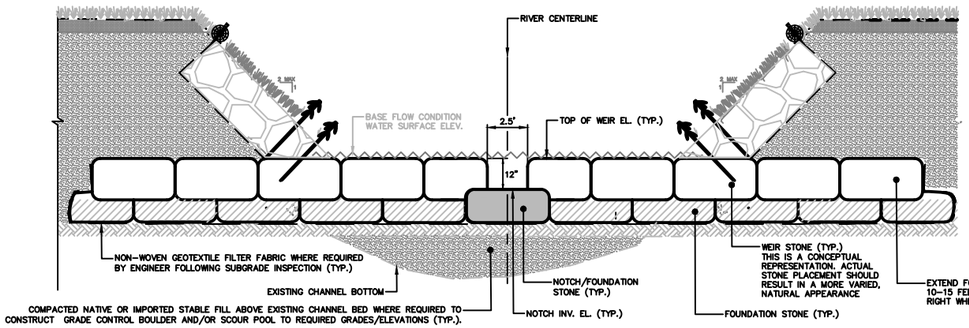
PROJ. No.: 20170390.U30
DATE: JUNE 2022

CD-503



NATURE-LIKE FISHWAY LAYOUT

SCALE 1"=30'



NATURE-LIKE FISHWAY BOULDER WEIR TYPICAL SECTION

NOTE:

REFER TO THE SITE GRADING AND LAYOUT PLANS FOR TOP OF NATURE-LIKE FISHWAY BOULDER WEIR AND NOTCH INVERT ELEVATION INFORMATION.

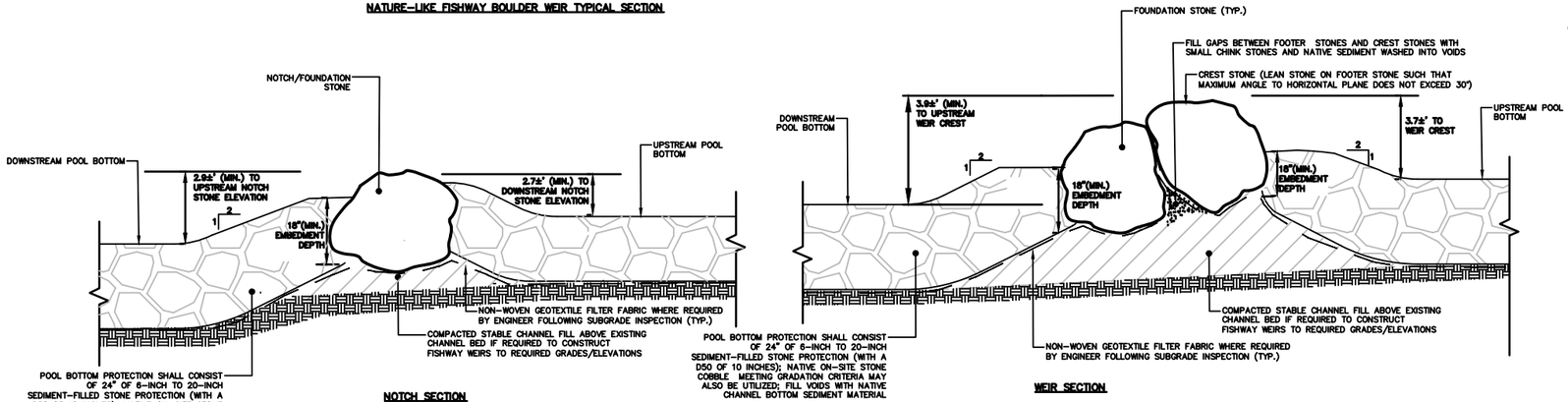
NATURE-LIKE FISHWAY BOULDER WEIR

STONE TYPE	STONE LENGTH (A)*	STONE WIDTH (B)	STONE HEIGHT (C)
FOUNDATION/NOTCH STONE	3.0'-4.0'	2.0'-3.0'	3.0'-3.5'
WEIR STONE	3.0'-4.0'	2.0'-3.0'	3.0'-3.5'

* 'A' DIMENSION REFERS TO LENGTH OF STONE PERPENDICULAR TO FLOW; 'C' DIMENSION REFERS TO WIDTH OF STONE PARALLEL TO FLOW.

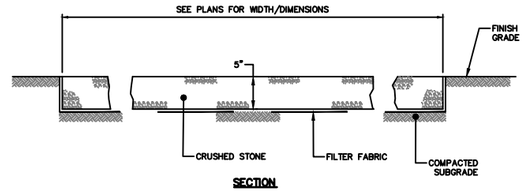
** ADDITIONAL WEIR STONE MAY BE PLACED BEHIND & ABUTTING THE NOTCH STONES AS DIRECTED BY THE ENGINEER TO OBTAIN REQUIRED NOTCH WIDTH.

*** DIMENSIONS SELECTED FOR ANY FOUNDATION/NOTCH AND WEIR STONES SHALL RESULT IN A MINIMUM WEIGHT OF 2,400 LBS ASSUMING THE STONE HAS AN APPROXIMATE UNIT WEIGHT OF 160 LBS/CF.



TYPICAL NATURE-LIKE FISHWAY WEIR AND RESTING POOL PROFILE

NOT TO SCALE

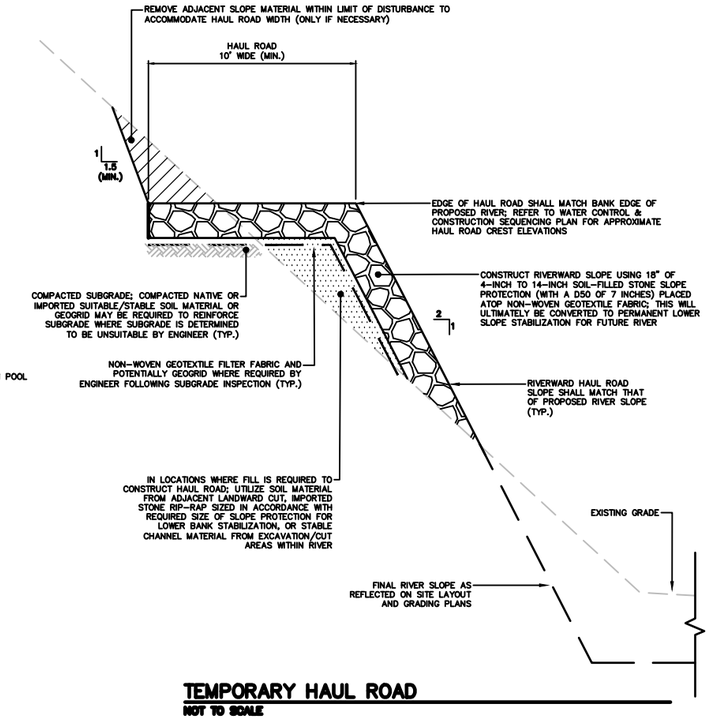


NOTES:

1. MAINTAIN ANTI-TRACKING APRON IN GOOD CONDITION THROUGHOUT CONSTRUCTION PERIOD.
2. ADJACENT ROADWAY SHALL BE SWEPT DAILY TO REMOVE ANY MATERIAL THAT MAY BE TRACKED ONTO PAVEMENT.
3. WIDTH OF APRON SHALL NOT BE LESS THAN WIDTH OF INGRESS OR EGRESS.
4. CRUSHED STONE SHALL CONFORM TO THE REQUIREMENTS OF STANDARD SPECIFICATIONS SECTION M2.01.1 (1 1/2 INCH).
5. FILTER FABRIC SHALL BE NON-WOVEN AND BE LISTED WITHIN MASSDOT'S APPROVED MATERIALS LIST FOR CLASS 1 AND 2 APPLICATIONS.

TEMPORARY STONE CONSTRUCTION ACCESS

NOT TO SCALE



TEMPORARY HAUL ROAD

NOT TO SCALE

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER

SCALE:
HORZ.: AS NOTED
VERT.:
DATUM:
HORZ.: NAD83
VERT.: NAVD88
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GRAPHIC SCALE

CITY OF HAVERHILL

CONSTRUCTION DETAILS

LITTLE RIVER DAM REMOVAL AND RESTORATION

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

CD-504

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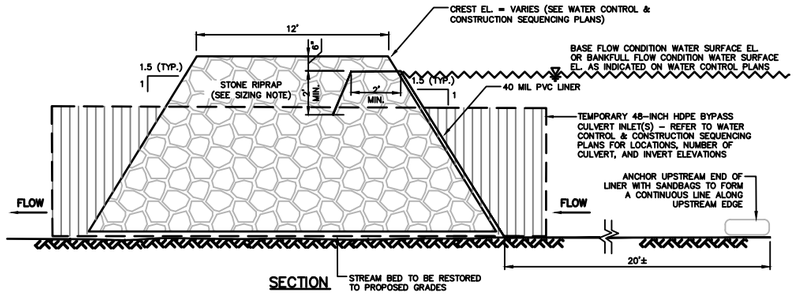
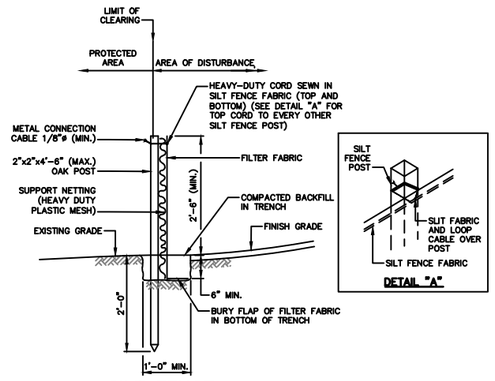
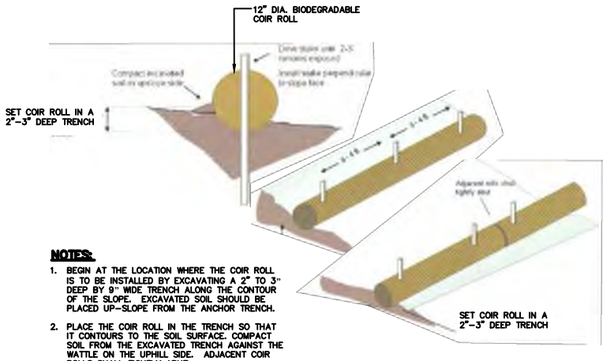


TEMPORARY RIVER CROSSING
NOT TO SCALE



SILT FENCE
NOT TO SCALE



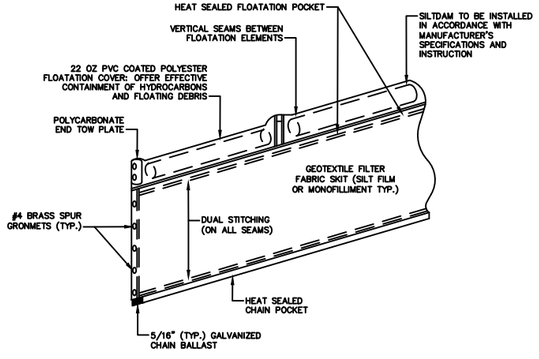
NOTES:

1. BEGIN AT THE LOCATION WHERE THE COIR ROLL IS TO BE INSTALLED BY EXCAVATING A 2" TO 3" DEEP BY 9" WIDE TRENCH ALONG THE CONTOUR OF THE SLOPE. EXCAVATED SOIL SHOULD BE PLACED UP-SLOPE FROM THE ANCHOR TRENCH.
2. PLACE THE COIR ROLL IN THE TRENCH SO THAT IT CONTOURS TO THE SOIL SURFACE. COMPACT SOIL FROM THE EXCAVATED TRENCH AGAINST THE WATTLE ON THE UPHILL SIDE. ADJACENT COIR ROLLS SHALL TIGHTLY ABUT.
3. SECURE THE COIR ROLL WITH 36" LONG (2"x2") STAKES SPACED EVERY 3' TO 4' ON CENTER AND WITH A STAKE ON EACH END. STAKES SHOULD BE DRIVEN THROUGH THE MIDDLE OF THE COIR ROLL LEAVING AT LEAST 2" TO 3" OF STAKE EXTENDING ABOVE THE COIR ROLL. STAKES SHALL BE DRIVEN PERPENDICULAR TO THE SLOPE FACE.

BIODEGRADABLE COIR ROLL (FOR PERIMETER EROSION CONTROL MEASURE)
NOT TO SCALE

1. OVERALL SUMP PIT DIMENSIONS SHALL BE COMPATIBLE WITH ANTICIPATED SEEPAGE RATES AND PUMP SIZE TO BE USED.
2. THE STANDPIPE DIAMETER AND NUMBER OF PERFORATIONS SHALL BE COMPATIBLE WITH THE PUMP SIZE BEING USED.
3. PERFORATIONS IN THE STANDPIPE SHALL BE EITHER CIRCULAR OR SLOTS. PERFORATION SIZE SHALL NOT EXCEED 1/2" IN DIAMETER.
4. **CRUSHED STONE SHALL CONFORM TO THE GRADATION LISTED FOR CRUSHED STONE IN SUBSECTION M2.01.4 OF THE MASSDOT STANDARD SPECIFICATIONS FOR 3/4-INCH CRUSHED STONE. CRUSHED STONE SHALL EXTEND A MINIMUM OF 12" BELOW THE BOTTOM OF THE STANDPIPE.**
5. IF EXCESSIVE MOVEMENT OF FINE SOIL PARTICLES FROM THE SURROUNDING EXISTING SOILS IS ANTICIPATED, A PROPERLY DESIGNED GEOTEXTILE SHALL BE PLACED BETWEEN THE EXISTING SOILS AND THE CRUSHED STONE OR GRAVEL BACKFILL.
6. THE STANDPIPE SHALL EXTEND A MINIMUM OF 12" ABOVE THE SURROUNDING GROUND.
7. **WHEN USED FOR WATER CONTROL DURING THE CONSTRUCTION OF THE LOWER SLOPE AND TOE PROTECTION ASSOCIATED WITH BIOENGINEERED SLOPE STABILIZATION, TREE REVETMENT SYSTEM, AND THE OUTFALL HEADWALL AND ASSOCIATED CHANNEL BOTTOM SCOUR PROTECTION; PUMP DISCHARGE MAY NEED TO BE DIVERTED THROUGH A DEWATERING BAG PRIOR TO BEING DIRECTED INTO THE BROOK IF IT IS DETERMINED BY THE ENGINEER THAT THE DISCHARGE IS TURBID OR CLOUDY.**

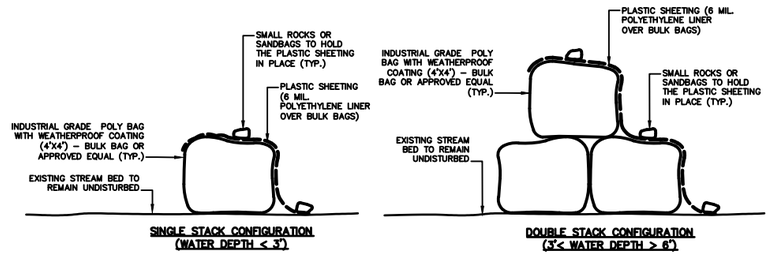
CRUSHED STONE SUMP DETAIL (FOR CONSTRUCTION DEWATERING PUMPS)
NOT TO SCALE



NOTES:

1. CURTAIN SHALL BE A TYPE III HEAVY DUTY CURTAIN THAT IS SUITABLE FOR INSTALLATION WITH FLOWS UP TO 5 FEET PER SECOND (FPS).
2. FLOATATION SIZE (6", 8" OR 12" DIA.) DETERMINED BY SKIRT DEPTH/SITE VARIABLES.
3. OTHER END TYPES AVAILABLE SUCH AS ALUMINUM UNIVERSAL SLIDE OR SLOTTED TUBE.
4. OPTIONAL TOP TENSION CABLE (5/16" TYP.) AVAILABLE FOR INCREASED STRENGTH.

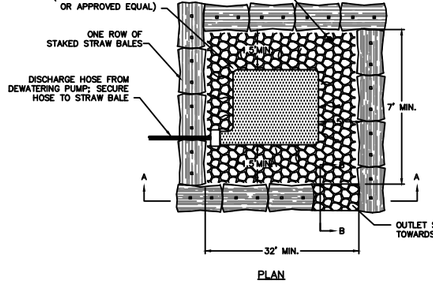
TYPE III FLOATING TURBIDITY CURTAIN
NOT TO SCALE



WATER CONTROL NOTES:

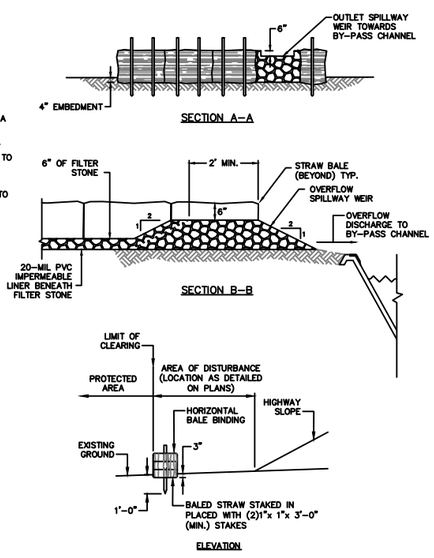
1. TEMPORARY SANDBAGS SHALL CONSIST OF POLYPROPYLENE LARGE SANDBAGS, BULK BAGS OR APPROVED EQUAL, AND SHALL BE FILLED WITH SAND CONFORMING TO SUBSECTION M1.04.0 (TYPE B) OF THE MASSDOT STANDARD SPECIFICATIONS.
2. INSTALL DURING PERIOD OF LOW-FLOW IN BROOK. MONITOR WATER CONTROL SYSTEM DAILY. PROMPTLY CORRECT SEEPAGE, BREAKAGE, OR OTHER EVIDENCE OF MOVEMENT TO ENSURE THAT TEMPORARY COFFERDAM(S) AND WATER BYPASS CONVEYANCES REMAIN STABLE AND FUNCTIONING AS INTENDED.
3. MAINTAIN CRUSHED STONE STUMP AND PUMPS AS NECESSARY TO MAINTAIN DEWATERED CONDITIONS WITHIN COFFERDAMMED AREAS SUFFICIENT FOR COMPLETION OF WORK AND PLACEMENT PROPOSED MATERIALS UNDER SAFE, CONTROLLED CONDITIONS.
4. REMOVE ALL SANDBAGS, ACCUMULATED SEDIMENT, AND OTHER COFFERDAM MATERIALS AFTER IN-RIVER CONSTRUCTION IN RESPECTIVE PHASE IS COMPLETE

TEMPORARY LARGE SANDBAG COFFERDAM (BULK BAGS OR APPROVED EQUAL)
NOT TO SCALE



NOTES:

1. STRAW BALES FOR EROSION CONTROL SHALL CONFORM TO SECTION 767 OF THE STANDARD SPECIFICATIONS INCLUDING MATERIALS AND CONSTRUCTION METHODS.
2. BALES OF STRAW SHALL BE FASTENED WITH WIRE AND HAVE A MINIMUM SIZE OF 1'x1.5'x3'.
3. FILTER STONE SHALL CONSIST OF 1-1/2 INCH STONE CONFORMING TO SUBSECTION M2.01.1 OF THE STANDARD SPECIFICATIONS.
4. FILTER FABRIC SHALL CONFORM TO A TYPE I FABRIC AS INCLUDED WITHIN SECTION M9.50.0 OF THE STANDARD SPECIFICATIONS.



NOTES:

1. THE DEWATERING BAG, DIRTBAG® DB55 OR APPROVED EQUAL, SHALL BE HEAVY DUTY AND CONSIST OF A NONWOVEN BAG SEWN WITH A DOUBLE NEEDLE MATCHING USING A HIGH STRENGTH THREAD.
2. EACH DEWATERING BAG SHALL HAVE A FILL SPOUT LARGE ENOUGH TO ACCOMMODATE A 4-INCH DISCHARGE HOSE. THE BAG SHALL BE PROVIDED WITH STRAPS TO SECURE THE HOSE AND PREVENT PUMPED WATER FROM ESCAPING WITHOUT BEING FILTERED.
3. MAINTAIN DEWATERING BAG(S) AS NECESSARY TO EFFICIENTLY FILTER SEDIMENT OR PASS WATER AT A REASONABLE RATE. USE OF EXCESSIVE FLOW RATES OR OVERFILLING DIRTBAG® WITH SEDIMENT WILL CAUSE RUPTURES OF THE BAGS OR FAILURE OF THE HOSE ATTACHMENT STRAPS.
4. DISPOSE OF DEWATERING BAG AND CONTENTS AT OFF-SITE DISPOSAL FACILITY IN ACCORDANCE WITH THE APPROVED SOIL MANAGEMENT PLAN OR AS DIRECTED BY ENGINEER.
5. INSTALL DEWATERING BAG AND CRUSHED STONE BEDDING WITH A SLOPE SO INCOMING WATER FLOWS DOWNHILL THROUGH THE BAG WITHOUT CREATING MORE EROSION. STRAP THE NECK OF DEWATERING BAG TIGHTLY TO THE DISCHARGE HOSE.

TEMPORARY DEWATERING BASIN WITH FILTER BAG
NOT TO SCALE

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No.	DATE	DESCRIPTION	DESIGNER	REVIEWER

SCALE:
HORZ.: AS NOTED
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DATUM:
HORZ.: NAD83
VERT.: NAVD88
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GRAPHIC SCALE

CITY OF HAVERHILL

CONSTRUCTION DETAILS

LITTLE RIVER DAM REMOVAL AND RESTORATION

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
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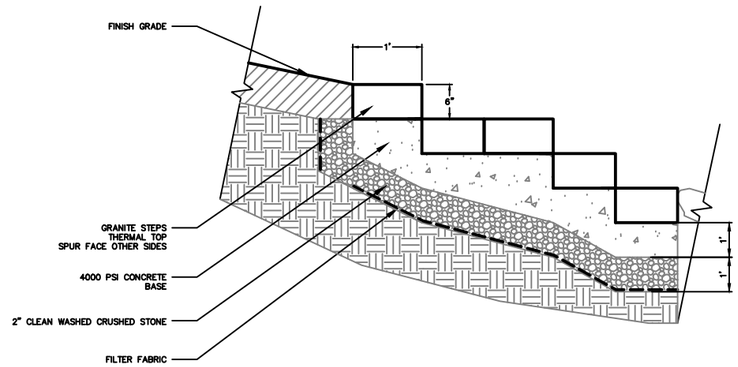
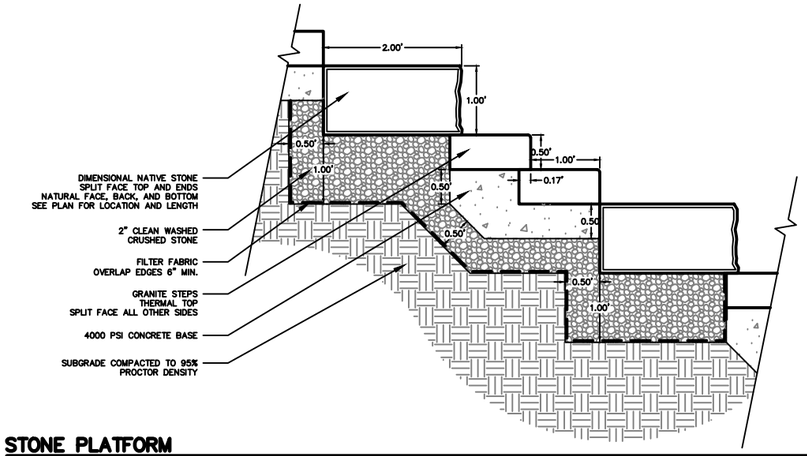
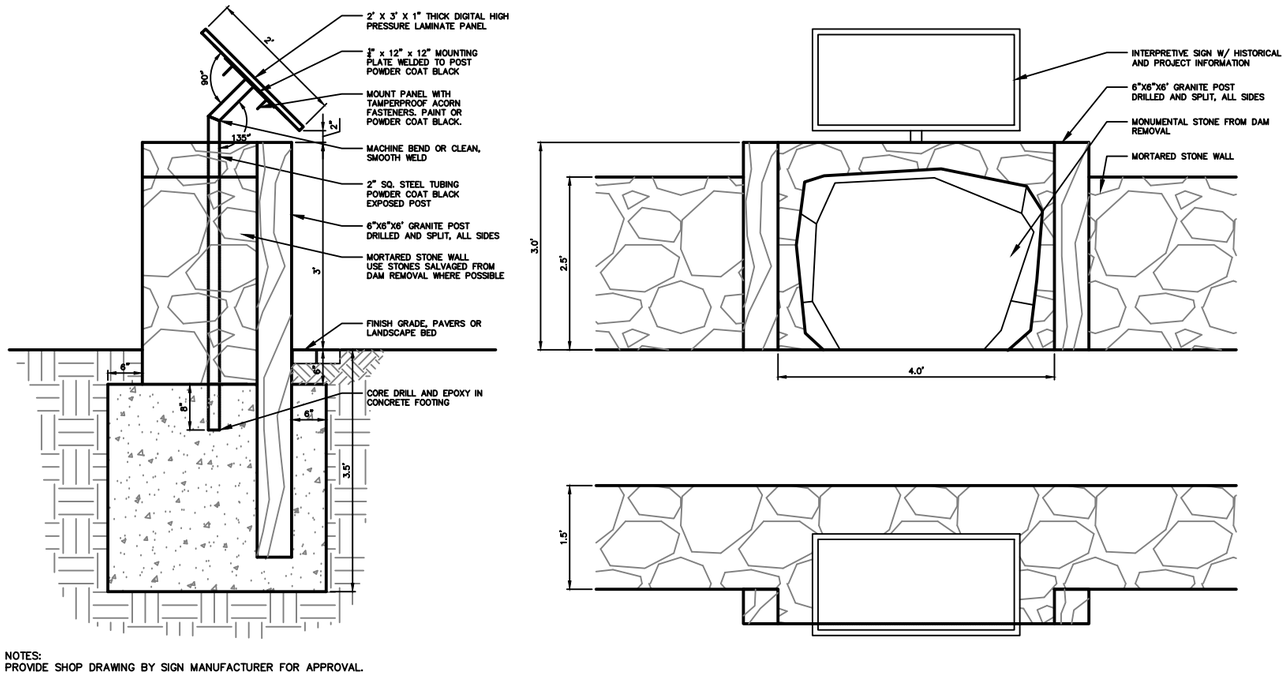
CD-505



GRANITE STEPS
N.T.S.

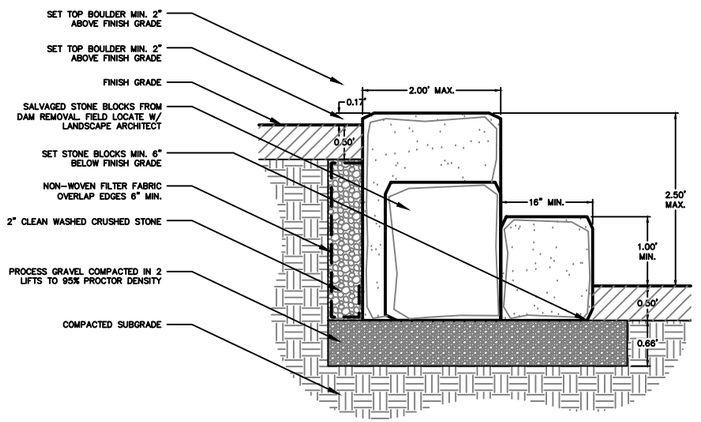


STONE PLATFORM
N.T.S.



NOTES:
PROVIDE SHOP DRAWING BY SIGN MANUFACTURER FOR APPROVAL.

STONE WALL AND INTERPRETIVE SIGN
SCALE: NOT TO SCALE



STACKED SALVAGED STONE BLOCKS
N.T.S.

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER

SCALE:
HORZ.: AS NOTED
VERT.:
DATUM:
HORZ.: NAD83
VERT.: NAVD88
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GRAPHIC SCALE

CITY OF HAVERHILL

CONSTRUCTION DETAILS

LITTLE RIVER DAM REMOVAL AND RESTORATION

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

CD-506

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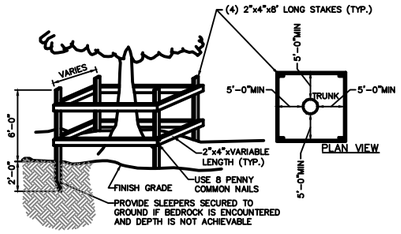
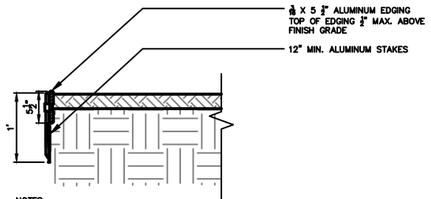


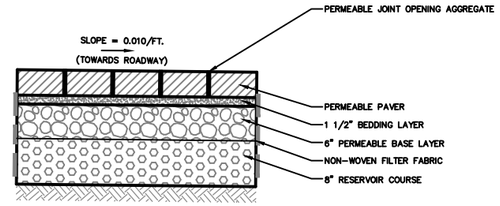
NOTES:
SEE LANDSCAPING PLAN FOR ADDITIONAL TREE PROTECTION NOTES.

TEMPORARY TREE PROTECTION
NOT TO SCALE



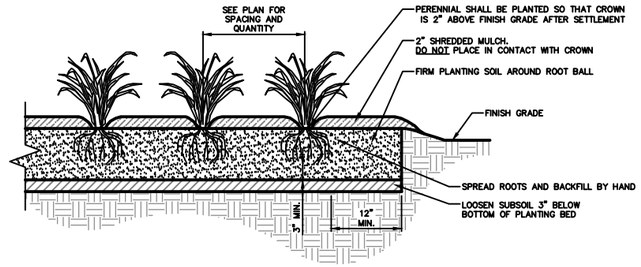
NOTES:
1. 16'-0" SECTIONS TO INCLUDE FIVE (5) 12" STAKES
2. 8'-0" SECTIONS TO INCLUDE THREE (3) 12" STAKES
3. COMPACT GRADES ADJACENT TO EDGING TO MINIMIZE SETTLING
4. CORNERS – CUT BASE OF EDGING HALF WAY AND FORM A CONTINUOUS CORNER.

LANDSCAPE EDGING
SCALE: NOT TO SCALE



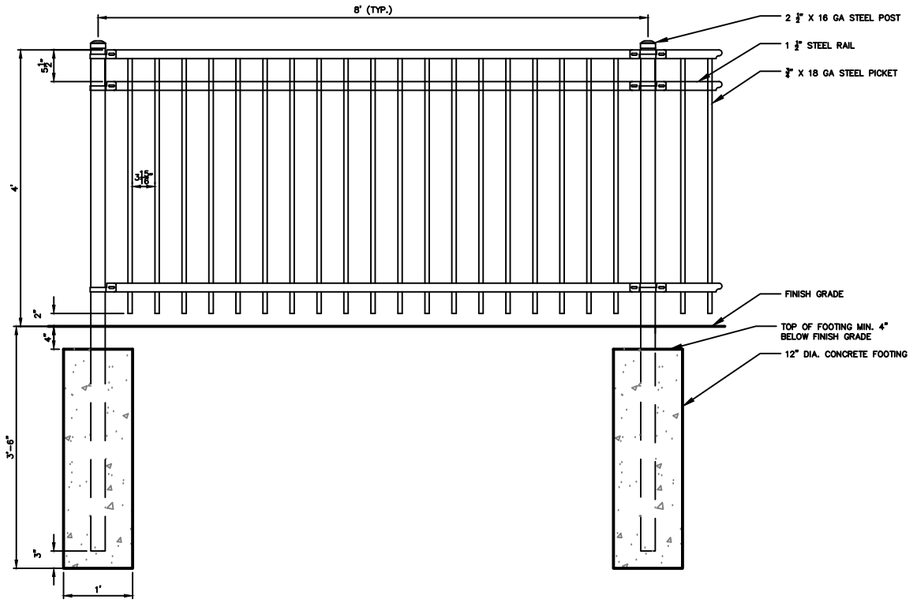
NOTES:
1. THICKNESS OF PERMEABLE CONCRETE PAVERS SHALL VARY BASED ON PRODUCT AND MANUFACTURER SELECTED.
2. THE MINIMUM THICKNESSES OF THE BEDDING LAYER, PERMEABLE BASE LAYER, AND RESERVOIR COURSE LAYER AS SPECIFIED ABOVE REPRESENT MINIMUM THICKNESSES AFTER COMPACTION.
3. PROTECT PERMEABLE PAVERS AND AGGREGATES FROM CONSTRUCTION VEHICLE TRAFFIC, RUNOFF FROM ADJACENT AREAS, AND SEDIMENTATION.

PERMEABLE PAVER SYSTEM
Scale: N.T.S.

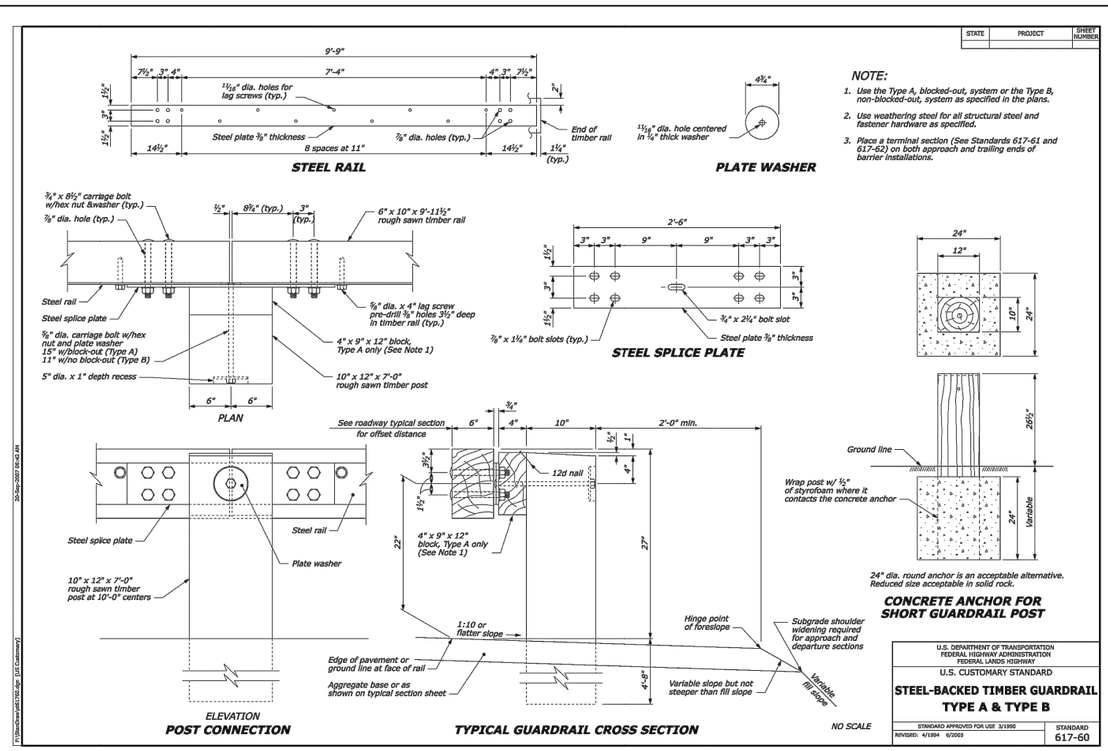


NOTES:
- SPADED PLANTING SOIL MIX SHALL BE PLACED 3" BELOW ROOT BALL AND BE MIXED WITH FERTILIZER. DO NOT COMPACT AFTER PLANTING.
- WATER THOROUGHLY AFTER PLANTING.
- PROVIDE WELL DRAINING SUBSOIL WHEN SOIL IS HEAVY OR COMPACTED.
- FOR CONTAINER GROWN PLANTS, USE FINGERS OR SMALL HAND TOOLS TO PULL THE ROOTS OUT OF THE OUTER LAYER OF POTTING SOIL; THEN CUT OR PULL APART ANY ROOTS CIRCLING THE PERIMETER OF THE CONTAINER.

PERENNIAL PLANT BED
Scale: N.T.S.



DECORATIVE FENCE
SCALE: NOT TO SCALE



STEEL BACKED TIMBER GUARDRAIL
NOT TO SCALE

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VERT.:
DATUM:
HORZ.: NAD83
VERT.: NAVD88
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GRAPHIC SCALE

CITY OF HAVERHILL

CONSTRUCTION DETAILS

LITTLE RIVER DAM REMOVAL AND RESTORATION

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

CD-507

File: J:\DWG\P2017\0390\U30\CivilPlan\20170390U30_DET01.dwg Layout: 11X17-CD-507 Plotted: 2022-12-08 3:23 PM Saved: 2022-12-08 2:44 PM User: CNauman
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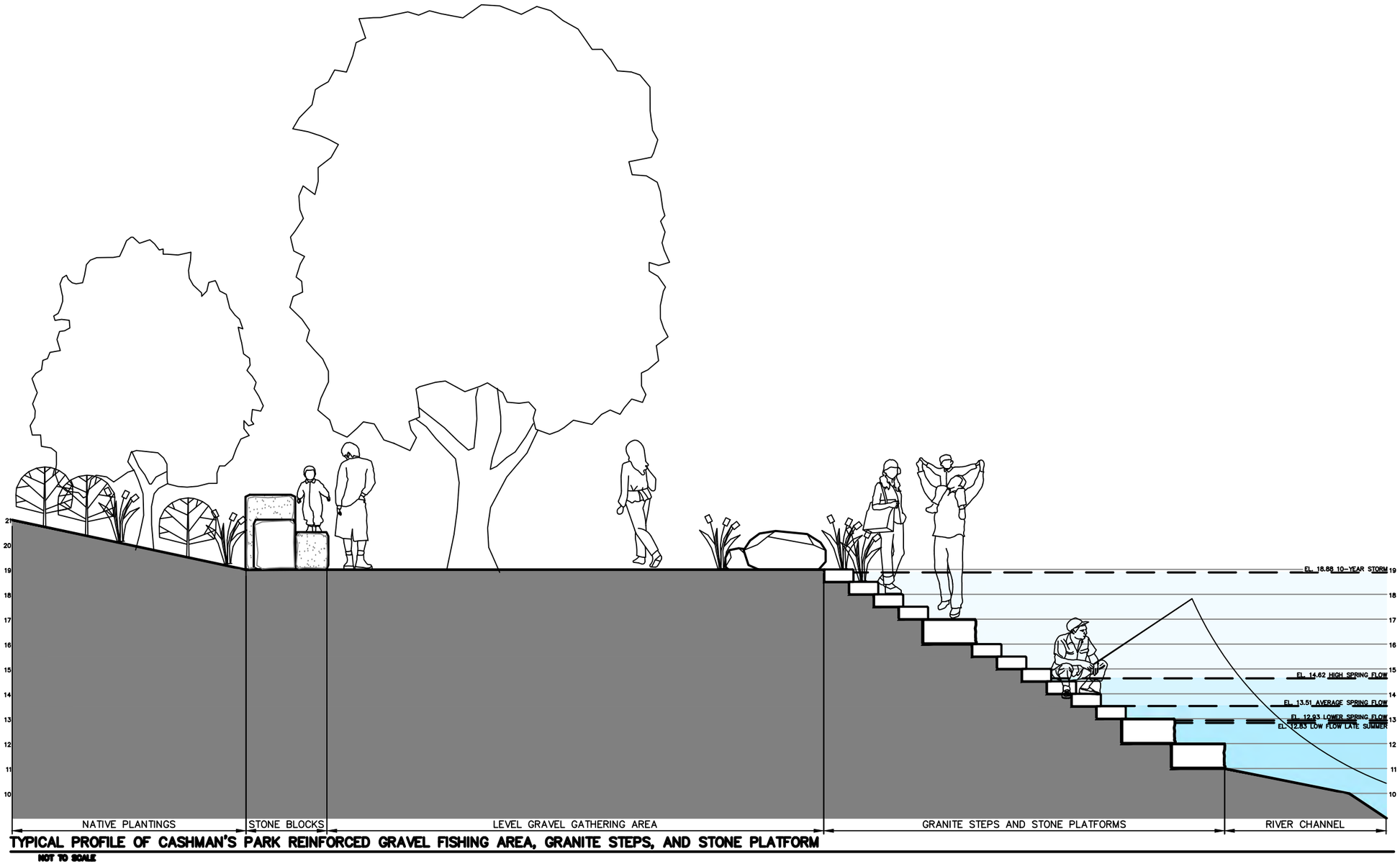

TYPICAL PROFILE OF CASHMAN'S PARK REINFORCED GRAVEL FISHING AREA, GRANITE STEPS, AND STONE PLATFORM

NOT TO SCALE

File: J:\DWG\P20170390\U30\Civil\Plan\20170390U30_DET01.dwg Layout: 11X17-CD-508 Plotted: 2022-12-08 2:44 PM Saved: 2022-12-08 2:44 PM User: CNauman
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No.	DATE	DESCRIPTION	DESIGNER	REVIEWER

SCALE:
HORZ.: AS NOTED
VERT.:
DATUM:
HORZ.: NAD83
VERT.: NAVD88
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GRAPHIC SCALE

CITY OF HAVERHILL

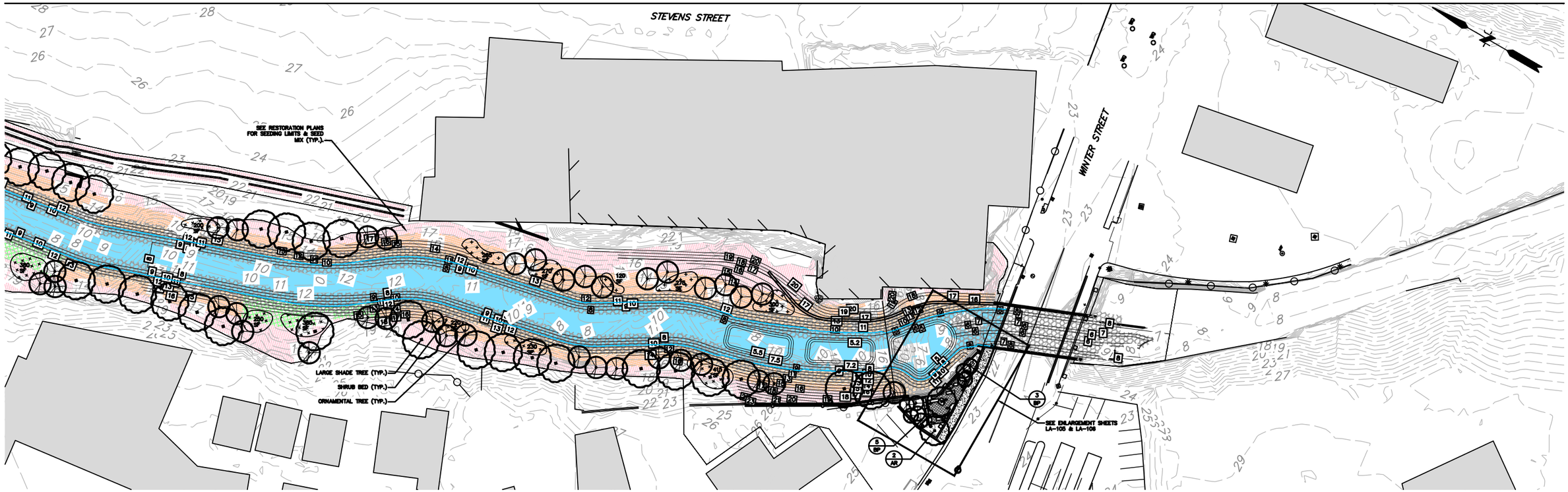
CONSTRUCTION DETAILS

LITTLE RIVER DAM REMOVAL AND RESTORATION

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

CD-508



PLANT LIST

KEY	BOTANICAL NAME	COMMON NAME	SIZE
	LARGE SHADE TREES		
AB	ABIES BALSAMEA	BALSAM FIR	6–7' HT.
AR	ACER RUBRUM	RED MAPLE	2"–2 ½" CAL.
AS	ACER SACHARINUM	SILVER MAPLE	2"–2 ½" CAL.
BA	BETULA ALLEGHANIENSIS	YELLOW BIRCH	2"–2 ½" CAL.
LL	LARIX LARCINA	AMERICAN LARCH	6–7' HT.
PO	PLATANUS OCCIDENTALIS	AMERICAN SYCAMORE	2"–2 ½" CAL.
PS	PRUNUS SEROTINA	BLACK CHERRY	2"–2 ½" CAL.
UA	ULMUS AMERICANA	AMERICAN ELM	2"–2 ½" CAL.
	ORNAMENTAL TREES		
AL	AMELANCHIER LAEVIS	ALLEGHENY SERVICEBERRY	6–8' HT.
BP	BETULA POPULIFOLIA	GREY BIRCH	1"–1 ½" CAL.
CA	CORNUS ALTERNIFOLIA	PAGODA DOGWOOD	1"–1 ½" CAL.
CC	CARPINUS CAROLINIANA	AMERICAN HORNBEAM	1"–1 ½" CAL.

	SHRUBS		
AA	ARONIA ARBUTIFOLIA	RED CHOKEBERRY	3 GAL.
AI	ALNUS INCANA	SPECKLED ALDER	3 GAL.
AM	ARONIA MELANOCARPA	BLACK CHOKEBERRY	3 GAL.
CP	CLETHRA ALNIFOLIA	SWEET PEPPERBUSH	3 GAL.
CR	CORNUS RACEMOSA	GRAY DOGWOOD	3 GAL.
HV	HAMAMELIS VIRGINIANA	WITCH HAZEL	3 GAL.
IV	ILEX VERTICILLATA	WINTERBERRY HOLLY	3 GAL.
KA	KALMIA ANGUSTIFOLIA	SHEEP LAUREL	3 GAL.
SL	SPIRAEA LATIFOLIA	MEADOWSWEET	3 GAL.
ST	SPIRAEA TOMENTOSA	STEEPLEBUSH	3 GAL.
VL	VIBURNUM LENTAGO	NANNYBERRY	3 GAL.

LEGEND:

LARGE SHADE TREE
TOTAL QTY: 222

UNLESS OTHERWISE NOTED ON LANDSCAPE PLAN, SELECT AT LEAST 2 OF THE FOLLOWING SPECIES IN EQUAL QUANTITIES
–AMERICAN SYCAMORE (PLATANUS OCCIDENTAILS, FACW)
–AMERICAN ELM (ULMUS AMERICANA, FACW)
–AMERICAN LARCH (LARIX LARCINA, FACW)
–BLACK CHERRY (PRUNUS SEROTINA, FACU)
–SILVER MAPLE (ACER SACCHARINUM, FACW)

UNLESS OTHERWISE NOTED ON LANDSCAPE PLAN, SELECT AT LEAST 2 OF THE FOLLOWING SPECIES IN EQUAL QUANTITIES
–RED MAPLE (ACER RUBRUM, FAC)
–YELLOW BIRCH (BETULA ALLEGHANIENSIS, FAC)
–BALSAM FIR (ABIES BALSAMEA, FAC)

ORNAMENTAL TREE
TOTAL QTY: 258

UNLESS OTHERWISE NOTED ON LANDSCAPE PLAN, SELECT AT LEAST 3 OF THE FOLLOWING SPECIES IN EQUAL QUANTITIES
–GRAY BIRCH (BETULA POPULIFOLIA, FAC)
–AMERICAN HORNBEAM (CARPINUS CAROLINIANA, FAC)
–ALTERNATE LEAF DOGWOOD (CORNUS ALTERNIFOLIA, FACU)
–SHADBUSH (AMELANCHIER LAEVIS, NI)

SHRUBS
TOTAL AREA: 30,000 SF

SELECT AT LEAST 2 OF THE FOLLOWING SPECIES IN EQUAL QUANTITIES, PLANTED AT 6' O.C.
–MEADOWSWEET (SPIRAEA LATIFOLIA, FACW)
–STEEPLEBUSH (SPIRAEA TOMENTOSA, FACW)
–SPECKLED ALDER (ALNUS INCANA, FACW)
–RED CHOKEBERRY (ARONIA ARBUTIFOLIA, FACW)
–WINTERBERRY HOLLY (ILEX VERTICILLATA, FACW)

SELECT AT LEAST 2 OF THE FOLLOWING SPECIES IN EQUAL QUANTITIES, PLANTED AT 6' O.C.
–BLACK CHOKEBERRY (ARONIA MELANOCARPA, FAC)
–SWEET PEPPERBUSH (CLETHRA ALNIFOLIA, FAC)
–GRAY DOGWOOD (CORNUS RACEMOSA, FAC)
–NANNYBERRY (VIBURNUM LENTAGO, FAC)
–SHEEP LAUREL (KALMIA ANGUSTIFOLIA, FAC)
–WITCH HAZEL (HAMAMELIS VIRGINIANA, FACU)

EXISTING TREE TO REMAN

PLANTING NOTES:

1. ALL PLANTING MATERIAL TO BE NURSERY GROWN STOCK SUBJECT TO A.A.N. STANDARDS
2. THE CONTRACTOR SHALL SUPPLY ALL PLANTS IN QUANTITIES SUFFICIENT TO COMPLETE THE WORK SHOWN ON THE DRAWINGS AND LISTED IN THE PLANT LIST. IN THE EVENT OF A DISCREPANCY BETWEEN QUANTITIES SHOWN IN THE PLANT LIST AND THOSE REQUIRED BY THE DRAWINGS, THE LARGER NUMBER SHALL APPLY.
3. PRECISE LOCATION OF ITEMS NOT DIMENSIONED ON THE PLAN ARE TO BE FIELD STAKED BY THE CONTRACTOR AND SHALL BE SUBJECT TO THE REQUIREMENTS SPECIFIED IN THE PREVIOUS NOTE.
4. ALL SHRUB MASSINGS AND TREE PITS SHALL BE MULCHED TO A DEPTH OF 3" WITH SHREDDED PINE BARK MULCH.
5. TREES SHALL NOT BE STAKED UNLESS OTHERWISE NOTED.
6. THE CONTRACTOR IS RESPONSIBLE FOR ANY DAMAGED VEGETATION AND SHALL REPLACE OR REPAIR ANY DAMAGED MATERIAL, AT HIS OWN EXPENSE. THE CONTRACTOR SHALL CONTACT "CALL BEFORE YOU DIG" AT 1–800–922–4455 PRIOR TO CONSTRUCTION.
7. ALL SHRUB AND GROUNDCOVER PLANTING AREAS SHALL HAVE CONTINUOUS BEDS OF TOPSOIL 12" DEEP. ALL SOD AND HYDROSEED AREAS SHALL HAVE A MINIMUM TOPSOIL BED OF 6".
8. THE CONTRACTOR IS RESPONSIBLE FOR LOCATING ALL UTILITIES IN THE FIELD. WHERE PLANT MATERIAL MAY INTERFERE WITH UTILITIES, THE CONTRACTOR SHALL NOTIFY THE LANDSCAPE ARCHITECT TO COORDINATE THEIR INSTALLATION.
9. FOR PLANTING SOIL MIX, SEE SPECIFICATIONS OR PLANTING DETAILS.
10. ALL EXISTING RILL, GULLY OR CHANNEL EROSION SHALL BE FILLED WITH APPROPRIATE BACKFILL MATERIAL, FINE RAKED, SCARIFIED AND STABILIZED WITH APPROPRIATE VEGETATIVE MATERIAL AND / OR APPROPRIATE SEDIMENTATION AND EROSION CONTROL MEASURES.
11. ADJUSTMENTS IN THE LOCATION OF THE PROPOSED PLANT MATERIAL AS A RESULT OF EXISTING VEGETATION TO REMAIN SHALL BE APPROVED BY THE LANDSCAPE ARCHITECT PRIOR TO INSTALLATION.
12. THE CONTRACTOR IS RESPONSIBLE FOR ALL MAINTENANCE REPAIR AND REPLACEMENT OF PLANT MATERIAL, AS REQUIRED, FOR THE DURATION OF THE PROJECT AND SUBSEQUENT WARRANTY PERIOD.
13. PLANTINGS INSTALLED IN THE DRY SUMMER MONTHS AND / OR LAWN SEEDED OUT OF SPRING OR FALL PERIODS, IF ALLOWED BY OWNER, WILL REQUIRE AGGRESSIVE IRRIGATION PROGRAMS AT THE CONTRACTOR'S EXPENSE, UNLESS OTHERWISE DIRECTED BY THE OWNER.
14. UPON COMPLETION OF PLANTING, REMOVE FROM SITE ALL EXCESS SOIL, MULCH, AND MATERIALS AND DEBRIS RESULTING FROM WORK OPERATIONS. CLEAN UP SHOULD BE COMPLETED AT THE END OF EACH WORKING DAY. RESTORE TO ORIGINAL CONDITIONS ALL DAMAGED PAVEMENTS, PLANTING AREAS, STRUCTURES AND LAWN AREAS RESULTING FROM LANDSCAPING OPERATIONS.
15. CONTRACTOR SHALL SURVEY, LOCATE, AND PROTECT ALL TREES WITHIN AREAS SHOWN AS "EXISTING VEGETATION TO REMAIN" WITHIN THE DEVELOPMENT ENVELOPE FOR REVIEW BY L.A. PRIOR TO CLEARING OPERATIONS.
16. CONTRACTOR TO RESEED ALL DISTURBED AREAS.

UTILITY NOTE

THE CONTRACTOR SHALL BE RESPONSIBLE FOR NOTIFYING "DIG SAFE" AT 811 OR 888–344–7233 TO ARRANGE FOR MARKING OUT EXISTING UNDERGROUND UTILITIES AT LEAST TWO WORKING DAYS PRIOR TO EXCAVATION.

THE UNDERGROUND UTILITIES DEPICTED HEREON ARE BASED ON FIELD LOCATION OF VISIBLE FEATURES, MAPS AND PLANS OF RECORD, UTILITY MAPPING OR OTHER SOURCES OF INFORMATION. THE ENGINEER MAKES NO GUARANTEE THAT THE UNDERGROUND UTILITIES SHOWN COMPRISE ALL SUCH UTILITIES IN THE AREA, EITHER IN SERVICE OR ABANDONED. THE ENGINEER FURTHER DOES NOT WARRANT THAT THE UNDERGROUND UTILITIES SHOWN ARE IN THE EXACT LOCATION INDICATED ALTHOUGH THE ENGINEER DOES DECLARE THAT THEY ARE DEPICTED AS ACCURATELY AS POSSIBLE FROM INFORMATION AVAILABLE. THE ENGINEER HAS NOT PHYSICALLY LOCATED THE UNDERGROUND UTILITIES.

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER

SCALE:
HORZ.: 1" = 70'
VERT.:
DATUM:
HORZ.: NAD83
VERT.: NAVD88
0 35 70
GRAPHIC SCALE

CITY OF HAVERHILL

LANDSCAPE AND PLANTING PLAN NO. 1

LITTLE RIVER DAM REMOVAL AND RESTORATION

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

LA-101

File: J:\DWG\P20170390\U30\Civil\Plan\20170390U30_LND01.dwg Layout: 11X17-LA-101 Plotted: 2022-12-08 3:24 PM Saved: 2022-12-08 2:50 PM User: CNauman
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LAYER STATE:
MS VIEW:

MATCH LINE SEE SHEET LA–103

MATCH LINE SEE SHEET LA–101

SEE RESTORATION PLANS FOR SEEDING LIMITS & SEED MIX (TYP.).

LARGE SHADE TREE (TYP.)

ORNAMENTAL TREE (TYP.)

SHRUB BED (TYP.)

MBTA RAILROAD

STEVENS STREET

LITTLE RIVER STREET

APPLE STREET

BENJAMIN STREET

CLIFF STREET

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER

SCALE:
HORZ.: 1" = 70'
VERT.:
DATUM:
HORZ.: NAD83
VERT.: NAVD88
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GRAPHIC SCALE

CITY OF HAVERHILL

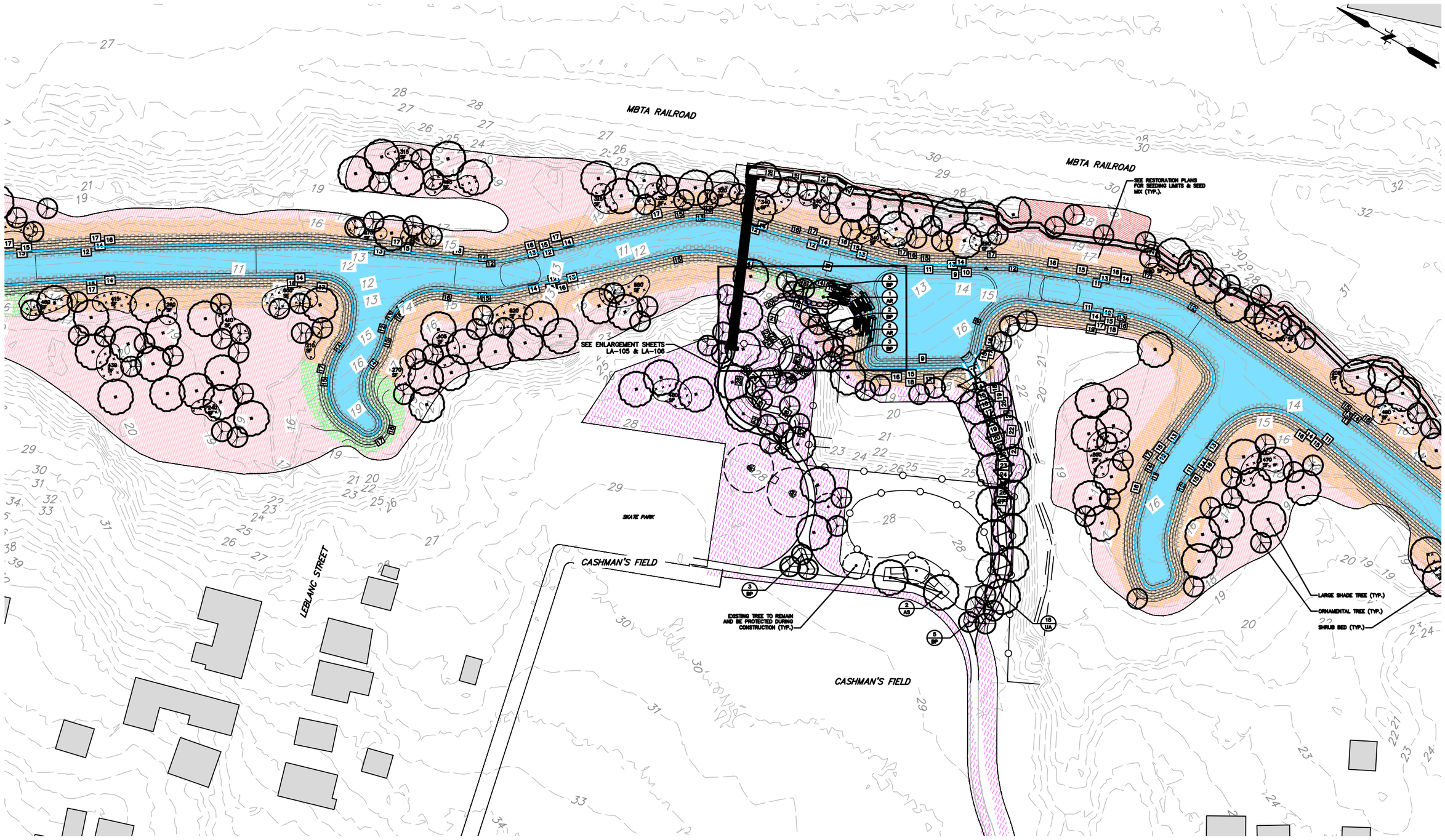
LANDSCAPE AND PLANTING PLAN NO. 2

LITTLE RIVER DAM REMOVAL AND RESTORATION

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

LA-102



No.	DATE	DESCRIPTION	DESIGNER	REVIEWER

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GRAPHIC SCALE

CITY OF HAVERHILL

LANDSCAPE AND PLANTING PLAN NO. 3

LITTLE RIVER DAM REMOVAL AND RESTORATION

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

LA-103

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LAYER STATE:
MS VIEW:

MBTA RAILROAD

SEE RESTORATION PLANS FOR SEEDING LIMITS & SEED MIX (TYP.).

ORNAMENTAL TREE (TYP.)

LARGE SHADE TREE (TYP.)

SHRUB PLANTING BED (TYP.)

WHITTIER PLACE

MATCH LINE SEE SHEET LA-103

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER

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HORZ.: NAD83
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GRAPHIC SCALE

CITY OF HAVERHILL

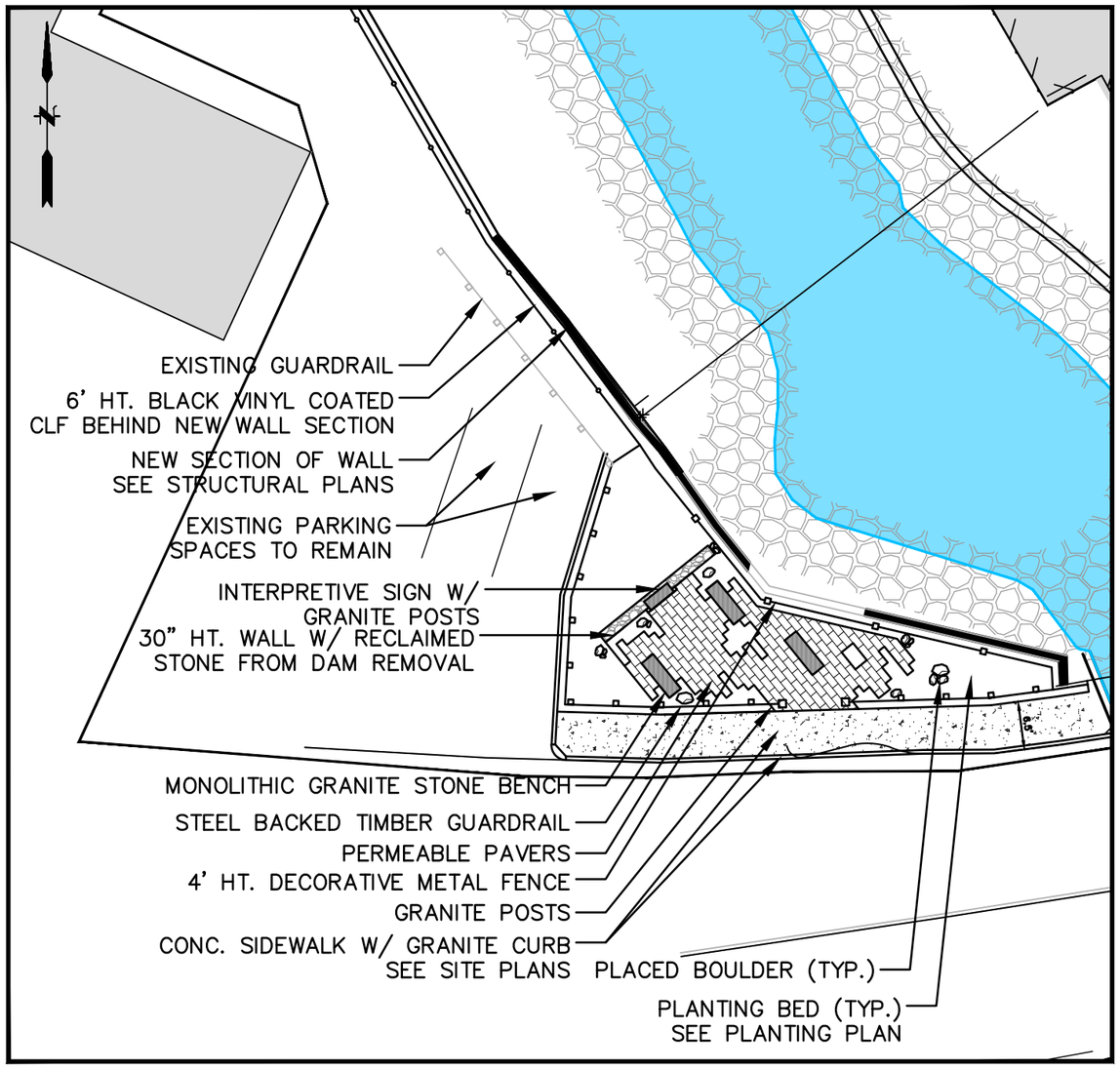
LANDSCAPE AND PLANTING PLAN NO. 4

LITTLE RIVER DAM REMOVAL AND RESTORATION

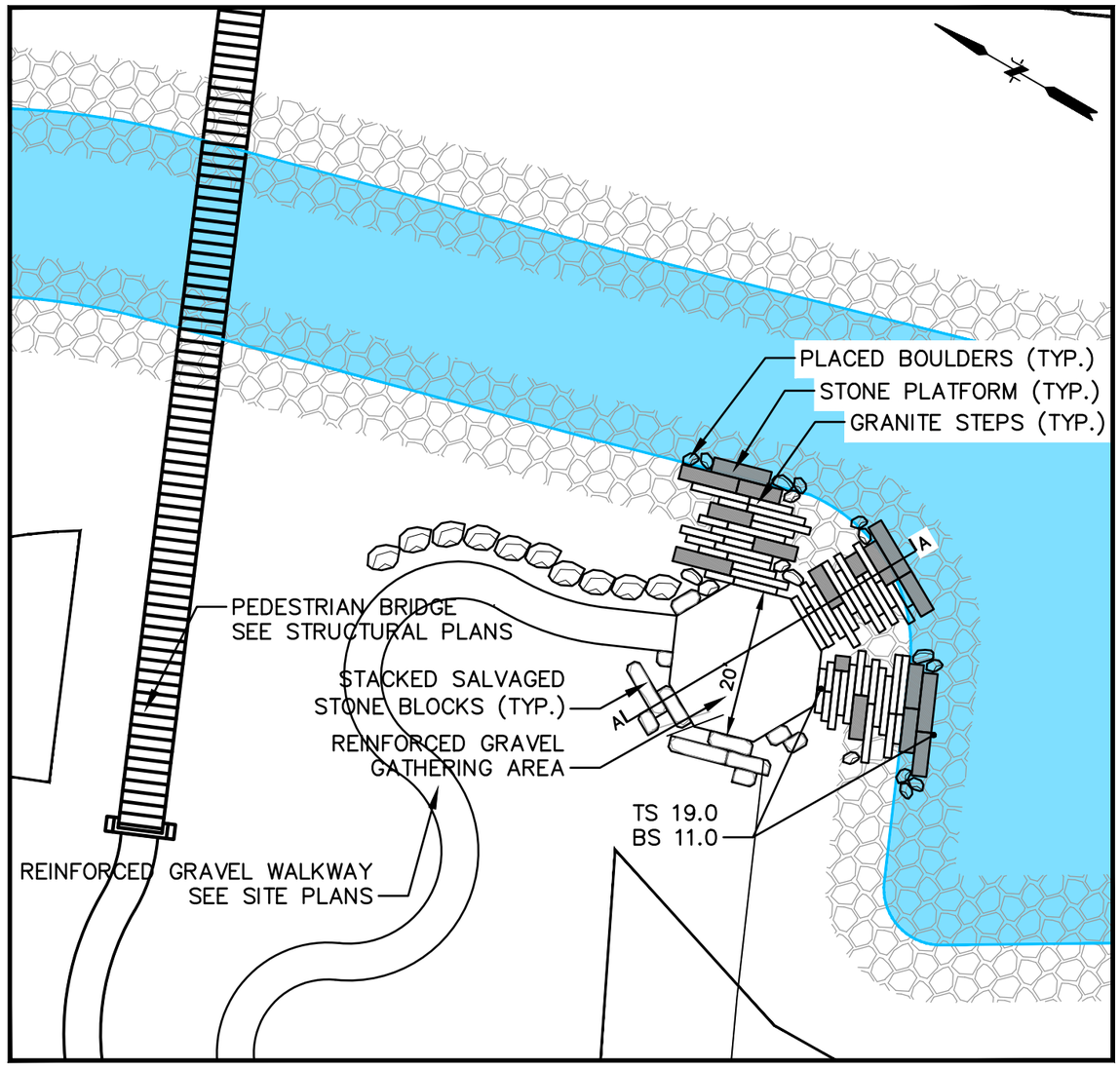
HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

LA-104



1 OVERLOOK - SITE PLAN ENLARGEMENT
SCALE: 1" = 20'



2 CASHMAN'S PARK - SITE PLAN ENLARGEMENT
SCALE: 1" = 20'

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DATUM:
HORZ.: NAD83
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GRAPHIC SCALE

CITY OF HAVERHILL

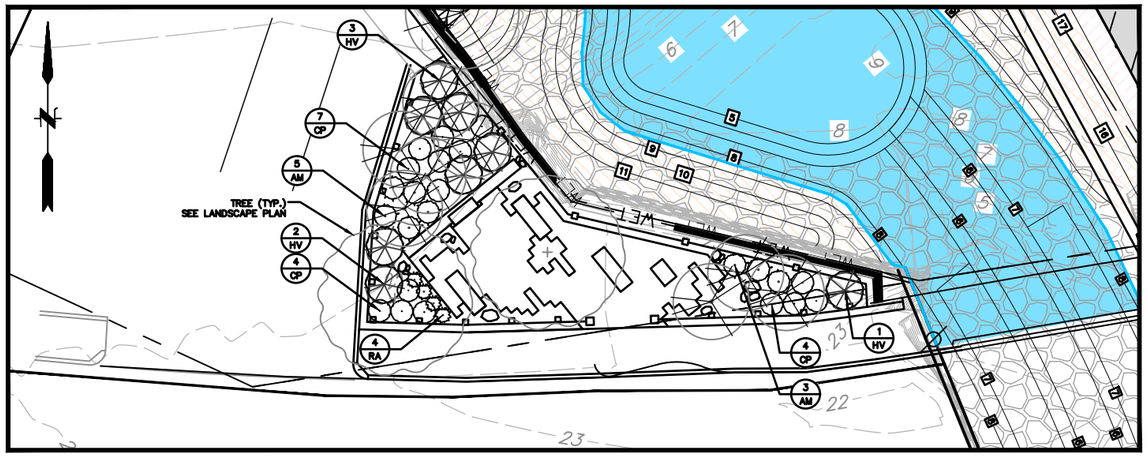
PLANTING PLAN ENLARGEMENTS

LITTLE RIVER DAM REMOVAL AND RESTORATION

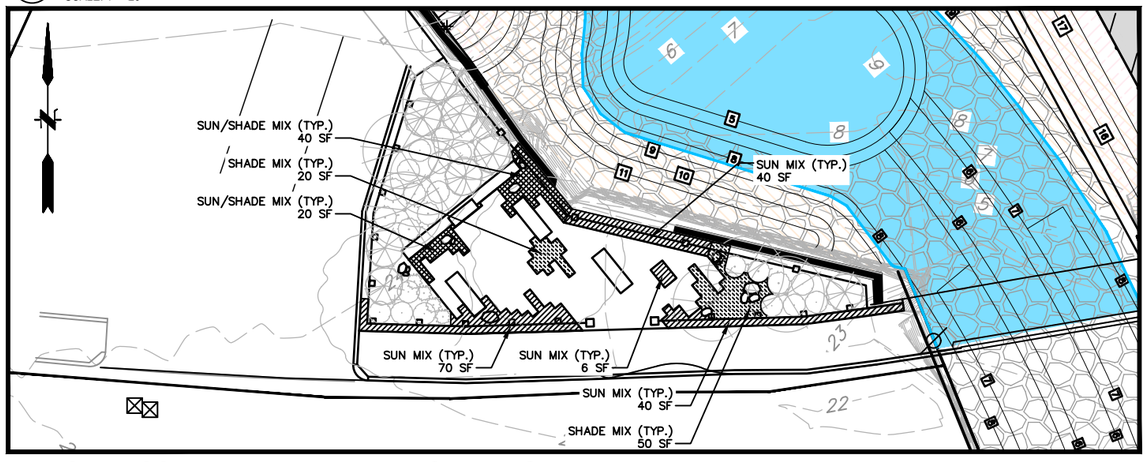
HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

LA-106



1 OVERLOOK - SHRUB PLANTING ENLARGEMENT
SCALE: 1" = 20'



2 OVERLOOK - PERENNIAL PLANTING ENLARGEMENT
SCALE: 1" = 20'

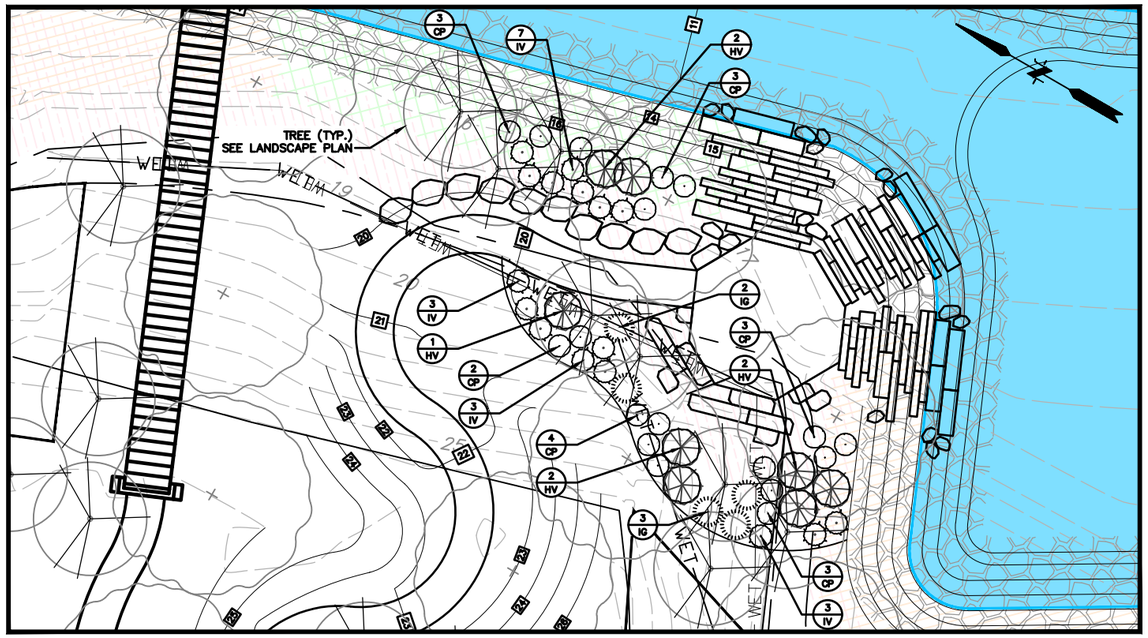
PLANT LIST

KEY	BOTANICAL NAME	COMMON NAME	QTY	SIZE
	SHRUBS			
AM	ARONIA MELANOCARPA	BLACK CHOKEBERRY	8	3 GAL.
CP	CLETHRA ALNIFOLIA	SWEET PEPPERBUSH	33	3 GAL.
HV	HAMAMELIS VIRGINIANA	WITCH HAZEL	16	5-6' HT.
IG	ILEX GLABRA	INKBERRY	5	5 GAL.
IV	ILEX VERTICILLATA 'RED SPRITE'	RED SPRITE WINTERBERRY	16	3 GAL.
RA	RHUS AROMATICA 'GRO LOW'	GRO LOW SUMAC	4	3 GAL.

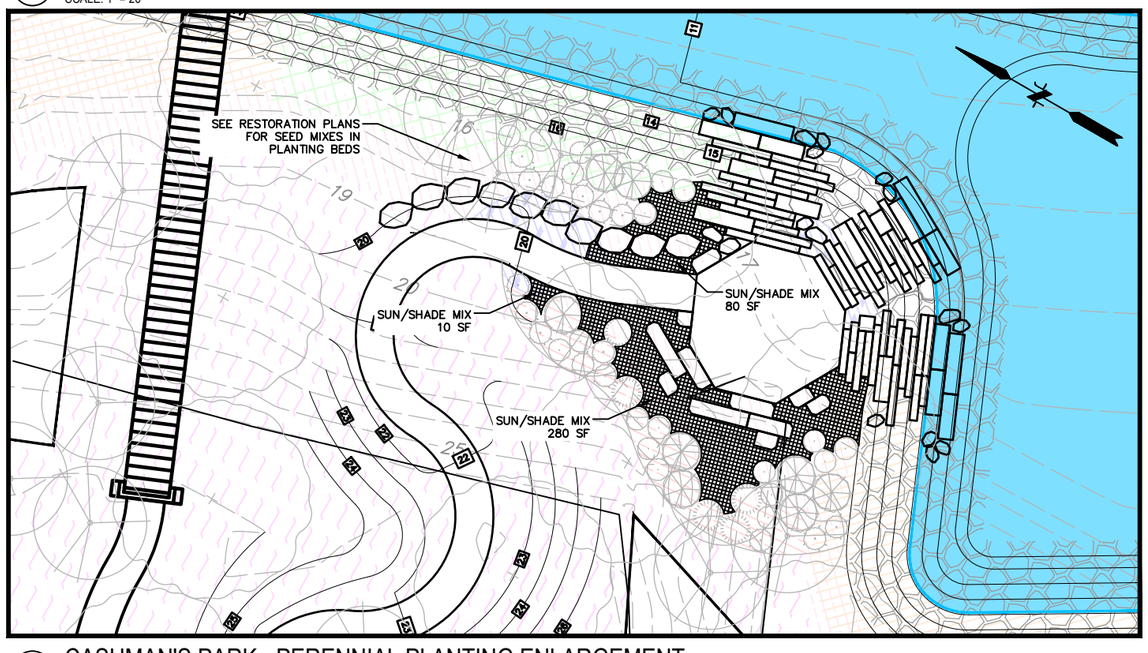
SUN MIX
PLANT THE FOLLOWING SPECIES AT 18" O.C. IN EQUAL QUANTITIES
- –CAREX ROSEA (ROSY SEDGE)
- –PANICUM VIRGATUM (SWITCHGRASS)
- –ASTER NOVAE–ANGLIAE (NEW ENGLAND ASTER)
- –ASCLEPIAS TUBEROSA (BUTTERFLY MILKWEED)

SHADE MIX
PLANT THE FOLLOWING SPECIES AT 18" O.C. IN EQUAL QUANTITIES
- –DENNSTAEDIA PUNCTILOBULA (HAY–SCENTED FERN)
- –THELYPTERIS NOVEBORACENSIS (NEW YARD FARM)
- –AQUILEGIA CANADENSIS (RED COLUMBINE)
- –CAREX ROSEA (ROSY SEDGE)

SUN/SHADE MIX
PLANT THE FOLLOWING SPECIES AT 18" O.C. IN EQUAL QUANTITIES
- –DENNSTAEDIA PUNCTILOBULA (HAY–SCENTED FERN)
- –ASTER NOVAE–ANGLIAE (NEW ENGLAND ASTER)
- –ASCLEPIAS TUBEROSA (BUTTERFLY MILKWEED)
- –CAREX ROSEA (ROSY SEDGE)



3 CASHMAN'S PARK - SHRUB PLANTING ENLARGEMENT
SCALE: 1" = 20'



4 CASHMAN'S PARK - PERENNIAL PLANTING ENLARGEMENT
SCALE: 1" = 20'

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER

SCALE:
HORZ.: 1" = 20'
VERT.:
DATUM:
HORZ.: NAD83
VERT.: NAVD88
0 10 20
GRAPHIC SCALE

CITY OF HAVERHILL

SITE PLAN ENLARGEMENTS

LITTLE RIVER DAM REMOVAL AND RESTORATION

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

LA-105

File: J:\DWG\P2017\0390\U30\Civil\Plan\20170390U30_LND01.dwg Layout: 11X17-LA-105 Plotted: 2022-12-08 3:26 PM Saved: 2022-12-08 2:50 PM User: CNauman
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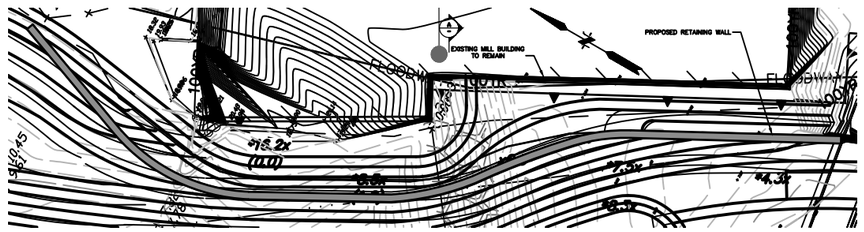
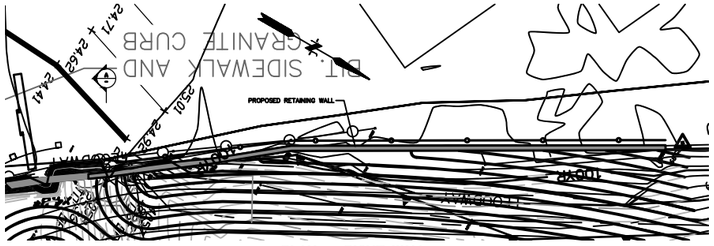
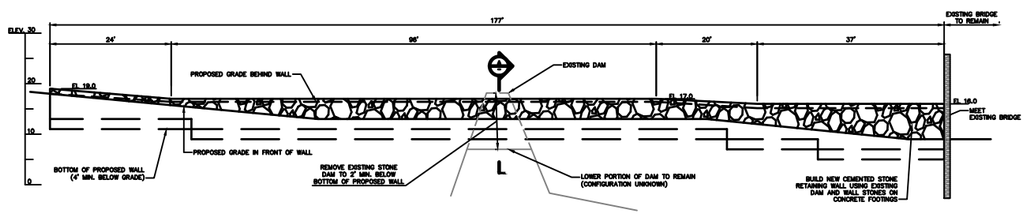


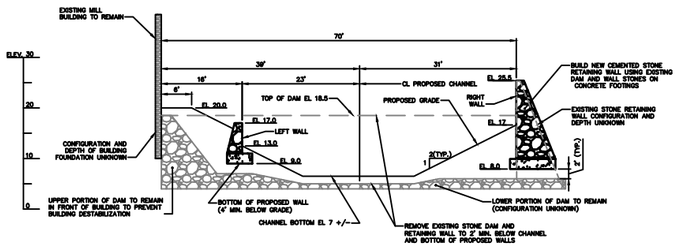
PLAN – LEFT WALL
SCALE: 1"=30'



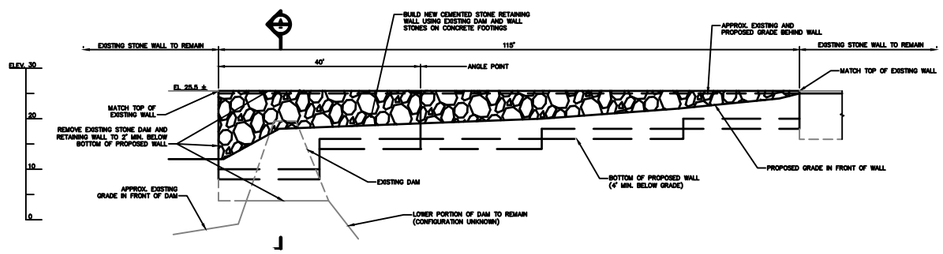
PLAN – RIGHT WALL
SCALE: 1"=30'



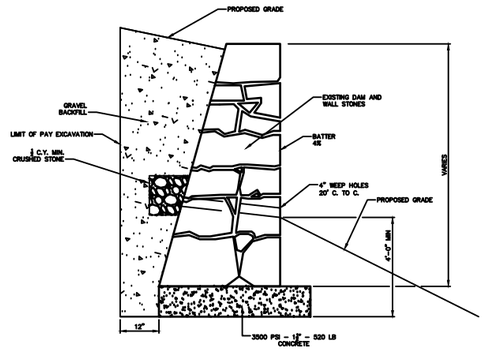
LEFT WALL ELEVATION
SCALE: 1"=30'



SECTION A – LOOKING DOWNSTREAM AT DAM
SCALE: 1"=30'



RIGHT WALL ELEVATION
SCALE: 1"=30'



TYPICAL SECTON – CEMENTED STONE MASONRY WALL
NOT TO SCALE

LAYER STATE:
MS VIEW:

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER

SCALE:
HORZ.: 1" = 30'
VERT.:
DATUM:
HORZ.: NAD83
VERT.: NAVD88
0 15 30
GRAPHIC SCALE

FUSS&O'NEILL
1550 MAIN STREET, SUITE 400
SPRINGFIELD, MA 01103
413.452.0445
www.fando.com

CITY OF HAVERHILL

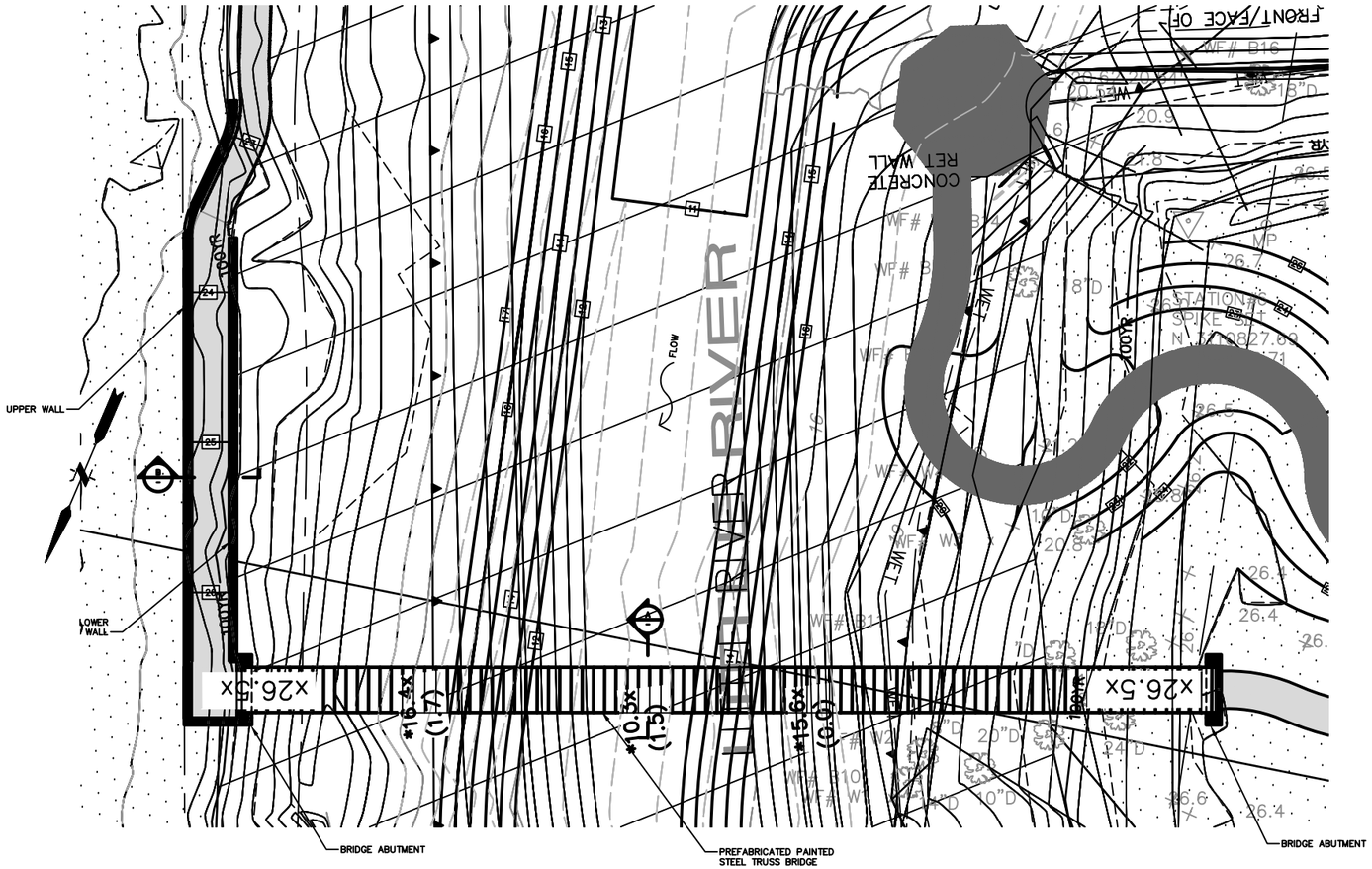
RETAINING WALL DETAILS

LITTLE RIVER DAM REMOVAL AND RESTORATION

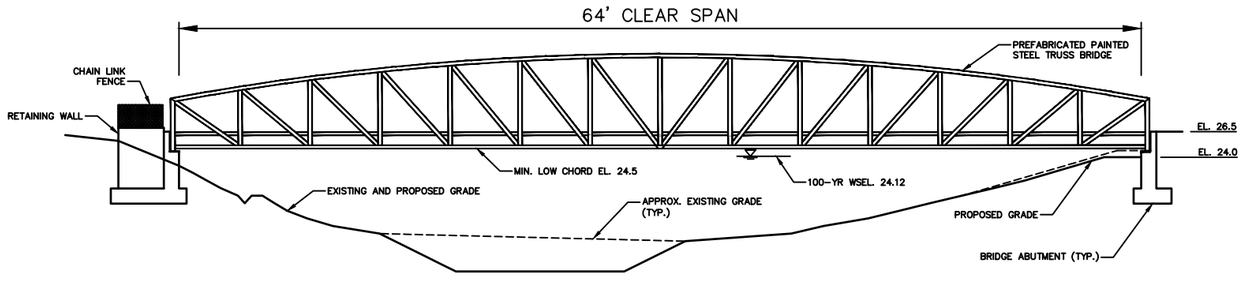
HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: JUNE 2022

S-101



PLAN – PEDESTRIAN BRIDGE
SCALE: 1"=20'



PEDESTRIAN BRIDGE NORTH ELEVATION
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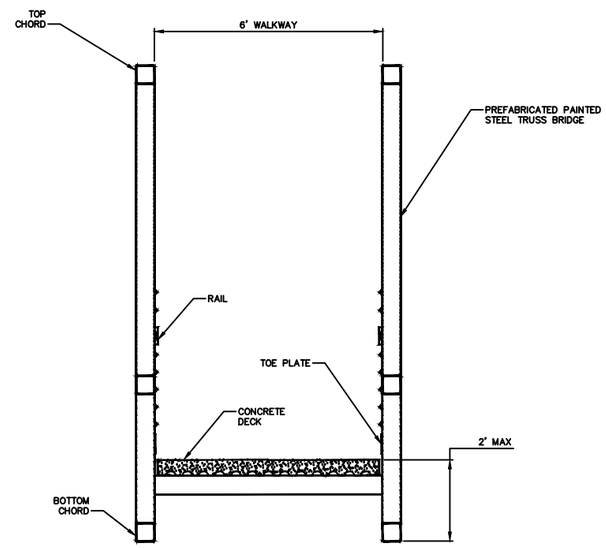

SECTION A – BRIDGE SECTION
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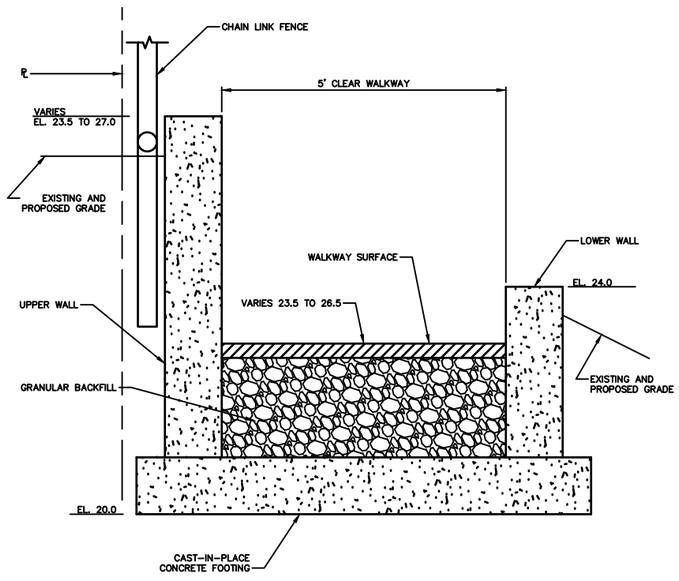

SECTION B – RETAINING WALL SECTION
SCALE: 3/8"=1'-0"

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER

LAYER STATE:
MS VIEW:

SCALE:
HORZ.:
VERT.:
DATUM:
HORZ.: NAD83
VERT.: NAVD88
0
GRAPHIC SCALE

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CITY OF HAVERHILL

PEDESTRIAN BRIDGE DETAILS

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HAVERHILL MASSACHUSETTS

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DATE: JUNE 2022

S-102

HYDROLOGIC AND HYDRAULIC MODELING ANALYSIS

TO: MVP Action Grant Steering Committee, Haverhill, MA

FROM: Julianne Busa, Ph.D.; Sean Arruda, P.E., CFM; Lara Sup, P.E.
Fuss & O'Neill, Inc.

DATE: June 30, 2022 (**Revised December 15, 2023 and March 14, 2024**)

RE: **Little River Dam Removal**
Hydrologic and Hydraulic Modeling Analysis
MVP Action Grant – City of Haverhill

Fuss & O'Neill has prepared a hydrologic and hydraulic analysis of the Little River (River) to assess the impacts the Little River dam removal will have on upstream ecological wetland communities, fish passage, flooding, and sediment transport. Since the section of the Little River downstream of the dam is impacted by backflow from the Merrimack River during larger flood events as well as daily tidal fluctuations, these impacts were not only assessed under present-day hydrologic conditions, but also under future hydrologic conditions with consideration given to climate change as it relates to sea level rise and increased rainfall. Future climate conditions were modeled using the guidelines created by the Resilient Massachusetts Action Team (RMAT).

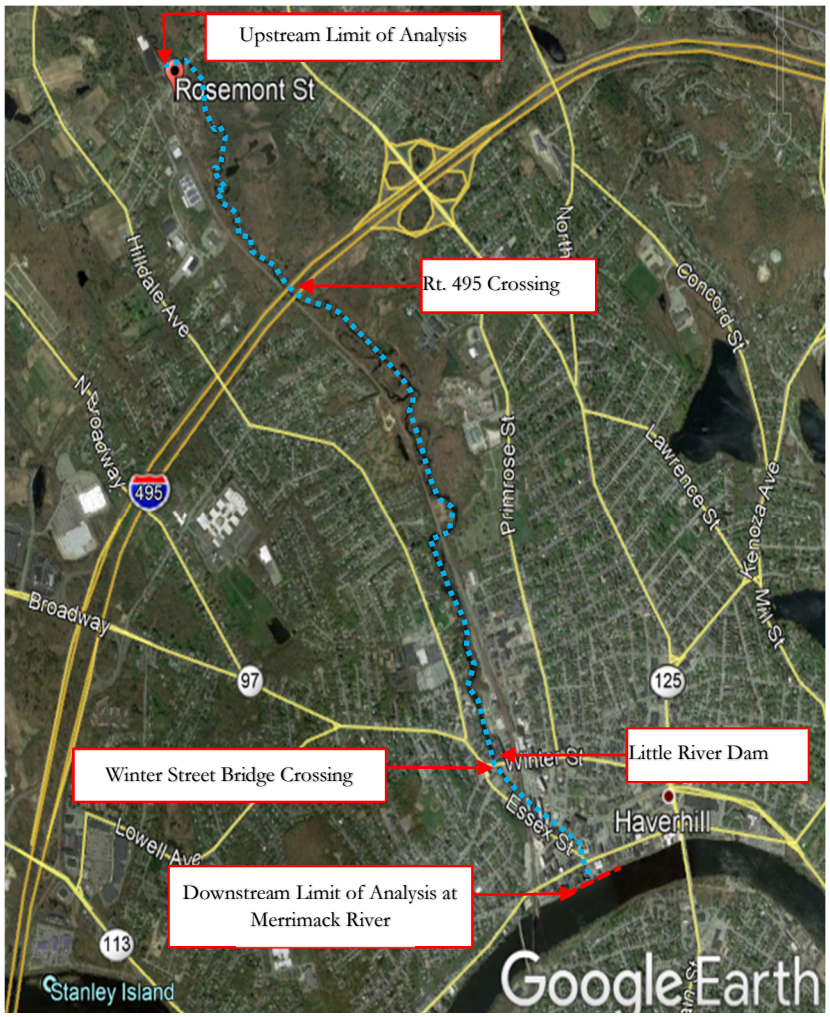

Figure 1: Project Limits of Hydraulic Analysis

For purposes of this analysis, the hydraulic model extends from a point approximately 120 feet upstream of the Rosemont Avenue bridge crossing (referred to as the Project's upstream limit of analysis) to the Little River's confluence/discharge to the Merrimack River as shown in Figure 1 (referred to as the Project's downstream limit of analysis).

Hydrologic Evaluation

In order to assess fish passage suitability, ecological alterations, sediment mobility concerns, structural impacts, and flood protection benefits associated with removing the dam, pre- and post-conditions hydraulic models were developed using HEC-RAS. The anticipated impacts associated with the removal of the Dam have been assessed at three primary hydrologic levels; (1) selected flood flow intervals including the 10-, 50-, 100-, and 500-year recurrence interval flood events; (2) the existing August/September water level which represents base flow conditions; and (3) upstream fish migration flow conditions for target species (i.e. during minimum, normal, and maximum operating conditions).

Flood Flow Approximation

Flood flows for this analysis were obtained from FEMA's Flood Insurance Study (FIS) for Essex County, Massachusetts dated July 19, 2018. Table 1 summarizes peak discharges that were utilized for the 10-, 2-, 1-, and 0.2-percent annual chance floods (commonly referred to as the 10-, 50-, 100-, and 500-year recurrence interval flood events):

Table 1: Summary of Discharges for Little River within Limit of Study

Flooding Source and Location	Drainage Area (Square Miles)	10-Percent 10-year Discharge (cfs)	2-Percent 50-year Discharge (cfs)	1-Percent 100-year Discharge (cfs)	0.2-Percent 500-year Discharge (cfs)
At Corporate Upstream Limits	20.8	660	1,065	1,275	1,865
Upstream of I-495 (RS15341)	27.0	980	1,640	1,990	3,030
At Winter Street (RS11387)	37.0	1,160	1,920	2,330	3,520

According to the FIS, peak flows for the Little River were prepared by Cullinan Engineering Co., Inc., for FEMA under Contract No. H-4797 in January 1981. These flows were derived from peak-discharge frequency relationships using procedures described in USGS's *Estimating the Magnitude and Frequency of Floods for Natural-Flow Streams (1977)*. This methodology was developed using multiple regression analyses to estimate flood peaks on ungauged, natural-flow streams in Massachusetts by relating peak discharges to basin and climatic parameters. These resulting peak discharges were then verified using statistically analyzed data from nearby stream gages with similar watershed characteristics using a multiplication factor equal to the ratio for the drainage areas. Refer to **Attachment 1** for a copy of pertinent information for the Little River obtained from the FIS.

Base Flow Approximation

Removal of the dam will alter water surface elevations upstream of the dam. The ecology of wetland systems upstream of the dam may be governed by water surface elevations during the seasonal low-flow period (referred to herein as the base flow) that occurs during the months of August and September. To quantify the anticipated reduction in upstream water levels during base flow conditions, the mean daily August-September flow was approximated and used to analyze the impact of dam removal on upstream water levels and wetlands.

Since the Little River is an ungauged river, Fuss & O'Neill used recorded USGS flow data from similar river basins to approximate the mean daily August-September flow. Three USGS gauge stations were chosen to make this approximation: East Branch Neponset River at Canton, MA (USGS 01105500), Indian Head River at Hanover, MA (USGS 01105730), and Wading River near Norton, MA (USGS 01109000). These three stations were chosen based on a combination of proximity, size, and other basin characteristics such as impervious cover, development, and slope. USGS StreamStats reports containing the contributing drainage area and relative statistics for each of these stations, as well as one for the current Little River Project Site, are provided as **Attachment 2**.

Daily flow data from 1990 to 2020 was retrieved from USGS, and the mean flow rates for each of the three stations during the months of August and September over this period were calculated. This base flow for the Little River site was calculated using the following formula:

$$Q_u = Q_g(A_u / A_g)$$

where Q_u is the flow rate at the ungauged site (South River), Q_g is the flow rate at the comparison station, A_u is the drainage area of the ungauged site, and A_g is the drainage area of the comparison station. The average of the three resulting values for Q_u was used as the base flow rate for this analysis. Table 2 below lists the resulting flow rates calculated using the above method.

Table 2: Calculation of Base Flow for Little River at Little River Dam (flow rates in cfs)

Station Name	Drainage Area (mi²)	Mean Flow, August-September	Qu Adjusted to Project Site
East Branch Neponset River	27.2	11.9	12.2
Indian Head River	30.5	12.4	11.3
Wading River	43.1	9.0	5.8
Little River (ungauged)	27.9		**9.8**

As shown, a base flow rate of 9.8 cfs was used to assess potential ecological effects upstream of the dam.

Fish Passage Flow Approximation

The removal of the Little River Dam will also result in a section of the river channel with an increased slope and reduced flow depths. In order to quantify flow velocities and depths to ensure that flow velocities and depths will be conducive for passage of targeted aquatic species, flows during the upstream fish passage/migration season were approximated using methods similar to those described within the base flow approximation section by analyzing flow data from similar river basins: East Branch Neponset River, Indian Head River, and Wading River.

Evaluation of fish passage flows must consider typical minimum, normal, and maximum flows, corresponding to the 95% exceedance, 50% exceedance, and 5% exceedance flows, respectively, during the upstream migration/passage season. The upstream migration/passage season is dependent on the project's target species. The Little River is a tributary to the Merrimack River in the Gulf of Maine watershed. Although the Merrimack River is a valuable resource for diadromous fish including river herring (Alewife and Blueback herring), as well as of American shad, gizzard shad, striped bass, rainbow smelt, Atlantic salmon, and sea lamprey and for catadromous species such as American eel; the Little River does not

support as many of these species. During a pre-application meeting that was held virtually on January 11, 2022 with representatives from both the Massachusetts Department of Marine Fisheries and Department of Environmental Resources, it was agreed that the target species for the Little River would be Alewife, Blueback herring, American eel, and potentially rainbow smelt as well as resident species such as perch, sunfish, and white sucker. The watershed of the Little River was too small to support American shad and striped bass. Per guidance from the Massachusetts Division of Marine Fisheries (DMF), the upstream migration/passage season is considered to last from March 1st to June 30th. Therefore, daily flow rates for this three-month period averaged over the past 30 years (same period used to calculate base flows) were used to approximate fish passage flows. The results of this analysis for the 5%, 50%, and 95% exceedance flows obtained from USGS for the fish passage season are provided in **Attachment 3**. A summary of flow approximation results using the three noted USGS stations is provided below in Table 3.

Table 3: Calculation of Fish Passage Flows for Little River at Little River Dam (all flow rates in cfs)

Station Name	Drainage Area (mi2)	Mean Q95%. Flow, Mar. 1 - June 30	$Q95\%_{,min}$ Adjusted to Project Site	Mean 50%, Mar. 1-June 30	$Q50\%_{,normal}$ Adjusted to Project Site	Mean Q5%, Mar. 1-June 30	$Q5\%_{,max}$ Adjusted to Project Site
East Branch Neponset River	27.2	15.0	15.0	56.0	57.0	199.0	204.0
Indian Head River	30.5	16.0	15.0	61.0	56.0	238.0	218.0
Wading River	43.1	16.0	10.0	86.0	56.0	283.0	183.0
Little River (ungauged)	27.9		**13.3**		**56.3**		**201.7**

Current and Projected Tidal Conditions at Project Site

The section of the Little River that is downstream of the Little River Dam, especially within the Little River Conduit, is tidally impacted. The Little River empties into the Merrimack River through this conduit. While there is not a NOAA tidal station located immediately at the confluence of the Little River and the Merrimack River, there is a NOAA tidal station located along the Merrimack River (at the Bates Bridge) approximately 3.1 miles downstream of the Little River confluence. Table 4 represents approximate tidal conditions based on a review of tidal information recorded at this station. Tidal elevations are referenced to NAVD88 and were obtained using NOAA's Online Tides & Currents website (Datums - NOAA Tides & Currents) as included in **Attachment 4**.

Table 4: Approximate Present-Day Tide Elevations at the Mouth of the Merrimack River

Station Name	MLLW (feet)	MLW (feet)	MTL (feet)	MHW (feet)	MHHW (feet)
Merrimack River at Riverside Park (Bates Bridge)	**-1.38**	-1.26	1.60	4.46	4.92

Note: Per NOAA's 2021 Tide Predictions at this station, it appears that high tide elevations are expected to exceed El. 4.92 feet (NAVD88) between 1 to 10 days per month with tides reaching as high as El. 5.8 feet NAVD88).

Based on a review of the City of Haverhill's *Flood Protection System Improvement Plans*[1], the Little River Conduit is approximately 0.38 miles in length and extends from its outlet at the Merrimack River to its inlet that is located approximately 630 feet downstream of the Little River Dam. The invert elevations of the Little River Conduit (Conduit) range between El. -3.3 feet (NAVD88) to El. 5.2 feet (NAVD88). As a result, the majority of the section of the Little River within this Conduit are impacted by tides daily. However, it does

[1] City of Haverhill, Massachusetts, Flood Protection System Improvements (CWSRF-3662 / IFB020-13), AECOM USA, Inc. (February 14, 2013).

not appear that there is a significant tidal impact within the River upstream of the Conduit given approximate river channel bottom elevations between the Little River dam and the inlet of the Conduit that exceed El. 5.8 feet (NAVD88) with exception to periods of extreme high tides and/or coastal storm surge events. In such cases, the Dam restricts extreme high tide levels from extending any further upstream.

Although tidal effects within the River between the Dam and the Little River Conduit are relatively minor under present-day conditions, it should be noted that the sea level around Boston has risen by 8 inches since 1950 and is expected to continue rising. As documented within the *Massachusetts State Hazard Mitigation and Climate Adaptation Plan (SHMCAP)*, sea levels surrounding Boston are expected to rise by approximately 1.7 feet by 2040, 2.4 feet by 2050, 4.2 feet by 2070, and 7.6 feet by 2100 assuming a 'high' scenario. The following table (Table 5) summarizes projected mean lower low water (MLLW), mean low water (MLW), mean high water (MHW), and mean higher high water (MHHW) levels within the Little River in the vicinity of the Dam due to sea level rise (SLR).

Table 5: Estimated Present-Day versus Projected Tidal Elevations at Little River Dam

Time	SLR Increase	MLLW (feet)	MLW (feet)	MTL (feet)	MHW (feet)	MHHW (feet)
Present Day	----	-1.38	-1.26	1.60	4.46	4.92
2040	+1.7 feet	0.32	0.44	3.30	6.16	6.62
2050	+2.4 feet	1.02	1.14	4.00	6.86	7.32
2070	+4.2 feet	2.82	2.94	5.80	8.66	9.12
2100	+7.6 feet	6.22	6.34	9.20	12.06	12.52

As shown in the table above and in Figure 2 below, current sea level rise projections indicate that mean high water levels are expected to regularly (daily) extend as far upstream as the Dam sometime between 2050 and 2070. For reference, the top elevation of the Merrimack River Floodwall varies from 23.05 to 23.20 feet (NAVD88). The Little River Conduit has varying cross sections; but at the outlet to the River it consists of an arch with an internal width of 21.5 feet, an internal height ranging from 12.3 to 13.3 feet, and a v-shaped concrete bottom with a maximum added depth of 2.7 feet at its vertex.

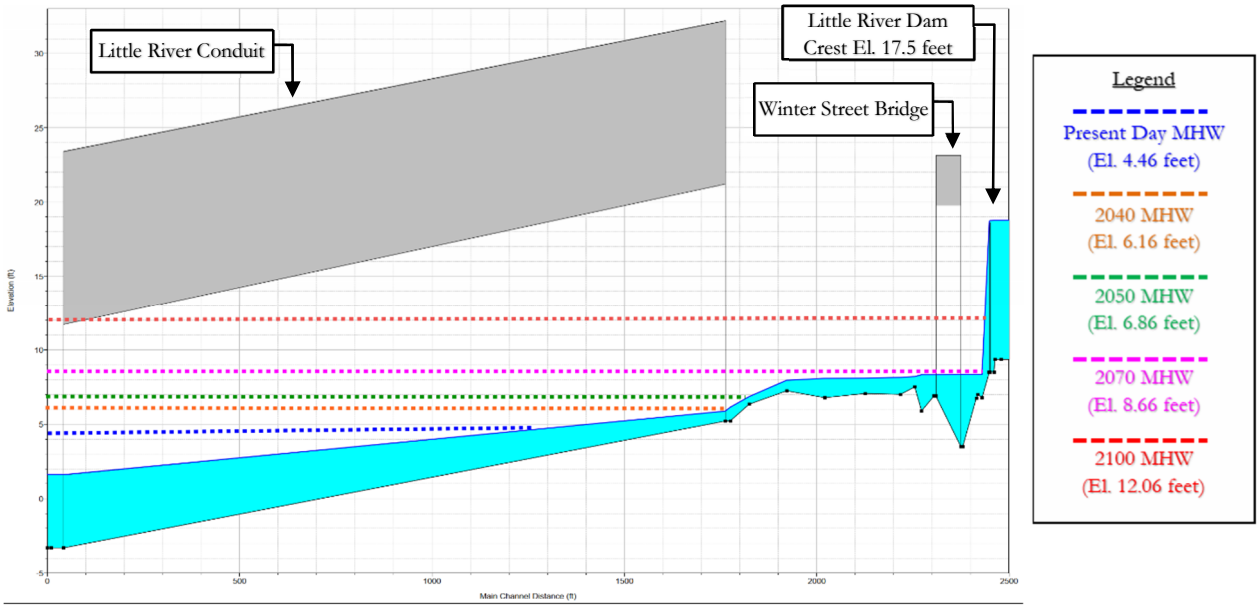

Figure 2: Present-Day and Projected Mean High Water Levels at Little River Dam

Hydraulic Evaluation

To develop a pre-conditions hydraulic model of the River within the Project's limit of analysis prior to dam removal, Fuss & O'Neill first developed a HEC-RAS model of the River from hydraulic back-up data that was provided by FEMA. For purposes of this memorandum, this initial hydraulic model created by Fuss & O'Neill will be referred as FEMA's Duplicate Effective Model. The Duplicate Effective Model was then updated with bathymetric survey of the River to more accurately reflect the existing hydraulic conditions of the River.

This improved, Pre-Dam Removal model was then used as a basis for comparison to assess hydraulics through the River following the removal of Little River Dam. This hydraulic assessment was critical to:

- understanding the potential effects that the lowering of the river's profile would have on adjacent structures to remain (particularly the building upstream of the dam on river left, upstream bridge structures, and the downstream Winter Street Bridge) and in designing measures/improvements to mitigate adverse impacts and protect such structures;
- performing a sediment mobility assessment;
- understanding the erosion potential of banks, and
- designing river restoration practices to maximize safe and effective fish passage.

Duplicate Effective Hydraulic Model

The current flood zone mapping for the Little River is based upon a detailed flood study which is documented in FEMA's Flood Insurance Study (FIS) for Essex County, Massachusetts (All Jurisdictions) dated July 19, 2018. The flood zone boundaries, which include Zone AE and Zone X in addition to the River's floodway, are depicted on the following Flood Insurance Rate Maps (FIRMs):

- FIRM No. 25009C0078F (dated July 3, 2012);
- FIRM No. 25009C0086F (dated July 3, 2012);
- FIRM No. 25009C0087F (dated July 3, 2012);
- FIRM No. 25009C0088F (dated July 3, 2012); and
- FIRM No. 25009C0089G (dated July 19,2018) Version Number 2.3.3.0.

For the Little River, the 1-percent annual chance flood elevations depicted within the FIS are based on flood elevations computed from a HEC-2 hydraulic model developed by USACE in 1976 and updated in 1979 ("1979 HEC-2 Model"). The 1-percent annual change flood elevations are based on flood elevations determined at each cross section.

Hydraulic Back-up Data (Obtained from FEMA)

In order to create the Duplicate Effective Model for Little River from a point approximately 120 feet upstream of the Rosemont Avenue bridge crossing (referred to as the Project's upstream limit of analysis) to the Little River's confluence/discharge to the Merrimack River (referred to as the Project's downstream limit

of analysis), Fuss & O'Neill obtained hydraulic back-up data (from FEMA) used to create the hydraulic model that is currently reflected within the Flood Insurance Study (FIS) and Flood Insurance Rate Maps (FIRMs) for Essex County, Massachusetts (All Jurisdictions). A copy of pertinent sections of that information that was provided to Fuss & O'Neill is included within **Attachment 5.**

This information includes river channel geometry, Manning's coefficients used in the river channel and its overbank areas, bridge/culvert geometry, peak flows utilized throughout the stretch of the flooding sources being analyzed, and floodway limits and pertinent input data. The input data was received in HEC-2 format.

Vertical Datum Conversion

Contour and water surface information included within the hydraulic back-up data provided by FEMA utilize elevations relative to the National Geodetic Vertical Datum of 1929 (NGVD29). However, contour and water surface information reflected within the current FIS and FIRMs utilize elevations relative to the North American Datum of 1988 (NAVD88). For comparison purposes, water surface elevations generated within the Duplicate Effective Model can be converted to NAVD by subtracting 0.80 feet from the NGVD values as recommended by the current county-wide FIS (with an effective date of July 19, 2018).

Hydraulic Methodology

In order to create the Duplicate Effective Model of the Little River within the Project's limit of analysis, the U.S. Army Corps of Engineers (USACE) Hydrologic Engineering Center's River Analysis System (HEC-RAS) software, Version 5.0.7, was utilized.

Since water surface elevations included within the flood profiles of the Little River were generated from a HEC-2 hydraulic model, the steady flow option that allows conveyance calculations to be performed between every coordinate point in the cross section overbanks was selected since this is similar to the approach used in HEC-2.

Model Results and Comparison

Based on information provided within the hydraulic back-up (input) data received from FEMA, the Duplicate Effective Model within our limit of study includes:

- 44 cross sections; and
- 5 bridges.

Table 6 provides a comparison between 1-percent annual chance base flood water surface elevations (WSEs) computed by HEC-RAS for the Little River with those water surface elevations currently listed in the FIS for the county of Essex, Massachusetts (July 19, 2018).

Table 6: Duplicate Effective Model vs. Flood Insurance Study -1-Percent Annual Chance Base Flood WSE Comparison

Cross Section	River Station[1]	Duplicate Effective Base Flood WSE (ft.) NGVD29	Duplicate Effective Base Flood WSE (ft.) NAVD88	FIS Base Flood WSE (ft.) NAVD88	WSE Difference (ft.)
A	1775	17.53	16.7	22.4	-5.7[2]

Cross Section	River Station[1]	Duplicate Effective Base Flood WSE (ft.) NGVD29	Duplicate Effective Base Flood WSE (ft.) NAVD88	FIS Base Flood WSE (ft.) NAVD88	WSE Difference (ft.)
B	1825	17.76	17.0	22.4	-5.4[2]
C	2305	17.91	17.1	22.4	-5.3[2]
D	2380	23.22	22.4	22.4	0.0
E	4030	24.96	24.2	24.2	0.0
F	6115	26.75	26.0	26.3	-0.3
G	6195	27.44	26.6	26.6	0.0
H	7472	27.77	27.0	26.9	+0.1
I	8185	27.97	27.2	27.1	+0.1
J	10915	28.59	27.8	27.6	+0.2
K	11325	29.14	28.3	28.2	+0.1
L	11381	29.15	28.3	28.2	+0.1
M	12987	31.09	30.3	30.2	+0.1
N	15341	35.75	35.0	34.8	+0.2

Notes:

1 River station represents the river section reference number provided within the FEMA flood profile provided in the 2018 Flood Insurance Study.

2 The reason for discrepancy in excess of 6 inches is due to the subsequent application of 1% backwater impact from the Merrimack River. The HEC-2 analysis did not account for backwater impacts from the Merrimack River in its hydraulic analysis, whereas the profile included in the FIS was adjusted by extending a straight hydraulic line at El. 22.4 feet (NAVD88) up the Little River until it met the hydraulic grade line from the analysis upstream of the Little River Dam.

For this analysis, it was determined that a 0.5-foot WSE differential between results obtained from the Duplicate Effective Model and base flood WSEs provided within the FIS was within acceptable limits considering that the existing model was generated using HEC-2. As illustrated in Table 6, the 100-year water surface elevations approximate those listed within the FIS to within 0.3 feet or less with exception to Sections A through C. As a result, it was concluded that the results of the duplicate effective model accurately reflected the results included within FEMA's FIS. The reason for discrepancies in excess of 6 inches between Sections A through C did not have to do with modeling errors, but rather FEMA's subsequent application of 1% backwater impact from the Merrimack River. FEMA's original HEC-2 analysis did not account for backwater impacts from the Merrimack River, whereas the current profile of the River included in the FIS was adjusted by FEMA by extending a straight hydraulic line at El. 22.4 feet (NAVD88) up the Little River until it met the hydraulic grade line from the analysis upstream of the Little River Dam. This was done by FEMA to represent the worst case condition of a 1% annual chance flood peak on the Merrimack River coinciding perfectly in time with a 1% annual chance flood peak on the Little River.

Duplicate Effective Model water surface profiles for the 10-, 50-, 100-, and 500-year floods are included in **Attachment 6** along with a summary of results from the HEC-RAS analysis.

Pre-Dam Removal Hydraulic Model

To further improve the accuracy of the initial hydraulic model in order to better assess hydraulic impacts to the river as a result of dam removal, field survey of the Little River Dam and adjacent areas (Project Site) was performed and bathymetric data was collected in select locations in the River to a point approximately 3,625 feet upstream of the Dam. As a result, Fuss & O'Neill made the following modifications to the duplicate effective hydraulic model of the River within the Project's limit of analysis:

- Added 59 river cross-sections from a point 125 feet downstream of the Winter Street Bridge up to the MBTA Railroad Bridge, allowing development of a more accurate hydraulic model of this section of the River within the Project Site. Refer to Figure 3 for a depiction of river cross section locations where channel bathymetry was obtained. Channel sections shown in red represent FEMA river sections; channel sections shown in orange represent F&O added river cross sections.

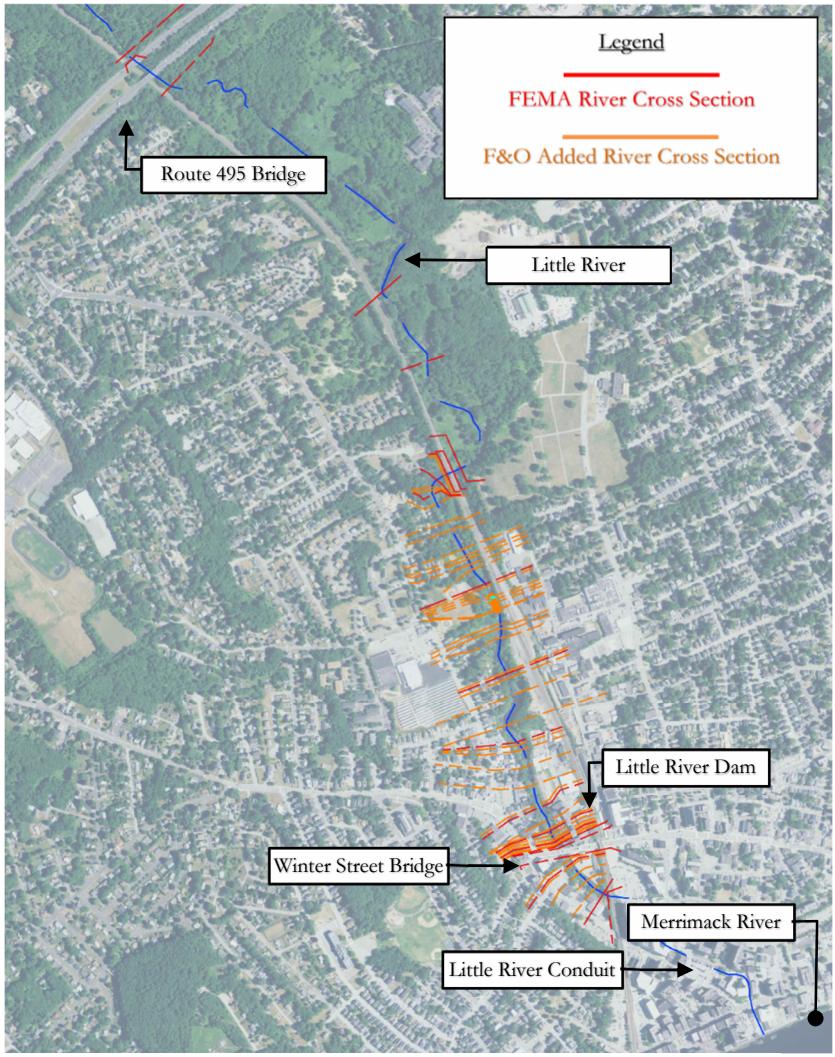

Figure 3: Little River Hydraulic Model Cross Section Locations

- Revised/modified channel geometry for FEMA cross sections from a point 125 feet downstream of the Winter Street Bridge up to the MBTA Railroad Bridge to reflect current conditions. These in-river channel geometry revisions were based on the following field survey work:
    - Approximate channel bathymetry obtained at selected transect locations upstream of the dam on November 17, 2020 by Fuss & O'Neill, Inc. (F&O).

  - Approximate channel bathymetry obtained at selected transect locations on December 15, 2020 by (F&O or Others).
  - Revised/modified channel geometry for FEMA and F&O cross sections based on additional survey of channel bathymetry obtained at select locations in fall of 2021 and winter of 2022.

  Refer to **Attachment 7** for a full-size depiction of all river cross-sections used in the hydraulic analysis that were added or revised by F&O in developing the updated hydraulic model. Channel bathymetry/spot elevations obtained during F&O's field surveys are also shown.

- Revised geometry of the Little River Conduit inlets and outlets to match record drawing information included within the City's "Flood Protection System Improvements" dated February 14, 2013.
- Changed the dam to an in-line structure. In FEMA's model, the dam was modeled as a raised channel bed. As a result, F&O changed the dam to an actual structure. The crest elevation of the dam was raised to El. 18.62 feet-NAVD88, which correctly reflects the elevation of the dam's spillway crest.
  - In order to maintain similar flood elevations upstream of the dam as documented within FEMA's FIS, the steady flow expansion and contraction coefficients at sections immediately upstream and downstream of the dam was increased to 0.6 and 0.8, respectively. This is typical for sections having abrupt hydraulic transitions.
- Changed high flow bridge modeling approach to consistently utilize the Bridge Pressure Flow Computation method.
  - The submerged inlet discharge coefficient Cd varies depending upon the depth of water upstream with values for Cd ranging from 0.27 to 0.5, with a typical value of 0.5 commonly used in practice. As a result, this typical value of 0.5 was used at all bridges within the project modeling limits.
  - The combined submerged inlet and outlet discharge coefficient typically ranges from 0.7 to 0.9, with a value of 0.8 commonly used for most bridges. As a result, this value of 0.8 was used at all bridges within project modeling limits.
- Channel and overbank roughness factors largely remained unchanged from the 1979 HEC-2 Model. The only changes included the change to a few sections just upstream of the dam that had main channel roughness coefficients of 0.029.
- Since the majority of sections upstream of the dam (between the dam and upstream MBTA railroad) were modeled by FEMA as having a 0.065 main channel roughness coefficient, which is typical for main channels with sluggish reaches and deep pools/weeds, the main channel roughness coefficients for the few sections immediately upstream of the dam were changed since the sections immediately upstream of the dam would represent a sluggish reach.
- Fuss & O'Neill used flood flows reported in the 1979 HEC-2 Model for the 10-, 50-, 100-, and 500-year flood events. However, to better reflect actual hydraulic conditions this analysis was run as a mixed-flow regime hydraulic analysis. When mixed-flow regime is used, HEC-RAS allows for subcritical flow, supercritical flow, hydraulic jumps, and drawdowns (as applicable). Because starting

boundary condition water surface elevations are necessary at the upstream and downstream limits of this type of hydraulic analysis, reported water surface elevations obtained from the 1979 HEC-2 Model were utilized.

Water surface elevations and flow velocities computed from this improved Pre-Dam Removal Hydraulic Model during base conditions, the upstream fish migration period, and selected flood flow events (i.e. 10-, 50-, 100-, and 500-year floods) will be used as a basis for comparison for post-dam removal water surface elevations and flow velocities. Water surface profiles and modeling results for the improved Pre-Dam Removal Hydraulic Model are included in **Attachment 8**.

Post-Dam Removal Hydraulic Model

Hydraulic conditions following dam removal were first modeled by simply removing the inline structure (representing the Dam) from the model geometry and performing the hydraulic analysis using HEC-RAS. This initial analysis assumed that the channel bottom upstream of the Dam would remain unchanged (i.e. that channel bottom sediment would remain in-place). After reviewing the preliminary hydraulic results from this analysis (i.e. the anticipated flow velocities and shallow flow depths) and the composition and gradation of the existing sediment that is located throughout the river channel upstream of the dam, it was concluded that channel bottom high points (which could represent areas of sediment build-up) are likely to erode during both low flow and flood event conditions. As a result, cross section geometry between the Winter Street Bridge and the MBTA Railroad Bridge was altered to reflect the following additional changes made to the post-dam removal hydraulic model:

- The removal of sediment build-up and other localized channel bottom high points immediately downstream of the Winter Street Bridge and between the Dam and the MBTA Railroad Bridge due

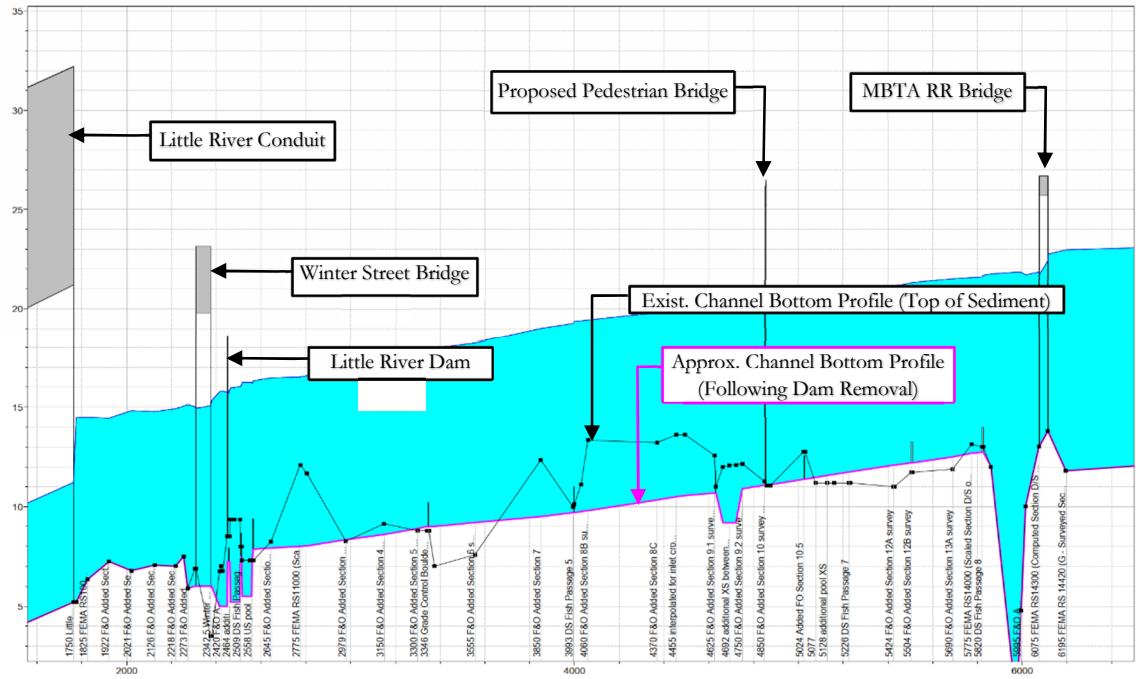

Figure 4. Approximate Channel Bottom Following Dam Removal

to the high mobility potential of the fine sediment that exists throughout the channel bottom upstream of the Dam. This involved reducing the elevation of the channel bottom to reflect the creation of a thalweg (the deepest point within the channel) at the majority of the cross sections throughout the reach between the Dam and the MBTA Railroad Bridge. This also involved actively removing sediment accumulated behind the dam. As shown in Figure 4, this results in the creation of a more uniform channel bed slope.

- Removing the majority of sediment from localized high points and areas of increased flow velocities and stabilizing the channel bed within the river's thalweg immediately following dam removal reduces the risk of an uncontrolled headcut progressing upstream through the sediment and an uncontrolled release of sediment into the Little River Flood Conduit and Merrimack River. The changes made to the channel bottom do not reflect the complete removal of sediment (outside of the thalweg) as it would be assumed that mobile sediments would remain in the channel bed or newly formed bank areas following proposed dam removal and channel grading and would also settle out in existing scour hole areas or eroded sections within the channel bottom. Stabilizing the channel bottom within the thalweg will also assist in providing assurance that minimum flow depths will be maintained for aquatic and recreational passage during lower flow conditions.
- The filling of the large scour hole currently present under the Winter Street Bridge with adequately sized scour countermeasures (designed for the worst-case flood flow velocity) to reduce the risk of further scour following dam removal. Although flood flow velocities through this bridge will be reduced following dam removal when compared to existing conditions, the current bridge channel bottom material is unstable. As a result, larger sized stone riprap will be installed to supplement and stabilize the existing channel bottom material. As the riprap is placed, its voids will be backfilled with natural streambed material/sediment.
- The elimination of a high point immediately downstream of the MBTA Railroad Bridge that has formed due to displacement of large stone material at the bridge.
- The addition of a fishing area and access with steps/terraces to provide access to the river at varying water levels at Cashman Park.
- The addition of six grade control boulder weirs and associated scour pools between the MBTA Railroad and Winter Street Bridges. This will provide adequate flow depths for river recreation during the summer months allowing kayaks and canoes to be able to pass through the reach.
- The addition of a nature-like fish way and associated scour pools upstream of the Winter Street Bridge. This will provide adequate flow depths and suitable flow velocities for the target species during the range of flows that are anticipated during the upstream fish migration season.
- The addition of a pedestrian bridge and recreational path immediately upstream of Cashman Park and along river left.

Post-Dam Removal water surface profiles and modeling results are included in **Attachment 9**.

Sediment Mobility and Scour Assessment Summary

Sediment mobility and scour potential are key aspects of dam removal projects and can significantly impact implementation costs. If sediment exists within the headpond, this sediment can become mobile once the dam is removed resulting in the transfer of sediment to downstream locations including the Little River

Conduit. Furthermore, there can also be adverse environmental and water quality impacts to downstream areas if this sediment is substantially impacted by contaminants trapped by the dam. The removal of dams can also have potential impacts at upstream and downstream bridge locations requiring the need for bridge foundation replacement, protection, or other in-river improvements to reduce or eliminate scour potential. In support of the feasibility investigation for the removal of the Little River Dam completed in 2021, an Environmental Site Assessment (ESA) was performed to evaluate the size, composition, and quality of the impounded sediments that could potentially be mobilized as a result of dam removal. Refer to Fuss & O'Neill's *Little River Dam Removal Sediment Quality and Depth Assessment Memorandum (dated December 30, 2020)* for more detail. In summary, the general subsurface conditions of the river channel upstream of the dam was determined to include a layer of organic silt (occasionally overlain by fine gravel) which was underlain by a native channel bottom horizon consisting of sandy silt. Upstream organic silt/sediment depths ranged between 1.0 to 2.5 feet at the specific transect locations where sediment was analyzed. The river channel bottom downstream of the dam, however, was found to primarily be comprised of only cobbles with little to no sediment. The sediment samples collected at the three locations/transects within the headpond (referred to herein as Transects 1, 2, and 3) yielded D_{50} particle sizes of 0.2647 millimeters (or 0.010 inches), 1.2535 millimeters (or 0.049 inches), and 0.0901 millimeters (or 0.004 inches). Refer to **Attachment 10** for the results of the sieve analyses performed for each sample obtained.

To determine if river flow following removal of the dam would be capable of transporting this channel bed sediment, the velocity required to initiate motion (V_c) of the D_{50} size of channel bed sediment (as obtained through laboratory sieve analyses) was compared to the calculated mean velocity (V) of the flow in the main channel and/or overbank areas subsequent to dam removal (as obtained from HEC-RAS post-removal analysis results) at the three locations/transects where the sediment was collected and sampled. If the critical velocity of the bed material was larger than the mean velocity in the channel (Vc > V) at each location/ transect, it was assumed that sediment in that location would not become mobile as a result of dam removal. If the critical velocity was less than the mean velocity (Vc < V), it was then assumed that sediment would become mobile as a result of dam removal at that location/transect. The following equation (Equation 6.1, HEC-18) for critical velocity was used to determine if river flow following removal of the dam would potentially be capable of transporting bed material to downstream areas including the Little River Conduit.

$$V_c = K_u * y^{1/6} * D^{1/3} \quad \textbf{(Equation 6.1)}$$

where:

V_c =	Critical velocity above which bed material of size D and smaller will be transported, ft/s
y =	Average depth of flow, ft.
D =	Particle size for V_c, ft.
D_{50} =	Particle size in a mixture of which 50 percent are smaller, ft.
K_u =	11.17

Table 7 lists the anticipated post-dam removal flood event channel depths and flow velocities at each upstream transect location during low-tide conditions (i.e. assuming no backwater impacts from the Merrimack River); Table 8 provides a summary of computed flow velocities at each location during the analyzed flow/flood events and identifies locations where the potential for sediment mobility exists.

Table 7: Post Dam-Removal Flow Depths and Critical Flow Velocities

Transect Location	Corresponding River Section(s)	Post Dam Removal Average Channel Depths (feet)[1]				Post Dam Removal Critical Flow Velocities for D_{50} Particles (fps)			
		Base Flow Condition	10-Year Flood	50-Year Flood	100-Year Flood	Base Flow Condition	10-Year Flood	50-Year Flood	100-Year Flood
1	1E (RS2449-RS2480)	1.72	6.32	8.52	9.98	1.17	1.45	1.52	1.56
2	8A (RS3850-RS4000)	1.72	4.29	4.87	6.04	1.96	2.28	2.33	2.41
3	12A (RS5510)	1.78	2.54	4.88	6.25	0.82	0.87	0.97	1.01

Table 8: Post Dam Removal Computed Flow Velocities and Sediment Mobility Potential

Transect Location	Corresponding River Section(s)	Post Dam Removal Computed Average Flow Velocities (fps)[1,2]				Potential for Sediment Mobility			
		Base Flow Condition	10-Year Flood	50-Year Flood	100-Year Flood	Base Flow Condition	10-Year Flood	50-Year Flood	100-Year Flood
1	1E (RS2450-RS2480)	0.34	3.86	3.79	3.46	Low	High	High	High
2	8A (RS3850-RS4000)	0.23	3.77	2.85	2.32	Low	High	High	High
3	12A (RS5510)	0.22	4.38	4.12	3.78	Low	High	High	High

Notes:

[1] Where transects are located between one or more river sections, the average channel velocity or depth was used.

[2] Flow velocities are associated with model geometry that reflects the removal of some sediment from the headpond to create a more uniform channel bed slope between the site of the existing Dam and the MBTA railroad bridge.

In summary, it appears that there is a high potential that sediment within the headpond between the Dam and the MBTA railroad will become mobile during all analyzed flood events following dam removal, excluding base flow conditions. Since the results of our ESA revealed that the total concentrations of PCBs and VOCs for the samples collected at one of the transect locations (Transect #2) exceeded the MassDEP Maximum Allowable Contaminant Level (MACL) for reuse at a lined landfill and that levels of certain contaminants found in Transect #1 and Transect #2 exceeded their applicable Probability Effect Concentrations (PECs), the sediment in this location will be removed during Phase 1B of the project, as shown on the Water Control and Construction Sequencing Plan.

Based on the average loose depth of sediment that was approximated from sediment depths obtained by F&O and TG&B Marine Services at 19 river section locations (as shown in Table 9) during its November 6 and November 17, 2020 field investigations, it was conservatively approximated that 15,000 cubic yards of sediment that exists within the section of the River between the Dam and the MBTA Railroad could potentially become mobile following dam removal.

Table 9: Headpond Sediment Depth Summary Table

Cross Section	A (12' off Left River Edge)	B (Center of River)	C (12' off Right River Edge)
1E (Transect 1)	1.2	2.2	1.4
1F	0.0	0.0	1.4
2	1.2	0.3	0.0
3	0.7	1.2	1.1
4	0.5	0.8	2.0
5	2.6	0.4	1.8
6	0.5	0.5	2.6
7	1.8	0.3	2.9

Cross Section	A (12' off Left River Edge)	B (Center of River)	C (12' off Right River Edge)
8A (Transect 2)	2.5	2.5	2.5
8B	2.0	0.8	0.2
8C	0.0	0.0	0.1
9	0.0	1.1	1.5
10	2.3	1.5	0.0
11	1.5	0.4	2.5
12A (Transect 3)	1.8	1.5	2.5
12B	0.6	0.3	0.8
13A	2.4	0.2	0.6
13B	0.0	0.0	1.2
14	0.0	0.0	0.0
Average Loose Depth of Sediment		1.05 feet	
Approximate Headpond Area		392,380 square feet	
Approx. Loose Sediment Volume in Headpond Approx. Sediment Volume (accounting for 30% Shrinkage Typical for Cohesive Silt)		412,000 cubic feet (or 15,260 cubic yards) 288,400 cubic feet (10,680 cubic yards adjusted)	

Note:
Sediment depths represent the depth of the loose organic layer of sediment/silt within the bottom of the river channel and not the native silty/sandy layer beneath.

Since a portion of this sediment is impacted/contaminated and will be removed and disposed of at a licensed facility prior to full dam removal (approximately 1,000 to 1,500 cubic yards) and a portion of the clean sediment will be re-used as sediment-fill or surficial bank material for river restoration purposes (approximately 2,700 to 4,800 cubic yards), it is anticipated that only a fraction of this total quantity of sediment would be allowed to mobilize naturally downstream in a controlled manner. Based on the results of our hydraulic analysis, flow velocities within the downstream river channel and Little River conduit (during dry- and wet-weather flow conditions) will ultimately flush this remaining sediment out to the Merrimack River with minimal impacts to hydraulics through the river channel or conduit.

Increased flow velocities are also predicted to occur at bridges within the Project Site due to dam removal during both base flow and flood conditions. Maximum flow velocities associated with the 0.2% or 1% annual chance floods (whichever velocity is greater) are listed in Table 10 along with the actual increase in velocity as compared to pre-dam removal (existing) conditions. Although flow velocities generally increase due to dam removal, notable increases are only anticipated to occur at the Winter Street and MBTA railroad bridges. It is at these two bridge locations where scour countermeasures are proposed to avoid adverse impacts to the stability of the structures, given that changes to the bridges themselves are not included in this project.

Table 10: Channel Flow Velocities Within Little River Bridges During the 0.2% or 1% Annual Chance Flood Event

Structure	Highest Velocity Within Bridge (ft/sec)	Velocity Change at this Location Due to Dam Removal (ft/s)
Winter Street Bridge	9.9	+1.1
MBTA Railroad Bridge	7.9	+0.9
Valley Pipe Support Structure	2.3	+0.0
I-495 Bridges	10.6	+0.1
Rosemont Avenue Bridge	11.1	+0.0

According to the following riprap sizing equation obtained from the U.S. Department of Transportation Federal Highway Administration's *Hydraulic Engineering Circular No. 23, Bridge Scour and Stream Instability Countermeasures: Experience, Selection, and Design Guidance-Third Edition Volume 2 (September 2009), Design Guideline 14 for Rock Riprap at Bridge Abutments,* it was determined that scour countermeasures beneath the Winter Street Bridge shall consist of riprap meeting the gradation of "National Stone Association Modified NSA No. R-8" or "FHWA Class VII" riprap ranging in size from 15 inches to 48 inches with a median (d50) size of 24 inches; and that scour countermeasures beneath the MBTA Bridge shall consist of riprap meeting the gradation of "National Stone Association Modified NSA No. R-7" or "FHWA Class IV" riprap ranging in size from 9 inches to 30 inches with a median (d50) size of 15 inches.

$$\frac{D_{50}}{y} = \frac{K}{(S_s - 1)}\left[\frac{V^2}{gy}\right] \qquad (14.1)$$

where:

D_{50} = median stone diameter, ft (m)
V = characteristic average velocity in the contracted section (explained below), ft/s (m/s)
S_s = specific gravity of rock riprap
g = gravitational acceleration, 32.2 ft/s^2 (9.81 m/s^2)
y = depth of flow in the contracted bridge opening, ft (m)
K = 0.89 for a spill-through abutment
1.02 for a vertical wall abutment

Since the size of riprap beneath the MBTA Bridge is unknown, the Contractor shall make exploratory investigation of the material beneath the bridge prior to construction (and after incremental dam removal) and notify the Engineer of the results so that it can be determined if the existing material meets the necessary size requirements or if the existing material will need to be replaced or supplemented with imported stone meeting the NSA No. R-7 or FHWA Class IV gradation requirements.

Riprap sizing for both bridges was completed for the bankfull, 10%, 2%, 1%, and 0.2% annual chance floods. The 1% annual chance flood yielded the largest median stone size of 24 inches for the Winter Street Bridge. The 2% annual chance flood yielded the largest median stone size of 15 inches for the MBTA Bridge. While an excavator will be used to transport and place material at the bridge openings, a mini-excavator or skid steer will be used to push the stone into place (particularly within the Winter Street bridge opening) and to fill voids with native channel bottom sediment.

The layer of NSA No. R-8 (FHWA Class VII) stone riprap to be installed under the Winter Street Bridge shall be approximately 48-inches thick and have its voids filled with native river channel sediment. The layer of NSA No. R-7 (FHWA Class IV) stone riprap to potentially be installed under the MBTA Railroad Bridge (pending the results of pre-construction investigations) shall be approximately 36-inches thick and have its voids filled with native river channel sediment.

Refer to **Attachment 11** for calculations supporting the sizing of scour countermeasures beneath the Winter Street and MBTA Bridges.

Channel and Bank Stabilization Measures

In addition to the potential for scour due to high velocity at the Winter Street and MBTA Railroad Bridges, there is a risk of erosion along the banks of the River between the Dam and the MBTA Railroad Bridge. Base condition elevations are expected to drop between 3.8 feet and 10.4 feet between the Dam and MBTA Railroad Bridge, between 3.6 and 3.8 feet between the MBTA Railroad Bridge and the Valley Pipe Support Structure, and between 0.3 and 3.6 feet between the Valley Pipe Support Structure and the I-495 Bridges. Flood elevations associated with the 10-, 50-, and 100-year floods are also expected to drop by up to 5.5 feet upstream of the Dam site following dam removal. As the banks are formed of fine-grained (and therefore highly mobile) material, in locations where base condition and/or flood elevations have dropped more than 2 feet to 3 feet (i.e. between River Sections RS2449-RS5160, or from the Dam upstream to Cashman Park) and the banks are not retained by existing concrete walls, bank stabilization measures are proposed. These measures consist of the installation of natural coir matting and coir fascines planted with native plant seed mixes for upland and wetland communities and plantings along the upper banks of the newly aligned river channel (i.e. above the bankfull water surface elevation) and within newly exposed bench areas (that were previous under water). The coir matting will be 100% biodegradable with a longevity of 4-6 years in order to allow for the adequate establishment of vegetation. The lower banks of the newly aligned river channel (below the bankfull water surface elevation) will be protected by an 18-inch thick layer of soil-filled stone riprap where necessary and planted with fast-growing native live stakes. The stone shall consist of 4- to 14-inch stones with a median stone size of 7 inches.

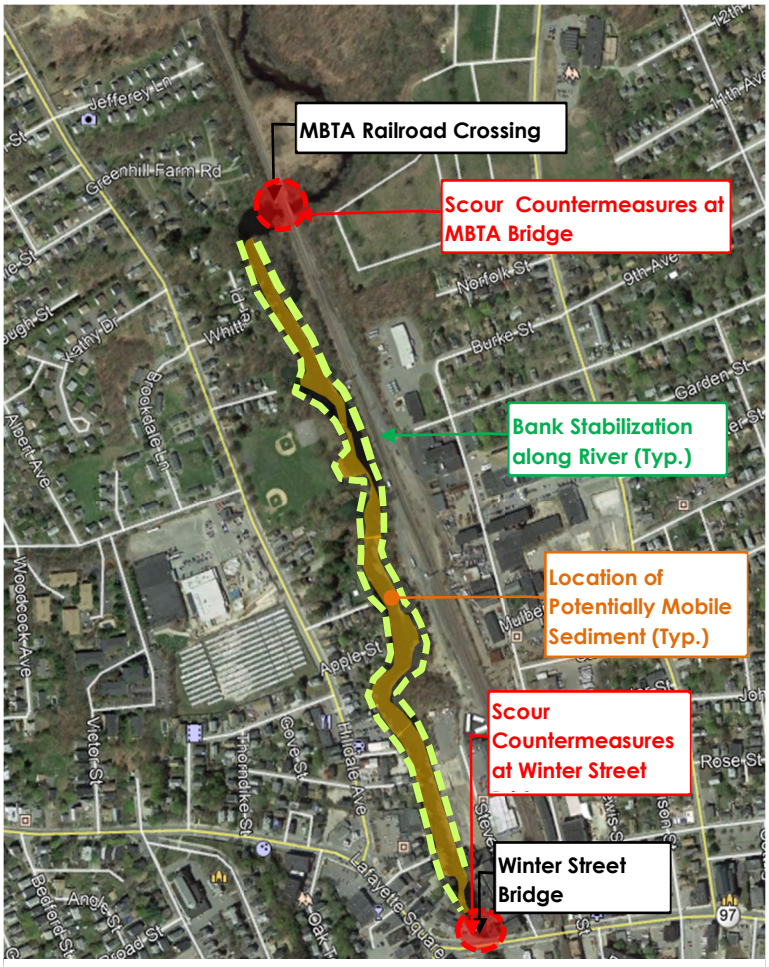

Figure 5: Potential Sediment Removal, Scour Countermeasure, and Bank Stability Concern Locations

To limit the mobility of sediment along the channel bottom (in locations outside of proposed scour pools and the nature-like fishway) and to form a stable channel bottom, it was determined that the existing channel bottom substrate shall be reinforced with a six-inch thick layer of native or imported natural stone ranging in size from 1- to 4-inches with a median stone size of 2-inches where determined necessary. *Technical Supplement 14C, Stone Sizing Criteria, of Part 654 National Engineering Handbook (Issued August 2007)* was used as guidance in sizing channel bottom and bank stabilization measures for the Little River following dam removal. Since there are many techniques for sizing stone with each method having been derived under

specific conditions and developed for particular applications, results obtained from several of the recommended techniques were compared in order to determine a convergence of results and in making a final selection on stone sizing. Refer to **Attachment 11** for supporting calculations.

Aquatic (Fish) and Recreational Passage Assessment

The removal of the Little River Dam will result in a section of the river channel with reduced flow depths and increased flow velocities during all flow conditions including the upstream migration period of the target fish species. The following sections summarize the biological characteristics of the target species including the minimum flow depths and maximum flow velocities necessary to assess safe and effective fish passage.

Fish Passage Design Criteria Used in Evaluation of Dam Removal

In evaluating the minimum flow depth that would be required to effectively pass fish during the upstream and downstream fish passage migration seasons, the following guidance from USFWS's *Fish Passage Engineering Design Criteria (June 2019)* was considered:

> *Providing sufficient depth allows fish to swim normally (i.e., fully submerged, including dorsal fin) and may alleviate any adverse behavioral reaction to shallow water. In general, engineering recommends that the depth of flow be greater than or equal to two times the largest fish's body depth. Greater depth criteria may apply to various fishway components to meet the needs of certain species or to address site-specific concerns.*

As discussed earlier in the report, it was agreed upon with both MassDMF and MassDER that the target species for the Little River would be Alewife, Blueback herring, American eel, and potentially rainbow smelt (should they successfully pass through the Little River Conduit) as well as resident species such as perch, sunfish, and white sucker. Maximum body lengths, depths, and swim speeds of target migratory fish within the project area are shown in Table 12 below. From this table it is noted that the maximum body depth of alewife, the largest fish of the project's target species, is approximately 3.5 inches. **This translates to a minimum 7-inch (or 0.58 feet) flow depth required for the effective passage of alewife**. Table 11 also lists other design parameters (e.g. minimum weir opening width, minimum weir opening depth, and minimum channel/pool depths) to be used in the design of nature-like fishways. All of the parameters provided in Table 11 were obtained from *Appendix C* of USFWS's *Fish Passage Engineering Design Criteria (June 2019)* document.

Table 11: Summary of Biological Characteristics and Fishway Design Criteria for Target Species

Target Species	Maximum Body Depth (in)	Burst Speed (ft/sec)	Prolonged Speed (ft/sec)	Cruising Speed (ft/sec)	Min. Flow Depth Required (ft)	USFWS Recommended Fishway Min. Weir Opening Width (ft)	USFWS Recommended Fishway Min. Weir Opening Depth (ft)	USFWS Recommended Fishway Min. Pool Depth (ft)
Alewife	**3.5**	6.0	**3.0**	1.0	0.6	**2.50**	0.75	2.00
Blueback herring	3.1	6.0	**3.0**	1.0	0.5	2.25	**1.00**	**2.00**
American eel (adult)	3.1	1.0	0.5	0.2	0.5	0.75	1.00	2.00
Rainbow Smelt	1.4	**3.25**	1.9	0.5	0.25	1.00	0.50	1.50

In addition to flow depths, flow velocities are also a major consideration for the design of channel modifications to improve fish passage. As shown below, different fish within the target species have differing burst, prolonged, and cruising speeds reflective of their respective endurance characteristics. Burst speeds are generally accepted as the speed a fish can swim between 2 and 10 seconds, prolonged speeds are generally accepted as the speed a fish can maintain for five to eight minutes before tiring (Bell (1991) and Bain (1999)), and cruising/sustained speeds are considered the speed that a fish can maintain for hours.

In collectively reviewing the cruising, prolonged, and burst speeds of the target species, the following design criteria have been determined:

- A flow velocity of 3.0 feet per second or less was selected as the target (goal) prolonged speed for assessing effective passage for long distances upstream of the fishway during the 5%, 50%, and 95% exceedance flows, which would effectively support passage of Alewife and Blueback herring. It is assumed that juvenile American eel would find avenues for passage along the edges and bottom of the channel as well as at minor eddies where the actual flow velocity would be less than the average channel velocity reported by hydraulic modeling. Although not deemed critical at all locations and for all flow conditions during the upstream migration period, the prolonged speed of rainbow smelt (1.9 feet per second or less) was also considered since rainbow smelt could potentially utilize the river following dam removal should they be able to successfully pass through the downstream Little River Conduit.
- A flow velocity of approximately 3.25 feet per second or less was selected as the target (goal) burst speed for assessing effective passage for migrating upstream for short distances (i.e. through weir openings and/or riffles). This was based on the burst speed for smelt being the limiting (most conservative) species since the burst speed of Alewife and Blueback herring is 6.0 feet per second. It is, however, noted in *Appendix C* of *USFWS's Fish Passage Engineering Design Criteria* document that the actual burst speed of smelt could be as high as 3.9 feet per second but was conservatively rounded down. It is also recognized that juvenile American eel would find avenues for passage along the edges and bottom of the channel as well as at minor eddies where the actual flow velocity would be less than the average channel velocity reported by hydraulic modeling.

Need for Fish and Recreational Passage Improvements

A hydraulic analysis was initially performed that reflected the removal of the dam and creation of an 18-foot wide, uniformly sloped low-flow channel within the existing river channel and headpond area between the MBTA and Winter Street Bridges. A low-flow channel with an 18-foot bottom width was proposed throughout the reach upstream of the Dam (between the Dam and the MBTA Railroad Bridge) in order to accommodate passage for recreational purposes (i.e. canoeing and kayaking). It also provides for a flowing river channel width of between 25 feet to 35 feet during normal low-flow and spring flow conditions which mimics the natural river channel width upstream of the immediate project area; and will result in the creation of a more uniform and stable channel bed slope. The bottom of the thalweg would be reinforced with native and/or imported stone, cobbles, and gravel material. Stabilizing the channel bottom within the low-flow channel will also assist in maintaining flow depths for both aquatic and recreational passage during minimum and lower flow conditions.

Based on a review of post-dam removal channel depths and average channel flow velocities obtained through analysis, the following passage concerns were noted during the upstream migration period. Only

the section of the Little River between the I-495 Bridges and the River's confluence with the Merrimack River were assessed for passage since minimal changes in hydraulics are expected upstream of the I-495 Bridges during the upstream migration period. The channel grade differential between the upstream and downstream sides of the I-495 Bridges also functions as a barrier to passage.

- The first barrier to upstream passage is the Little River Conduit. The Little River Conduit is approximately 2,000 feet in length and could impact passage effectiveness given the unnatural culvert bottom and lack of natural light within. Rainbow smelt typically prefer clean, unsilted, and non-urban waters which may result in a non-ideal habitat for this particular species. In reviewing flow velocities within the culvert under varying tidal conditions and varying flows during the upstream migration period, the following conditions were noted that could also limit passage of the target species.
    - When flows in the culvert approach or exceed the 50% exceedance flow during the upstream migration period, flow velocities at the upstream end of the culvert are anticipated to limit passage of rainbow smelt during all tidal conditions. Therefore, effective passage for rainbow smelt will be limited to lower flows during the upstream migration period.
    - When flows approach or exceed the 5% exceedance flow during the upstream migration period, flow velocities within the upstream end of the culvert are anticipated to limit passage of river herring under all tidal conditions. Although not as much of a restriction for river herring (i..e blueback herring and alewife) as compared to rainbow smelt, these fish may have difficulty effectively passing through the culvert during the upstream migration period when flows exceed the 5% exceedance flow.
- The second barrier to upstream passage will occur within the section of the river channel approximately 160 feet upstream of the Little River Conduit. Flow velocities at this location exceed the burst speed of rainbow smelt during normal and higher flows (equivalent to or in excess of 50% exceedance flow conditions) expected during the upstream migration season. These flow velocities, however, do not exceed the burst speeds of river herring and should not be a passage concern for those species.
- The third barrier to upstream passage will occur within the section of the river channel approximately 70 feet to 120 feet upstream of the Winter Street Bridge. Flow velocities during higher upstream migration period flows will exceed the cruising speed of river herring and the burst speed of rainbow smelt.
- Lastly, removal of the dam without specific improvements to encourage fish passage will also result in:
    - impassable/shallow depths (less than 7 inches) in the sections of the river approximately 900 to 2,100 feet and approximately 2,370 to 3,130 feet upstream of the Winter Street Bridge during minimum (95% exceedance) flow conditions;
    - flow velocities that exceed the cruising speed of river herring approximately 2,370 to 3,130 feet upstream of the Winter Street Bridge during maximum(5% exceedance) flow conditions; and
    - flow velocities exceed the burst speed of rainbow smelt just downstream of the MBTA Bridge during the entire range of flows expected during the upstream migration season.

A summary of hydraulic modeling results for post-dam removal flow velocities and depths upstream of the Little River Conduit and downstream of the I-495 Bridges during the upstream migration season is provided below in Table 12. These results do not include any additional in-river improvements. Values in

red indicate values that exceed the burst speed of rainbow smelt or fall below minimum required flow depth for river herring.

Table 12: Hydraulic Summary Results for Dam Removal Alternative

Upstream Migration Flow Condition	Flow Velocities (ft/sec)	Average Flow Velocity (ft/sec)	Flow Depths (feet)	Average Flow Depth (feet)
Stretch of River between Little River Conduit and Winter Street				
Minimum Design Flow (Q95%)	0.36 – 3.06	1.39	0.58 - 2.53	1.32
Normal Design Flow (Q50%)	0.99 - 3.93	2.04	0.87 - 3.22	1.97
Maximum Design Flow (Q5%)	1.85 - 5.89	2.95	1.94 - 4.40	3.11
Stretch of River between Winter Street and MBTA Railroad				
Minimum Design Flow (Q95%)	0.01 – 4.09	0.98	0.35 - 13.67	1.17
Normal Design Flow (Q50%)	0.04 - 5.50	1.69	1.19 - 14.71	2.00
Maximum Design Flow (Q5%)	0.11 - 5.23	2.62	2.72 - 16.49	3.51
Stretch of River between MBTA Railroad and I-495 Bridges				
Minimum Design Flow (Q95%)	0.15 – 1.59	0.88	0.89 - 4.06	2.16
Normal Design Flow (Q50%)	0.42 - 2.26	1.25	1.94 - 5.24	3.21
Maximum Design Flow (Q5%)	0.76 - 3.06	1.73	3.38 - 7.36	5.05

A full summary of fish passage flow depths and velocities at all river sections within the Project Site following removal of the dam (with no in-river improvements) is provided in **Attachment 12**. Water surface profiles during the upstream fish passage migration season flow conditions following dam removal are depicted in Figure 6.

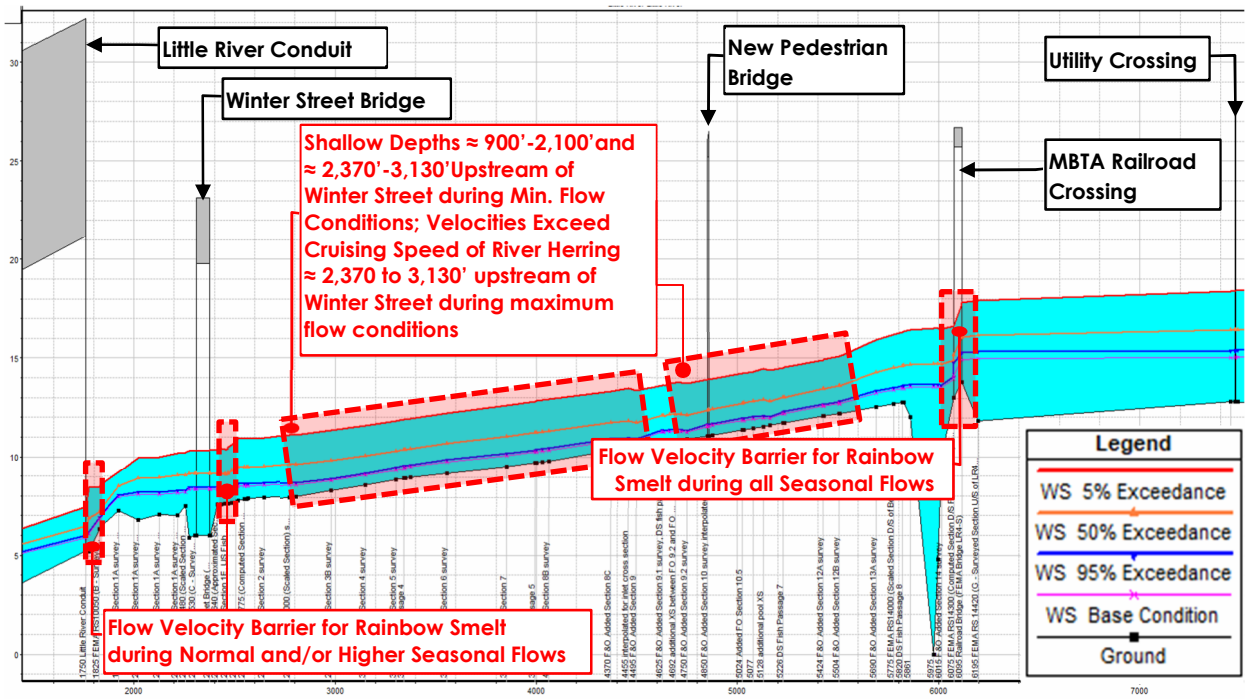

Figure 6: Post-Dam Removal Fish Passage Season Water Surface Profiles (with No Additional In-River Improvements)

Proposed Recreational and Fish Passage Improvements

Not only is achieving adequate depths (of 7 inches or more) important for fish passage, but it is also important in facilitating recreational use (i.e. kayaking and canoeing). Based on discussions with project partners, it was agreed that a minimum flow depth of 18 inches would be ideal during the low-flow season or during base flow conditions. This would also provide for better flow depths for aquatic passage of the target fish species and connectivity/habitat for resident fish species.

The following fish and recreational passage improvements, in addition to the establishment of a stable low-flow channel with an 18-foot bottom width, are proposed:

- A nature-like fishway between the Winter Street Bridge and a point approximately 200 feet upstream of the former dam location. Although flow depths in this location are suitable for fish passage of the target species during the upstream migration period, flow velocities exceed the cruising speed of river herring and the burst speed of rainbow smelt during maximum flow conditions (i.e. the 5% exceedance flow and greater). Removal of the dam will also result in relatively shallow depths (of 10 inches or less) throughout an approximate 225-foot section of the river between the Winter Street Bridge and a point approximately 200 feet upstream of the former dam location during minimum (95% exceedance) flow conditions. Although this meets the minimum passage depth requirement of 7 inches or more during the upstream migration period, there is little factor of safety. As a result, a riffle-pool style fishway was decided upon as the nature-like fishway to be installed in this section of the reach, and is described in greater detail in the subsequent sections. While it is understood that installing a nature-like fishway solely for fish passage is not absolutely essential (i.e. if rainbow smelt populations prove to be small and limited by hydraulics through the Little River Conduit), this system will also function as a deterrent for recreational passage (given the safety concerns with boaters reaching the entrance to the Little River Conduit. The notches of the weir openings will be limited to 30-inches, just wide enough to pass the target species, but just narrow enough to limit recreational passage.
- A series of six grade control boulders spaced intermittently from the nature-like fishway upstream to the MBTA Bridge. The primary purpose of these grade control boulders is to backwater flow to ensure that there will be approximately 18 inches of flow throughout the entire stretch of the river during low-flow or base flow conditions to facilitate recreational and aquatic passage at all periods throughout the year. Stabilized scour pools, approximately 30 feet in length, will be located downstream of each grade control boulder weir to dissipate energy, turbulence, and bed scour as water plunges over the crest of the boulder weirs. Refer to **Attachment 11** for grade control boulder weir and scour pool sizing computations. These grade control boulders will also eliminate any concerns in terms of shallow passage depths and flow velocities in excess of the cruising speed of river herring and burst speed of rainbow smelt upstream of the nature-like fishway to the MBTA Bridge. Only flow velocities beneath the MBTA Bridge during maximum flow conditions will remain a passage barrier to rainbow smelt. However, this will be limited to 5% or less of the time during the upstream migration period.

A summary of hydraulic modeling results for post-dam removal flow velocities and depths upstream of the Little River Conduit and downstream of the I-495 Bridges during the upstream migration season is

provided below in Table 13. These results account for inclusion of nature-like fishway and grade control boulders. Values in red indicate values that exceed the burst speed of rainbow smelt. As a result of the in-river improvements, minimum passage depths are met in all locations for all species. Although there are still a few locations where the maximum flow velocity will exceed the burst speed of rainbow melt during higher flow conditions, the flow velocities do not exceed the burst speeds of alewife and blueback herring and should not impede passage for those two species.

Table 13: Hydraulic Summary Results for Dam Removal Alternative

Upstream Migration Flow Condition	Flow Velocities (ft/sec)	Average Flow Velocity (ft/sec)	Flow Depths (feet)	Average Flow Depth (feet)
Stretch of River between Little River Conduit and Winter Street				
Minimum Design Flow (Q95%)	0.36 – 3.06	1.39	0.58 - 2.53	1.32
Normal Design Flow (Q50%)	0.99 - 3.93	2.04	0.87 - 3.22	1.97
Maximum Design Flow (Q5%)	1.85 - 5.89	2.95	1.94 - 4.40	3.11
Stretch of River between Winter Street and MBTA Railroad				
Minimum Design Flow (Q95%)	0.01 – 1.04	0.28	1.43 – 15.11	2.93
Normal Design Flow (Q50%)	0.03 – 2.80	0.85	2.09 – 15.63	3.53
Maximum Design Flow (Q5%)	0.11 – 4.83	1.92	3.39 - 16.64	4.67
Stretch of River between MBTA Railroad and I-495 Bridges				
Minimum Design Flow (Q95%)	0.15 – 1.59	0.88	0.93 - 4.02	2.14
Normal Design Flow (Q50%)	0.41 - 2.26	1.24	1.94 - 5.27	3.23
Maximum Design Flow (Q5%)	0.76 - 3.06	1.73	3.38 - 7.36	5.05

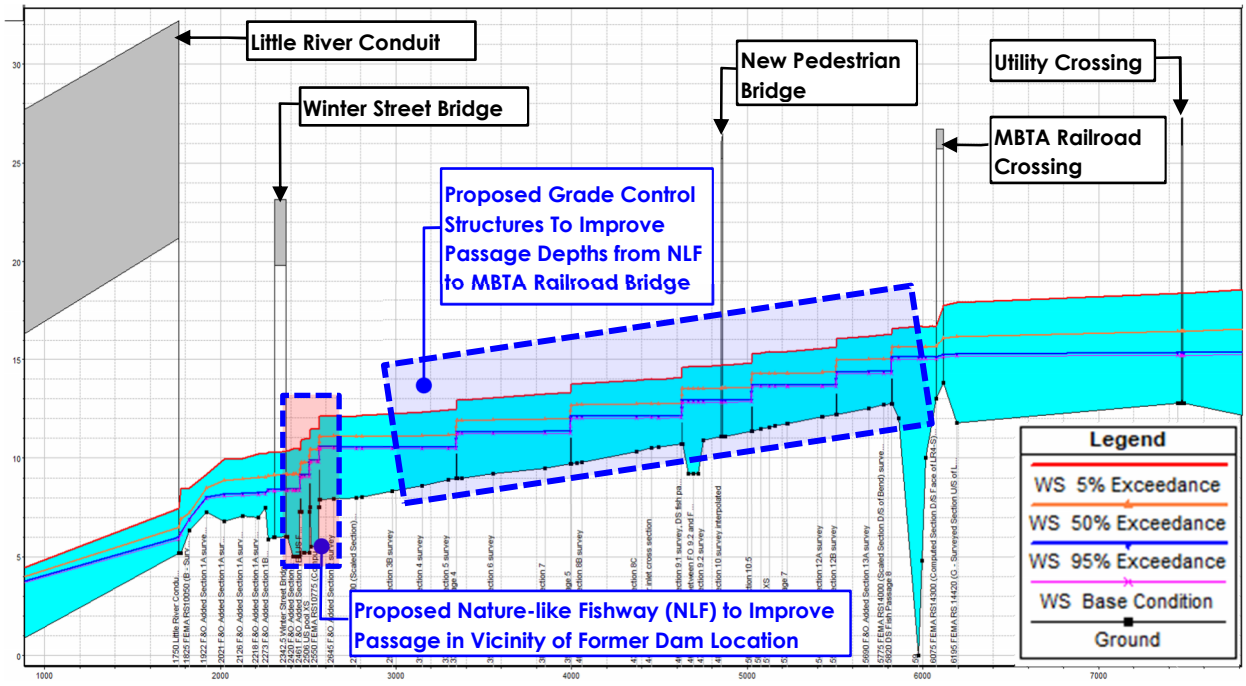

Figure 7: Post-Dam Removal Fish Passage Season Water Surface Profiles (with Additional In-River Improvements)

Riffle-Pool Nature-Like Fishway

Figure 8: Riffle-Pool Example (Filley Park and Lower Shannock Falls, F&O)

A riffle-pool design was chosen as the nature-like fish way to be installed upstream of the Little River conduit. Other designs, such as roughened channels/ riffles, can have high turbulence during periods of higher flows within the upstream migration season and may not achieve desired flow depths during minimum flow conditions, which can have adverse effects on the passage efficiency . The addition of pools to the system can help to dissipate such energy/turbulence and create areas of greater depths and low velocities for resting (i.e. where average flow velocities exceed the cruising speeds of the majority of fish included within the target species). The addition of pools also creates areas of refuge from terrestrial predators. Rainbow smelt is a schooling species and often aggregates in large numbers while resting in pools. Riffle-pool designs approximate pool-and-weir technical fishways in a more natural manner. Fish move through this type of fishway system by bursting over a boulder riffle or through an opening/gap within the riffle then momentarily resting in the upstream pool. Suitable fish passage

conditions (e.g., flow velocity) can often be created in riffle pools with slopes of 3% or less. Boulder weirs/riffles used to separate pools are typically braced upon footer stones and sized to remain stable under flood flow conditions. Photographs of an example riffle-pool system are provided in Figure 8.

Given this River's relatively low flow during minimum flow conditions of approximately 13.3 cubic feet per second (cfs), a riffle-pool system will provide better passage for the target species during minimum (95% exceedance) flow conditions than other nature-like fishway alternatives. The upstream-most riffle is also designed to create added depth for a short distance upstream to better facilitate aquatic and recreational passage.

The riffles will be constructed of large-sized boulders designed to resist movement during all analyzed storm events up to and including the 100-year flood. Using the Rosgen Equation (2001), it was calculated that the 10-year flood yielded the largest shear stress (of the design storms analyzed) and that boulders with a weight of approximately 2,400 pounds would be required to resist movement. In summary, the nature-like fishway will consist of:

- Three boulder riffles with resting/energy dissipation pools in-between and downstream.
- Weir notches in each riffle will remain 2.5 feet wide with heights/depths of approximately 12 inches. This meets USFWS recommendations of a minimum 2.5-foot-wide by 12-inch-deep weir opening for alewife. These are the most conservative values since blueback herring and rainbow smelt only require weir opening widths of 2.25 feet and 1.0 foot, respectively, and weir opening depths of 12 inches and 6 inches, respectively.
- The boulder riffles/weirs are spaced approximately 45 feet apart throughout the length of the fishway to form pools that are adequately sized to minimize Energy Dissipation Factors (EDF) of 2.09 or less during the upstream migration period. These pools will have an average bottom width of approximately 16 feet and have the following minimum depths below the water surface:
    - 3.4 feet during 95% exceedance (minimum) flow conditions;
    - 4.1 feet during 50% exceedance (normal) flow conditions; and
    - 5.4 feet during 5% exceedance (maximum) flow conditions.

    Flow velocities within the resting pools will limited to between 0.1 and 1.6 feet per second during minimum, normal, and maximum flow conditions during the upstream migration season. Boulders used to create the riffles/weirs shall have a minimum weight of 2,400 pounds.
- The substrate of the pools will consist of native and important sediment, cobbles, and scattered boulders forming a 24-inch thick layer of channel bottom protection with stones ranging between 6-inches to 20-inches (with a d50 of 10 inches). Native materials will be re-used to the maximum extent practical.
- Pool borders will be lined with lower riverbank slope protection consisting of native or imported soil-filled stone and joint plantings of native species to provide wetland habitat, stabilize channel banks and maintain required pool geometry to limit EDFs during higher flows.

Refer to **Attachment 13** for a full HEC-RAS summary of fish passage flow depths and velocities at all river sections within the Project Site following removal of the dam with in-river improvements.

Grade Control Boulder Weirs and Scour Pools (for Recreational Passage)

While the installation of a nature-like fishway will improve habitat and provide better flow depths for aquatic/fish passage in the immediate vicinity of the former dam location, added river restoration techniques/ measures such as natural boulder vanes (with notches for fish and canoe/kayak passage) strategically installed upstream of the fishway between Benjamin Street, Cashman's Park, and the MBTA Railroad will also be installed to create added depth during lower flows to better facilitate aquatic/fish and recreational passage. These vanes will also protect streambanks by redirecting the river's thalweg away from the streambank and toward the center of the channel and enhance in-stream habitat by creating scour pools and providing oxygen. A grade control boulder cross vane approximately 200 feet downstream of the MBTA railroad bridge at the river's sharp bend location is proposed to help reduce flow velocities and increase flow depths through the MBTA bridge which will eliminate the need to create a low-flow channel beneath the bridge and will also assist in reducing water level drops upstream of the MBTA Bridge.

Figure 9: Example of Boulder Vane
(USDA NRCS Georgia Fish and Wildlife Habitat Improvement Practices)

Overall, grade control boulder vanes are proposed at six locations upstream of the nature-like including the location approximately 200 feet downstream of the MBTA Bridge. These grade control boulder vanes will

backwater flow throughout the entire stretch of river within projects limits in order to ensure that there will always be a minimum flow depth of approximately 18 inches even during low-flow or base flow conditions. The grade control boulder vanes will consist of boulders having a minimum weight of 2,200 pounds. A notch in each grade control boulder vane/weir will be created to facilitate aquatic and recreational passage. The notches will be 3.5 feet wide with heights/depths of approximately 12 inches. This meets USFWS recommendations of a minimum 2.5-foot-wide by 12-inch-deep weir opening for alewife. This also exceeds the typical 36-inch to 37-inch maximum widths of most kayaks and canoes.

Downstream scour pools will consist of native and imported sediment, cobbles, and scattered boulders forming a 12-inch thick layer of channel bottom protection with stones ranging between 2-inches to 8-inches (with a d50 of 4 inches). Native materials will be re-used to the maximum extent practical. The pools will be approximately 30 feet in length and have a one-foot depth in order to adequately dissipate energy, turbulence, and bed scour as water plunges over the crest of the boulder weirs.

Refer to **Attachment 11** for grade control boulder weir and scour pool sizing computations.

Upstream Base Condition Water Level Changes and Changes to Upstream Wetland Communities

Removal of the dam will alter and/or shift upstream wetland communities. The extents of potential alterations to these adjacent wetlands are generally a function of the wetland's depth to groundwater (which can be governed by impounded base condition water surface elevations), underlying soil characteristics, and amount of surface runoff discharged from contributing subwatersheds. For preliminary analysis purposes, a drop of more than six inches in upstream base condition water-surface elevations was conservatively assumed to potentially result in an ecological change to adjoining upstream wetland communities. Based on the results of our analysis, the section of River between the Little River Dam and its crossing beneath the Interstate 495 (I-495) bridges will experience base condition water surface elevation drops of six inches or more. As shown in Figure 9 these drops will range between 3.8 feet and 10.4 feet between the Dam and the upstream MBTA Railroad bridge; between 3.6 feet and 3.8 feet between the MBTA Railroad bridge and the Utility Conduit Crossing; and between 0.3 feet and 3.6 feet between the Utility Conduit Crossing and the I-495 bridges.

According to MassDEP Wetland (2005) data, and as reflected in Figure 10, there are several wetland communities that border the River between the River's crossings with the MBTA bridge and Interstate 495 (I-495) Bridge. Based on MassGIS data, within that stretch of the River, there are approximately:

- 11.5 acres of deciduous wooded swamp;
- 13.4 acres of shrub swamp;
- 20.2 acres of shallow marsh meadow or fen;
- 2.8 acres of deep marsh; and
- 20.3 acres of open water/riverine habitat.

There are, however, no mapped natural heritage estimated habitats of rare wildlife, natural communities,

certified vernal pools, priority habitats of rare wildlife, or priority habitats of rare species.

A significant portion of the wetlands listed above may potentially be altered by the dam removal. It is possible that some existing areas of wetlands may convert to upland. Simultaneoulsly, it is likely that existing area currently inundated by the Little River Dam impoundment may develop into various wetland types once that land is exposed. As noted above, the specific changes will be dictated by additional factors such as underlyling soils and geology and site-specific patterns of surface and ground water circulation.

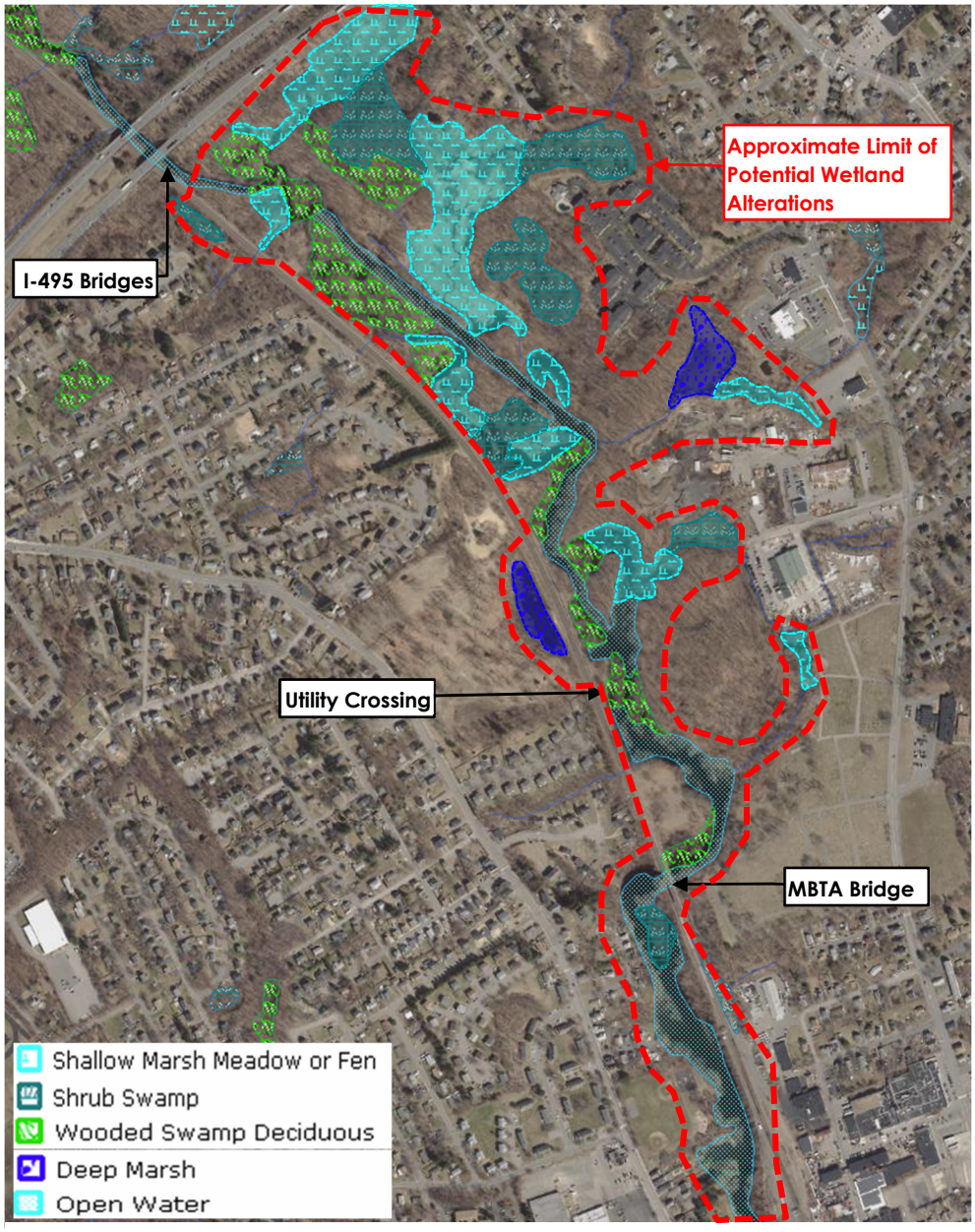

Figure 10: Wetland Communities Upstream of the Little River Dam

The removal of the dam is also expected to result in base condition average river width reductions. As shown in Figure 11, it is anticipated the river will revert back to its natural river width of approximately 25 to 35 feet (between the Dam and MBTA Railroad) under base flow conditions following full dam removal. This represents width reductions of approximately: 60 feet between the Dam and the upstream MBTA Railroad bridge; 25 feet between the MBTA Railroad bridge and the Utility Conduit Crossing; and 15 feet between the Utility Conduit Crossing and the I-495 bridges. It is likely that this area between the new river width and the former river width will revert to riparian habitat; and that riverine and wetland vegetation will gradually replace reservoir taxa (Stanley and Doyle 2003) within

these newly exposed riverbank areas.
Refer to **Attachment 14** for base condition flow pre- versus post- hydraulic analysis results. A series of grade control structures upstream of the former Dam will produce a water depth of 15 to 18 inches under base condition flow. These conditions are expected to still allow for canoeing and kayaking.

Figure 11: Low Flow River Width Reductions

Flood Reduction Benefits

Fully removing the Dam will result in a notable reduction in upstream water levels during flood events up to

Rosemont Avenue. The following table provides a summary of the range of upstream flood level reductions during the 10%, 2%, 1%, and 0.2% Annual Chance Flood Events commonly referred to as the 10-, 50-, 100-, and 500-year flood events. It is assumed that these are inland flood events with no coastal storm surge. This assumption was made to conservatively approximate changes in flood velocities since assuming storm surge elevations will result in more backflow impacts and lower flow velocities which would result in an underestimation of peak flow velocities that would result during inland flood events.

Table 14: Flood Level Reductions During the 10%, 2%, 1%, and 0.2% Annual Chance Flood Events

Section of River	10-Year Flood Level Reduction Range (Minimum to Maximum, feet)	50-Year Flood Level Reduction Range (Minimum to Maximum, feet)	100-Year Flood Level Reduction Range (Minimum to Maximum, feet)	500-Year Flood Level Reduction Range (Minimum to Maximum, feet)
Dam to MBTA Railroad Bridge	6.3-2.4 feet[1]	3.8–1.7 feet[1]	0.2-1.8 feet[1]	Less than 0.6 feet[1]
MBTA Railroad Bridge to Utility Crossing	1.6-1.2 feet	0.8-0.9 feet	0.1-0.3 feet	Less than 0.1 feet
Valley Pipe Crossing to I-495 Bridges	0.4-1.2 feet	0.4-0.8 feet	0.1-0.2 feet	Less than 0.1 feet
I-495 Bridges to Rosemont Avenue	Less than 0.5 feet	Less than 0.5 feet	Less than 0.1 feet	Less than 0.1 feet

1 Reductions will be less during coastal storm events. As reflected in the FIS, storm surge elevations in the Merrimack River were approximated to be El. 15.3 feet, El. 19.5 feet, El. 22.4 feet, and El. 28.7 feet during the 10-Year, 50-Year, 100-Year, and 500-Year flood events, respectively.

Figure 12 illustrates the reduction in flood levels during the 100-year flood event during an inland flood event.

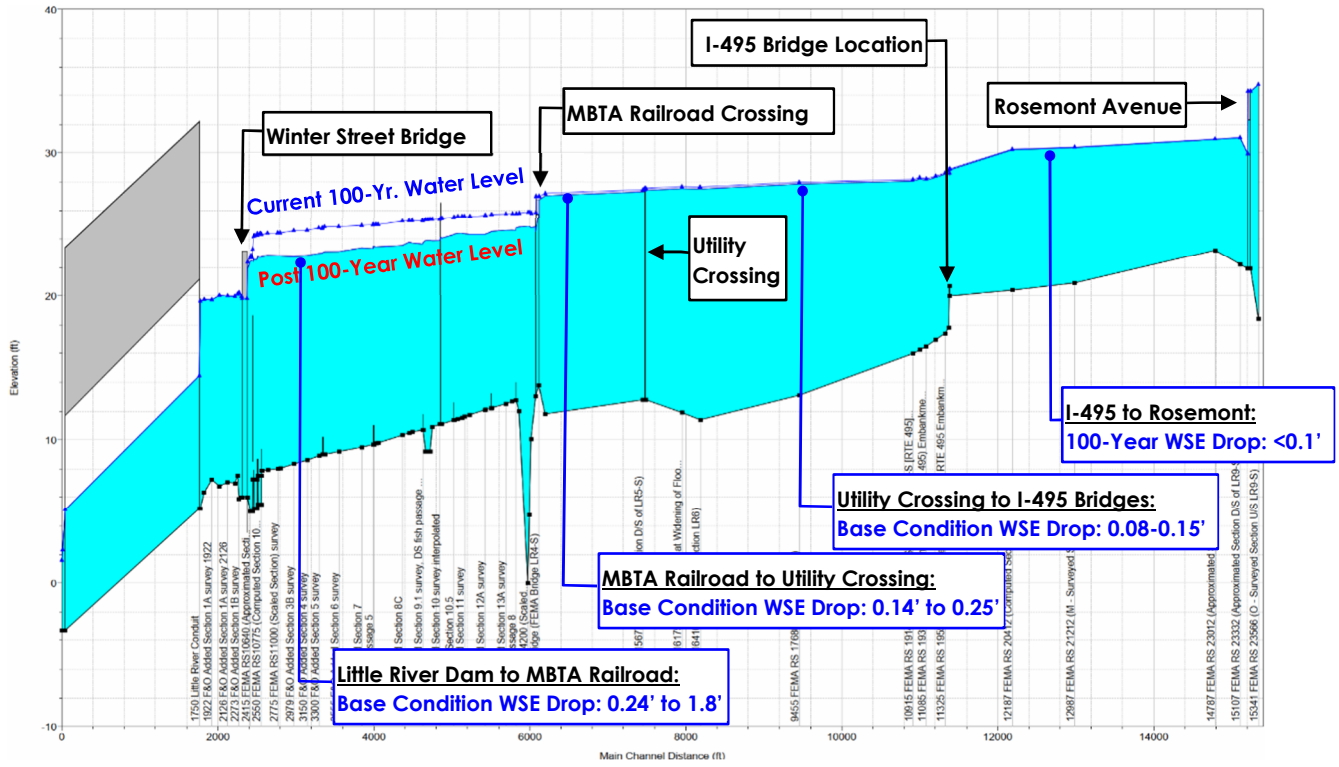

Figure 12: 100-Year Water Surface Elevation Reductions During Inland Flood Event

While these flood benefits will be realized during inland flood events, it is not anticipated that dam removal will have a significant impact on flood insurance rates for properties currently located within the floodplain. This is because the flood insurance rates are conservatively based on a 100-year flood event coupled with a storm surge scenario as reflected in the current FIS for Essex County. When applying backwater impacts from the Merrimack River during a coastal flood, 100-year flood reductions between the Dam and the MBTA Railroad will only range 0.1 and 0.9 feet as shown in Figure 13. Refer to **Attachment 15** for 10-, 50-, 100-, and 500-year pre vs post dam removal hydraulic results with inland flooding. Refer to **Attachment 16** for the 100-year pre vs post dam removal hydraulic results with coastal flooding.

It is important to note that with these reductions in flood elevations during inland storm events, there will be increases in flow velocities throughout the River between the Dam and the Rosemont Avenue Bridge. Such increases will be greatest just upstream of the Dam (e.g. the maximum increase in velocity is 3.4 ft/s approximately 30 feet upstream of the current location of the dam during the 10-year flood) and immediately downstream of the MBTA Railroad and I-495 Bridges. These increases in velocities at these specific locations may increase the potential for scour during flood events and require the installation of scour countermeasures (as previously mentioned in this memorandum).

Reductions in flood elevations during inland storm events may also leave banks vulnerable to undercutting and collapse in some locations upstream of the Dam. Based on the results of the pre- versus post-dam removal results for the 10-year, 50-year, 100-year, and 500-year inland storm events, it appears that reductions in flood elevations (coupled with increased flow velocities) will primarily occur between the Dam and the MBTA Bridge. As a result, bank stabilization is necessary along both sides of the River within this

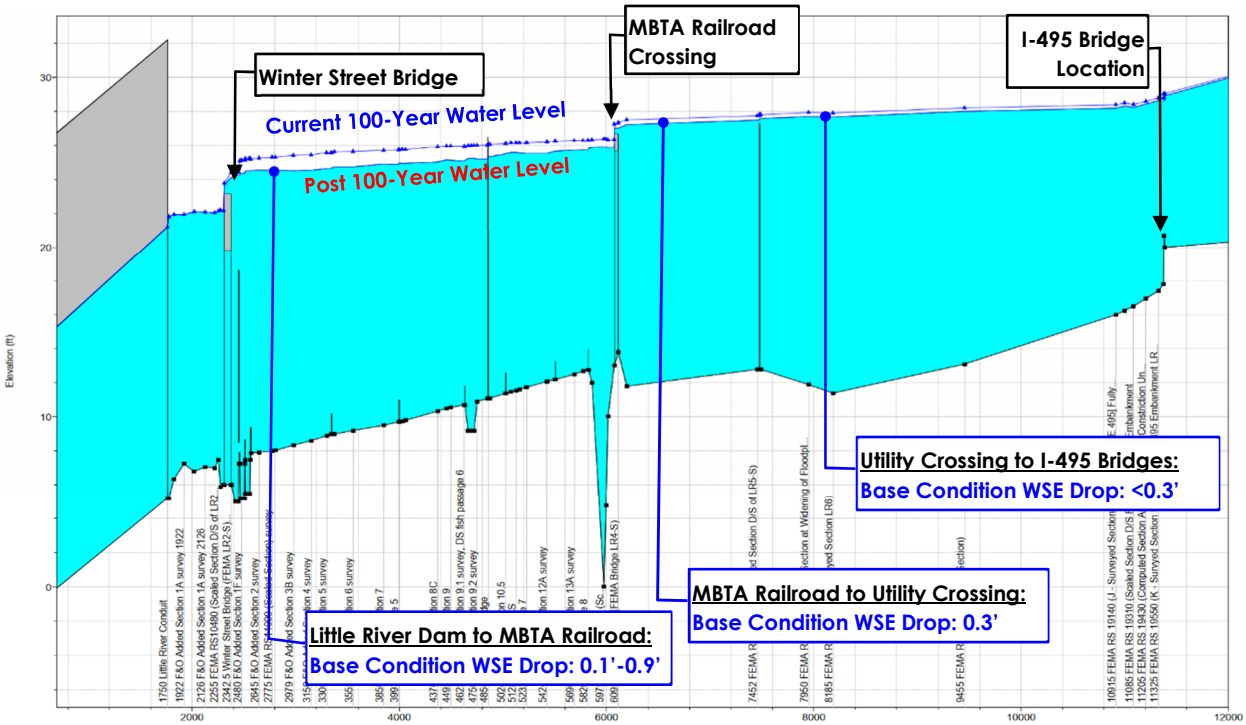

Figure 13: 100-Year Water Surface Elevation Reductions During Coastal Flood Event

stretch of the River. Stabilization measures are shown on the Site Layout and Grading Plan and consist of a combination of natural erosion control blanketing, biodegradable coir fascine with fast-growing native live stakes, lower river slope stabilization with stone, and native wetland/conservation seed mix.

Climate Change Applicability

Should climate change predictions documented within the *SHMCAP* become realized, it is anticipated that annual precipitation will increase up to 16% (or 7.3 inches), days with rainfall accumulation of greater than one inch will increase by 57% (or 4 days), the number of consecutive dry days will increase by 18 percent, and summer precipitation will decrease. It is also anticipated that there will be an increase in the intensity and frequency of larger storm events and a rise in sea levels.

Due to the removal of the dam, the limits of tidal inundation (during high tide conditions) will continuously extend further upstream than currently exists. Mean high water is anticipated to potentially rise to El. 5.8 feet (NAVD88) by the year 2070 based on the "high" scenario for Boston as documented within the SHMCAP. This 'high' scenario is recommended since sea-level rise is projected to be greater than the global average along the New England coast. In terms of in-river impacts, with the dam removed, high tide will extend approximately 1,400 feet upstream of the dam's current location in 2070 (up to Apple Street). The nature-like fishway installed in the vicinity of the dam will likely be inundated during mean high water conditions during 2070, but will continue to operate as designed under mean tide and mean low water conditions. As high tide levels continue to rise, more and more of the River will begin to experience inundation. This, however, will not adversely impact passage.

Table 15 reflects the impact to flood flows conveyed by the Little River at the project site as projected for 2070, using a flood flow magnification factor of 1.27 for 100-year design storm, and 1.2 for more frequent design storms per RMAT guidelines. In addition, for the climate change analysis a high tide water surface elevation of 5.8 feet (equivalent to the 2070 projected high tide) was assumed for the downstream boundary condition.

Table 15: Peak Flood Event Inflow Rates Projected for 2070

Location	Present-Day 10-Year Flood (cfs)	Projected 10-Year Flood (cfs)	Present-Day 50-Year Flood (cfs)	Projected 50-Year Flood (cfs)	Present-Day 100-Year Flood (cfs)	Projected 100-Year Flood (cfs)
RS 15341 - Upstream Limit of Model	980	1,176	1,640	1,968	1,990	2,527
RS 11387 – Upstream of I-495 Bridges	1,160	1,392	1,920	2,304	2,330	2,959

In general, climate change will lead to increased flow velocities during flood flows, which will increase scour potential throughout the project area. Flood elevations will also typically increase whether or not the Dam is removed. However, under a climate change scenario the removal of the Dam will reduce flood risks to upstream structures during analyzed flood events between Winter Street and the I-495 bridges. Flood reductions are most significant immediately upstream of the dam and during the smaller, more frequent flood events such as the 10-year flood event as shown in Table 16. Flood reductions are less significant during the larger, more infrequent flood events such as the 50- and 100-year flood events.

Table 16: Peak Flood Elevation Comparison Between Present-Day and Projected Flood Conditions

Location	Present 10-Year WSE (feet) With Dam	Projected 10-Year WSE (feet) With Dam	Projected 10-Year WSE (feet) Without Dam	Present 50-Year WSE (feet) With Dam	Projected 50-Year WSE (feet) With Dam	Projected 50-Year WSE (feet) Without Dam	Present 100-Year WSE (feet) With Dam	Projected 100-Year WSE (feet) With Dam	Projected 100-Year WSE (feet) Without Dam
RS 2645 – Just Upstream of Little River Dam	22.26	22.73	17.64	23.7	24.36	22.96	24.39	26.42	25.95
RS 4060 – In Vicinity of Little River Road	22.61	23.14	19.01	24.24	24.97	23.52	25.01	26.95	26.38
RS 6195 – Upstream of MBTA Railroad	23.94	24.68	23.31	26	27.13	26.96	27.16	28.41	28.35
RS-7488 – Upstream of Valley Pipe Support Structure	24.21	24.96	23.82	26.34	27.49	27.34	27.53	28.77	28.72
RS 12187 – Upstream of I-495 Bridges	27.16	27.84	27.7	29.23	30.21	30.16	30.26	31.59	31.58

Fish passage flows were also projected for 2070 using the same methods as that used for flood flows. Table 17 reflects the impact to fish passage flows conveyed by the Little River at the project site as projected for 2070, using a flood flow magnification factor of 1.2 for 5% and 50% exceedance flows, and decreasing the flood flow by a factor of 0.8 for 95% exceedance and base flow conditions to reflect future potential drought conditions. In addition, for the climate change analysis a high tide water surface elevation of 5.8 feet (equivalent to the 2070 projected high tide) was assumed for the downstream boundary condition. Refer to **Attachment 17** for pre-dam removal vs post-dam removal results for projected flood conditions (2070).

Table 17: Peak Fish Passage Inflow Rates Projected for 2070

Location	Present-Day 5% Exceedance Flow (cfs)	Projected 5% Exceedance Flow (cfs)	Present-Day 50% Exceedance Flow (cfs)	Projected 50% Exceedance Flow (cfs)	Present-Day 95% Exceedance Flow (cfs)	Projected 95% Exceedance Flow (cfs)	Present-Day Base Flow (cfs)	Projected Base Flow (cfs)
R.S. 15341 - Upstream Limit of Model	201.7	242.04	56.3	67.56	13.3	10.64	9.8	7.8
R.S. 11387 – Upstream of I-495 Bridges	201.7	242.04	56.3	67.56	13.3	10.64	9.8	7.8

The hydraulic analysis for these conditions indicates that under dam removal conditions, climate change will result in an increase in water surface elevations and flow depths throughout the project area in addition to flow velocities during the upstream migration season. Such increases in velocity will be marginal and will have little impact on fish passage. For example, a velocity barrier will still exist at the MBTA Railroad Bridge under future climate change conditions across the full range of fish passage flows. Although projected climate change conditions will reduce, but not eliminate flow depth barriers for most target species, flow depth fish passage barriers will still occur in multiple locations for striped bass. As a result, the nature-like fishway will still be beneficial in providing effective passage for this fish under projected climate change conditions. Climate change could also result in passage barriers to resident species during the summer months since climate change is expected to result in increased periods of drought. During these periods, base flows may decrease to levels where flow depths are inadequate for any upstream passage. The implementation of the riffle-pool fishway will provide areas of habitat or refuge (in the pools) for resident species during these drier periods (i.e. periods of extremely low flow).

Attachments

Attachment 1 – Pertinent Reference Information Obtained from FEMA Flood Insurance Study
Attachment 2 – StreamStats Hydrologic Characteristics for Nearby USGS Gauge Stations and USGS Recorded Flow Data for Base Condition Flow Determination
Attachment 3 – USFWS Fish Passage Flow Determination Spreadsheets
Attachment 4 – NOAA Tide Data for Merrimack River
Attachment 5 – FEMA Duplicate Effective Model Hydraulic Back-up Data
Attachment 6 – Duplicate Effective Model HEC-RAS Profile and Output Summary
Attachment 7 – Hydraulic Cross-Section Location Plans Including Bathymetric Topographic Information (Spot Elevations) Obtained from Field Investigations
Attachment 8 – Pre-Dam Removal Model HEC-RAS Profile and Output Summary (Flood Flows)
Attachment 9 – Post-Condition Model (With In-River Improvements) HEC-RAS Profile and Output Summary (Flood Flows)
Attachment 10 – Sediment Sieve and Mobility Analysis Results
Attachment 11 – Scour Countermeasure, Lower Riverbank Slope Protection, Channel Bottom Protection, Grade Control Boulder/Scour Pool, and Nature-like Fishway Weir/Pool Bottom Stone Sizing Computations
Attachment 12 – Post-Dam Removal (With No In-River Improvements) HEC-RAS Results for Fish Passage Assessment (Base Condition and Fish Passage Flows)
Attachment 13 – Post-Condition Model (With In-River Improvements) HEC-RAS Profile and Output Summary (Base Condition and Fish Passage Flows)
Attachment 14 – Pre- Versus Post-Dam Removal Comparison HEC-RAS Summary Profile and Results (Base Flow)
Attachment 15 – Pre- Versus Post-Dam Removal Comparison HEC-RAS Results for 10-, 50-, 100-, and 500- Year Inland Flooding Event
Attachment 16 – Pre- Versus Post-Dam Removal Comparison HEC-RAS Results for 100-Year Coastal Flooding Event
Attachment 17 – Climate Change Pre-Versus Post-Dam Removal HEC-RAS Summary Profiles and Results

Attachment 1

Pertinent Reference Information Obtained from FEMA Flood Insurance Study

FLOOD INSURANCE STUDY

ESSEX COUNTY, MASSACHUSETTS
(ALL JURISDICTIONS)
Volume 1 of 4

COMMUNITY NAME	COMMUNITY NUMBER
AMESBURY, CITY OF	250075
ANDOVER, TOWN OF	250076
BEVERLY, CITY OF	250077
BOXFORD, TOWN OF	250078
DANVERS, TOWN OF	250079
ESSEX. TOWN OF	250080
GEORGETOWN, TOWN OF	250081
GLOUCESTER, CITY OF	250082
GROVELAND, TOWN OF	250083
HAMILTON, TOWN OF	250084
HAVERHILL, CITY OF	250085
IPSWICH, TOWN OF	250086
LAWRENCE, CITY OF	250087
LYNN, CITY OF	250088
LYNNFILED, TOWN OF	250089
MANCHESTER BY THE SEA, TOWN OF	250090
MARBLEHEAD, TOWN OF	250091
MERRIMAC, TOWN OF	250092
METHUEN, CITY OF	250093
MIDDLETON, TOWN OF	250094
NAHANT, TOWN OF	250095
NEWBURY, TOWN OF	250096
NEWBURYPORT, CITY OF	250097
NORTH ANDOVER, TOWN OF	250098
PEABODY, CITY OF	250099
ROCKPORT, TOWN OF	250100
ROWLEY, TOWN OF	250101
SALEM, CITY OF	250102
SALISBURY, TOWN OF	250103
SAUGUS, TOWN OF	250104
SWAMPSCOTT, TOWN OF	250105
TOPSFIELD, TOWN OF	250106
WENHAM, TOWN OF	250107
WEST NEWBURY, TOWN OF	250108

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JULY 19, 2018

Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER
25009CV001C

Danvers, Town of	The hydrologic and hydraulic analyses for the January 1990 study were prepared by Anderson-Nichols and Company, Inc., for the Federal Insurance Administration (FIA), under Contract No. H-4524. This work, which was completed in November 1978, covered all significant flooding sources in the Town of Danvers (Reference 5).
Essex, Town of	The hydrologic and hydraulic analyses for the July 17, 1986 study were prepared by Stone & Webster Engineering Corporation for FEMA, under Contract No. H-4772. This work was completed in April 1984 (Reference 6).
Georgetown, Town of	The hydrologic and hydraulic analyses for the December 1979 study were performed by Sverdrup & Parcel and Associates, Inc., for the FIA under Contract No. H-4037. This work was completed in March 1978, and covered all significant flooding sources affecting the Town of Georgetown (Reference 7).
Gloucester, City of	The hydrologic and hydraulic analyses for the January 17, 1986 study were prepared by Stone & Webster Engineering Corporation for FEMA under Contract No. H-4772. This work was completed in September 1983 (Reference 8).
Groveland, Town of	The hydrologic and hydraulic analyses for the April 1980 study were performed by Sverdrup & Parcel and Associates, for the FIA under Contract No. H-4037. This work was completed in April 1978, and covered all significant flooding sources affecting the Town of Groveland (Reference 9).
Hamilton, Town of	The hydrologic and hydraulic analyses for the June 4, 1990 study were prepared by CDM for FEMA, under Contract No. EMW-86-R-2250. This work was completed in November 1987 (Reference 10).
Haverhill, City of	The hydrologic and hydraulic analyses for the August 16, 1982 study were prepared by Cullinan Engineering Co., Inc., for FEMA under Contract No. H-4797. The hydrologic and hydraulic analyses for a portion of the Merrimack River were performed by

TABLE 2 –FLOODING SOURCES STUDIED BY DETAILED METHODS-continued

Flooding Source Name	Description of Study Reaches
Howlett Brook & Pye Brook	In the Town of Topsfield, from its confluence with the Ipswich River to approximately 600 upstream from State Highway 97 (Haverhill Road)
Hussey Brook	In the Town of Andover, from its confluence with the Shawsheen River to approximately 3700 feet upstream from Beacon Street
Hussey Brook Tributary	In the Town of Andover, from its confluence with Hussey Brook to approximately 200 feet upstream from Beacon Street
Ipswich River	In the Town of Ipswich, from State Route 133 to the Essex County (Town of Lynnfield)/Middlesex County (Town of North Reading) County Limits
Jackman Brook	In the Town of Georgetown, from Parish Road to Jewett Street
Johnson Creek	In the Town of Groveland, from its confluence with the Merrimack River to Washington Street
Lake Attitash	On the City of Amesbury/Town of Merrimac Corporate Limits
Little River	In the City of Haverhill, from its confluence with the Merrimack River to approximately 5000 feet upstream from Rosemont Street
Massachusetts Bay	Along the eastern coastline of Essex County from its southern border to Cape Anne

been documented by gage records and high-water marks. Records at the Middleton gage on the Ipswich River give an indication of the magnitude of flood discharges in Danvers, located just downstream. The Middleton gage began operation in 1938. The flood of record occurred on January 26, 1979, and had a measured peak discharge of 835 cfs.

Georgetown has not experienced any severe storm damage in the past. Minor flooding has occurred throughout the town. Two of these areas are Baldpate Road, which floods due to runoff from Littles Hill, and Andover Street, North Street, and Bailey Lane at Parker River. Rock pond and Pentucket Pond have not had flood problems in the past.

Groveland has experienced extensive flooding in the past. The most notable storm was in 1936, a storm classified as being greater than a 1-percent-annual-chance storm. Major flooding inundated the banks of the Merrimack River. The hardest hit area was along Main Street, near Gardener Street. Bates Bridge over the Merrimack River was nearly overtopped. Also hit hard were areas along Johnson Creek from its confluence with Merrimack River to a point upstream of Main Street. Minor flooding is caused by blocked and inadequate culverts throughout the town.

History of flooding on the Merrimack River in Hamilton, Lawrence, and Merrimac contains information dating back to 1846. The most significant recorded floods were those occurring in March 1936 and September 1938. The 1936 flood was the result of a combination of heavy rains and excessive snowmelt. The 1938 flood was caused by torrential rains associated with a tropical storm passing over the Merrimack River basin at a time when the ground was saturated from an earlier storm. The USACE estimated that the 1936 flood has a recurrence interval in excess of 1-percent-annual-chance and the 1938 flood has a recurrence interval of approximately 2-percent-annual-chance. Flooding along the Little River is influenced by the rise in water-surface elevations from the Merrimack River, During severe flooding, the backwater from the Merrimack River extends up the Little River above the entrance to the arch culvert running under the city. During these periods of high backwater, pumps have been utilized to convey floodwaters from the Little River to the Merrimack River. The Massachusetts Geodetic Survey gathered Merrimack, Shawsheen and Spicket River high-water mark data in the City of Lawrence resulting from the 1936 flood (Reference 38).

Riverine flooding in Ipswich caused by inland precipitation runoff has led to little damage from the Ipswich and Miles Rivers due to limited construction in vulnerable areas. In March 1936 and March 1968, floods with recurrence intervals of approximately 50 years were recorded on the Ipswich River at the gage located at the Willowdale Dam. There is no gage on the Miles River, but it can be assumed that this river had floods of similar severity in 1936 and 1968. Neither flood had significant effects on developed land. Kimball Brook, another tributary of the Ipswich River, has flooded Peabody Street, Safford Street, and Cherry

area of 28 square miles and flood control storage of 46,000 acre-feet. The Edward MacDowell Dam, completed in 1950 at Peterborough, New Hampshire has a drainage area of 44 square miles and flood control storage of 12,800 acre-feet. The Franklin Falls Dam, completed in 1943 at Franklin, New Hampshire, has a drainage area of 1,000 square miles and flood control storage of 150,600 acre-feet. Hopkinton Lake Dam, completed in 1962 at Hopkinton, New Hampshire, has a drainage area of 382 square miles and a flood control storage of 70,100 acre-feet. Everett Lake Dam, completed in 1961 at Weare, New Hampshire, has a drainage area of 64 square miles and flood control storage of 85,500 acre-feet. Hopkinton Lake and Everett Lake Dam projects are considered to operate as a single unit since they are connected by a canal. By the operation of these five projects, peak flows at the Lowell gage would be reduced from 173,000 cfs to 112,000 cfs during a recurrence of the record 1936 flood. Tidal flood barriers have not been constructed and are not planned for this area; however, the USACE has constructed and maintains two jetties, 4,118 and 2,445 feet long respectively, at the confluence of the Merrimack River to maintain a good navigational opening and to reduce the erosion of Plum Island and Salisbury Beach.

In addition, several reservoirs exist in Haverhill that do not significantly contribute to flood control, including Crystal Lake Reservoir and Millvale Reservoir. Prior to the flood of September 1938, the Emergency Relief Administration completed construction of concrete floodwalls and a concrete pressure conduit along the north bank of the Merrimack River and the Little River in the vicinity of the center of the City of Haverhill. The concrete floodwalls are equipped with 2.5 foot concrete caps with a crest elevation of 25.7 feet. The Haverhill Flood Protection System includes a levee, the Little River Conduit, and a pump station. A re-alignment of the West Wing Wall area of the levee was performed in 2013-2014 during the construction of the Riverside Place Condominium Building. The accredited levee is shown on the effective FIRM as providing protection from the 1-percent-annual-chance flood.

The Essex Company Dam, also known as Great Stone Dam, is located on the Merrimack River in Lawrence (Reference 51), It was built to utilize the water power of Bodwells Falls. There are canals on both the north and south sides of the river, Under normal conditions, the canals would never be allowed to exceed an elevation of 41.77 feet due to control gates operated by the Essex Company. The dam does not provide flood protection other than to control water levels in the canals. The Malden Mills Dam is located at the outlet of Stevens Pond on the Spicket River. This dam provides flood control during periods of large flows in the Spicket River.

No tidal or riverine flood control structures have been built that would significantly affect flood conditions in Ipswich. The Willowdale dam is located approximately 4.6 miles upstream of State Route 133 on the Ipswich River. Also, there are several other small dams on the Ipswich and Miles Rivers within the town. These dams are used for water power, and none affect flood flows.

Flow frequencies for the Ipswich River in Ipswich were developed by the USGS from data at the gage located at the Willowdale Dam. These frequencies were based on a statistical analysis of the systematic discharge record of 46 years and a historic record of 92 years. The standard log-Pearson Type III method outlined by Water Resources Council Bulletin No. 17 was followed in the analysis (Reference 58). Once the 10-, 2-, l-, and 0.2-percent-annual-chance discharges were obtained at the gage, the flows downstream of the gage were adjusted by using a formula that relates the flows between two basins as a function of the drainage areas (Reference 70). Since the Miles River in Ipswich is ungaged, the l0-, 2-, l-, and 0.2-percent-annaul-chance discharges were computed based on the Massachusetts flood magnitude and frequency formulas developed by the USGS (Reference 55). The study contractor performed a separate evaluation of these formulas and found them to be applicable to the Ipswich region. The USGS formulas predict discharges based on the parameters of watershed drainage area and main channel slope.

Peak discharge-frequency relationships for the Little River and Riverside Airport Brook were derived using procedures described by the USGS in Estimating the Magnitude and Frequency of Floods for Natural-Flow Streams (Reference 55). The technique was developed using multiple regression analyses to estimate flood peaks on ungaged, natural-flow streams in Massachusetts by relating peak discharges to basin and climatic parameters. The resulting peak discharges were verified using statistically analyzed data from nearby stream gages with similar watershed characteristics using a multiplication factor equal to the ratio of the drainage areas to the 0.75 exponential power. They were found to be in general agreement. The derivation of peak discharge-frequency relationships for Creek Brook and Millvale Reservoir Brook used the previously referenced USGS method in conjunction with a numerical integration reservoir routing of triangular inflow hydrographs (References 71 and 72). The routing process was incorporated to take into account the effects of storage in Crystal Lake and Millvale Reservoir upstream of Creek Brook and Millvale Reservoir Brook, respectively.

For the Spicket River, flows of selected recurrence intervals were developed utilizing a drainage area-peak discharge relationship in conjunction with corresponding peak discharges from the pre-countywide FIS for the Town of Methuen (Reference 73). The discharges were further refined by applying an adjustment for impervious land area in consideration of extensive urbanization over the lower reaches of the stream (Reference 74).

The Saugus River watershed is a complex hydrologic system. It contains three major storage areas: Lake Quannapowitt, a large swampy area in Reading; the swamp by the Wakefield Industrial Park; and two major tributary streams (the Reading Drainage Canal and Beaverdam Brook).

TABLE 6 – SUMMARY OF DISCHARGES-continued

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (SQUARE MILES)	PEAK DISCHARGES (CUBIC FEET PER SECOND) 10-PERCENT ANNUAL CHANCE	2-PERCENT ANNUAL CHANCE	1-PERCENT ANNUAL CHANCE	0.2-PERCENT ANNUAL CHANCE
Corporate Limits (Parish Road)					
Jackman Street	0.66	12	19	22	34
Approximately 1,200 feet upstream of Jackman Street	0.45	8	13	15	24
Jewett Street	0.24	4	7	8	13
JOHNSON CREEK					
Approximately 430 feet downstream of Haverhill/Groveland Corporate Limits	6.00	511	731	877	1,623
At Main Street	4.30	225	350	410	720
At Gravel Road Over Dam	3.00	200	320	385	650
At Center Street	2.90	190	308	362	603
Approximately 620 feet upstream of Center Street	2.20	164	270	315	525
At Salem Street	2.10	148	233	270	442
At Uptrack Road	1.70	110	170	200	310
At Washington Street	1.50	98	145	164	252
LITTLE RIVER					
At Winter Street	37.00	1,160	1,920	2,330	3,520
Upstream of I-95	27.70	980	1,640	1,990	3,030
Downstream of Haverhill/ Plaistow corporate limits	20.80	660	1,065	1,275	1,865
MERRIMACK RIVER					
At Salisbury/Amesbury /Newburyport	5010.00	61,000	92,000	115,000	172,100

In those areas where the analysis indicated super critical flow conditions, critical depth was assumed for the flood elevations because of the inherent instability of supercritical flow.

Water-surface elevations of floods of the selected recurrence intervals for the communities in Essex County were computed using the USACE HEC-2 step-backwater computer program (Reference 79). Flood profiles were drawn showing computed water-surface elevations for floods of the selected recurrence intervals.

The Powwow River starting water-surface elevation for the 10-percent-annual-chance flood elevation was taken from the annual tidal stage-elevation; the 2-percent-annual-chance was taken from the 5-year tidal stage-elevation; the 1-percent-annual-chance flood elevation was taken from the 10- tidal stage-elevation; and the 0.2-percent-annual-chance flood elevation was taken from the 25-year tidal stage elevation (Reference 59). For the pre-countywide revised portion of the Powwow River, the starting water-surface elevation for the 1-percent-annual-chance flood was taken from the FIS for the Town of South Hampton, New Hampshire (Reference 60).

Starting water-surface elevations for Unnamed Tributary to Fish Brook was determined using the discharge characteristics of the dam downstream of Lockwood Lane.

Starting water-surface elevations for Ipswich River, Bartlett Brook, Boston Brook, Emerson Brook, Howlett Brook, Pye Brook, Mile Brook, Branch of Ipswich, Bennett's Pond Brook, Cleveland Brook, School Brook, Shute Brook, Fish Brook, Parker River, North Beverly Drainage Ditch, Miles River, Tributary A to the Ipswich River, Fiske Brook, and Fish Brook were computed using the slope/area method.

Starting water-surface elevations for the Ipswich River in Ipswich and for Parker River in Newbury were determined using critical depth.

Starting water-surface elevations for the Little River, Creek Brook, Millvale Reservoir Brook, Shawsheen River, Spicket River, Cochichewick Brook, Bare Meadow Brook, and Riverside Airport Brook were determined to be the normal water-surface elevation of the Merrimack River at their respective confluences.

Starting water-surface elevations for Fish Brook were based on a stage discharge rating curve developed at the dam located at its mouth. Starting water-surface elevations on Hussey Brook were found to be coincident with developed flood profiles on the Shawsheen River. Starting water-surface elevations for Hussey Brook Tributary were found to be coincident with developed flood profiles on Hussey Brook.

Starting water-surface elevations for Chubbs Brook, Mill River, Saugus River, and Centerville Creek were based on the average spring high tide level.

TABLE 7 – MANNING'S "n" VALUES-continued

Flooding Source	Channel "n"	Overbanks
Ipswich River (Middleton)	0.03-0.045	0.033-0.15
Ipswich River (Topsfield)	0.010-0.060	0.11
Ipswich River (Wenham)	0.010-0.060	0.11
Little River	0.029-0.065	0.030-0.125
Merrimack River (Andover)	0.035-0.020	0.065-0.075
Merrimack River (Haverhill)	0.025-0.035	0.065
Merrimack River (Lawrence)	0.028	0.07
Merrimack River (Merrimac)	0.030-0.040	0.060-0.100
Merrimack River (Methuen)	0.023	0.08
Merrimack River (Newburyport)	0.04	0.075
Merrimack River (North Andover)	0.022-0.032	0.060-0.080
Merrimack Tributary to Neal Pond	0.030-0.040	0.060-0.100
Mile Brook (Topsfield)	0.010-0.100	0.050-0.100
Miles River (Ipswich)	0.020-0.050	0.035-0.100
Miles River (Wenham)	0.020-0.050	0.020-0.070
Mill River (Gloucester)	0.013-0.040	0.1
Mill River (Newbury)	0.015-0.050	0.015-0.050
Mill River (Rowley)	0.015-0.060	0.015-0.090
Millvale Reservoir Brook	0.035-0.042	0.112-0.125
Mosquito Brook	0.020-0.070	0.020-0.070
North River (Peabody)	0.023-0.045	0.030-0.15
Parker River	0.020-0.040	0.1
Peat Meadow Brook	0.025-0.050	0.090-0.100
Porter River (Danvers)	0.020-0.040	0.035-0.090
Powwow River	0.035	0.06
Proctor Brook (Peabody)	0.023-0.045	0.030-0.15
Pye Brook (Topsfield)	0.010-0.100	0.050-0.100
Riverside Airport Brook	0.035-0.040	0.100-0.060
Saugus River	0.020-0.040	0.050-0.100
Saugus River (Lynnfield)	0.020-0.110	0.11
School Brook (Topsfield)	0.010-0.060	0.11
Shawsheen River	0.035-0.065	0.030-0.170
Shute River	0.012-0.050	0.035-0.100
Spicket River (Methuen)	0.035-0.050	0.060-0.080
Spicket River (Lawrence)	0.03	0.07

Figure 2, "Transect Schematic" represents s sample transect that illustrates the relationship between stillwater elevation, the wave crest elevation, the ground elevation profile and the location of the V/A zone boundary.

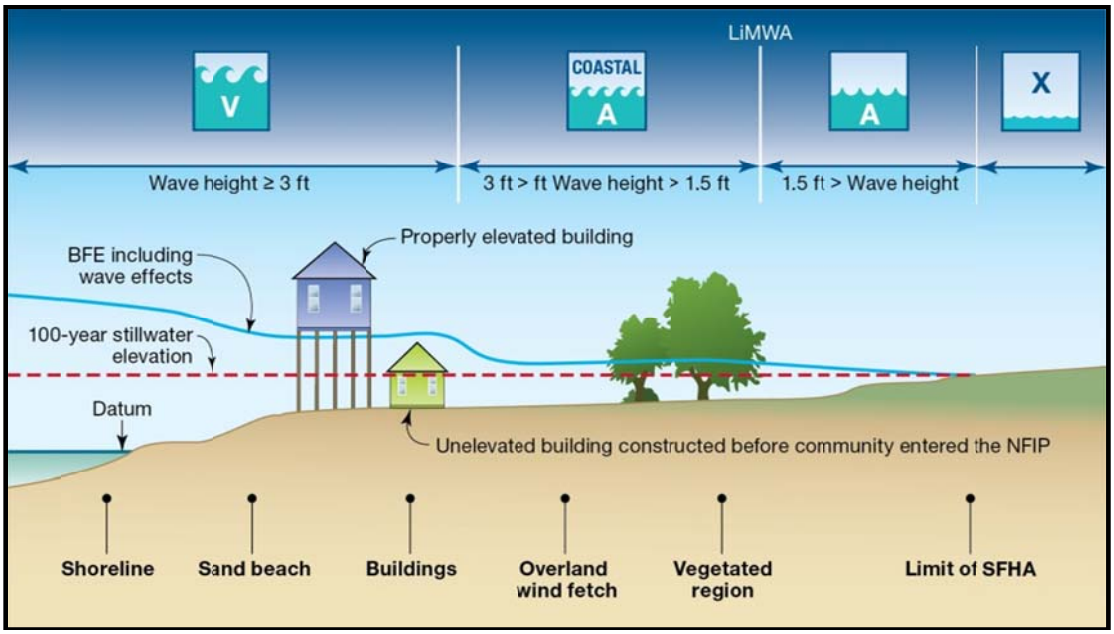


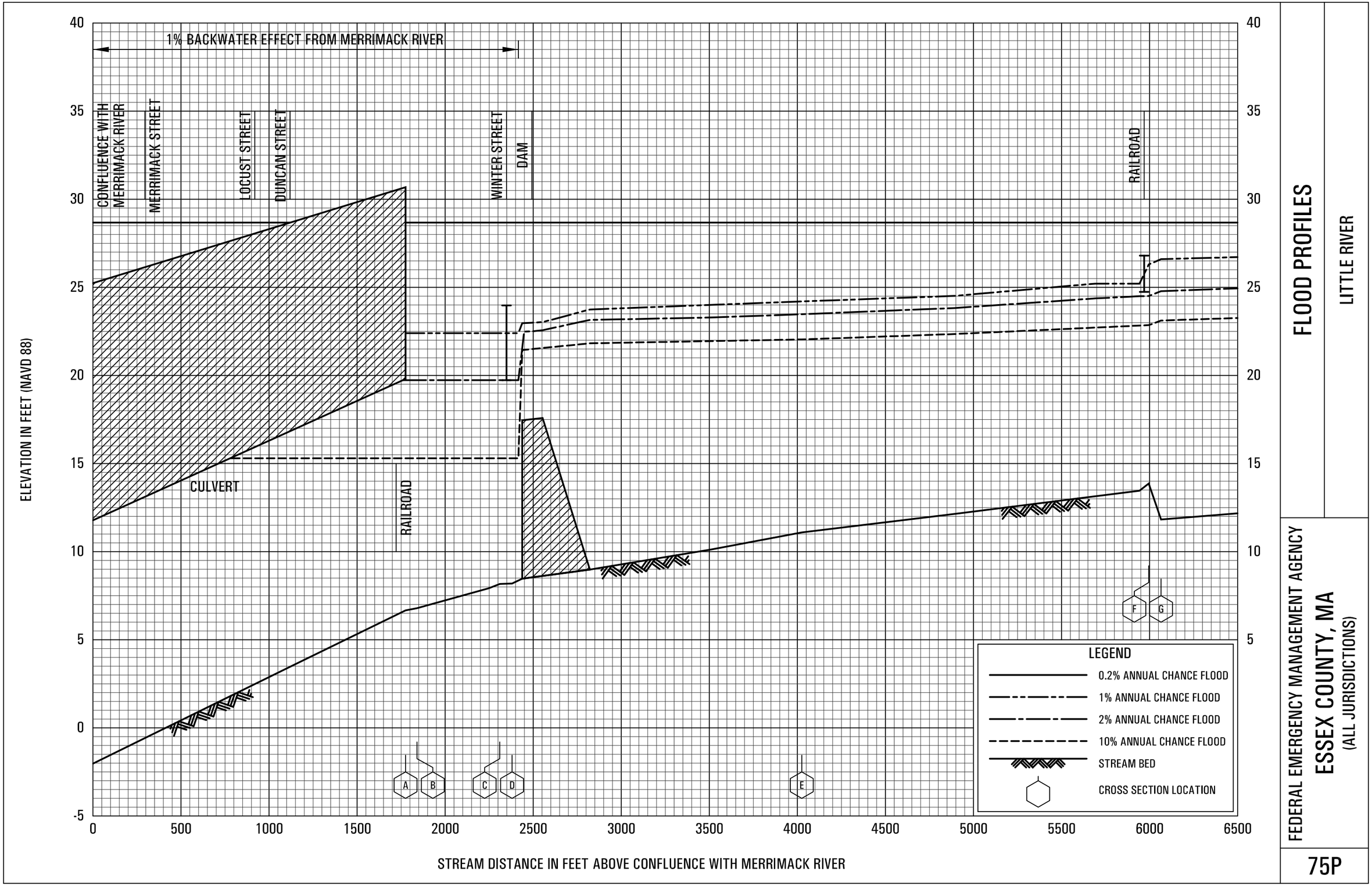
Figure 2. Transect Schematic

3.4 Vertical Datum

All FIS reports and FIRMs are referenced to a specific vertical datum. The vertical datum provides a starting point against which flood, ground, and structure elevations can be referenced and compared. Until recently, the standard vertical datum used for newly created or revised FIS reports and FIRMs was the National Geodetic Vertical Datum of 1929 (NGVD 29). With the completion of the North American Vertical Datum of 1988 (NAVD 88), many FIS reports and FIRMs are now prepared using NAVD 88 as the referenced vertical datum.

All flood elevations shown in this FIS report and on the FIRM are referenced to the NAVD 88. These flood elevations must be compared to structure and ground elevations referenced to the same vertical datum. Ground, structure, and flood elevations may be compared and/or referenced to NGVD 29 by applying a standard conversion factor. **The conversion factor from NGVD 29 to NAVD 88 is -0.8, and from NAVD 88 to NGVD 29 is +0.8.**

For information regarding conversion between the NGVD 29 and NAVD 88, visit the National Geodetic Survey website at www.ngs.noaa.gov, or contact the National Geodetic Survey at the following address:



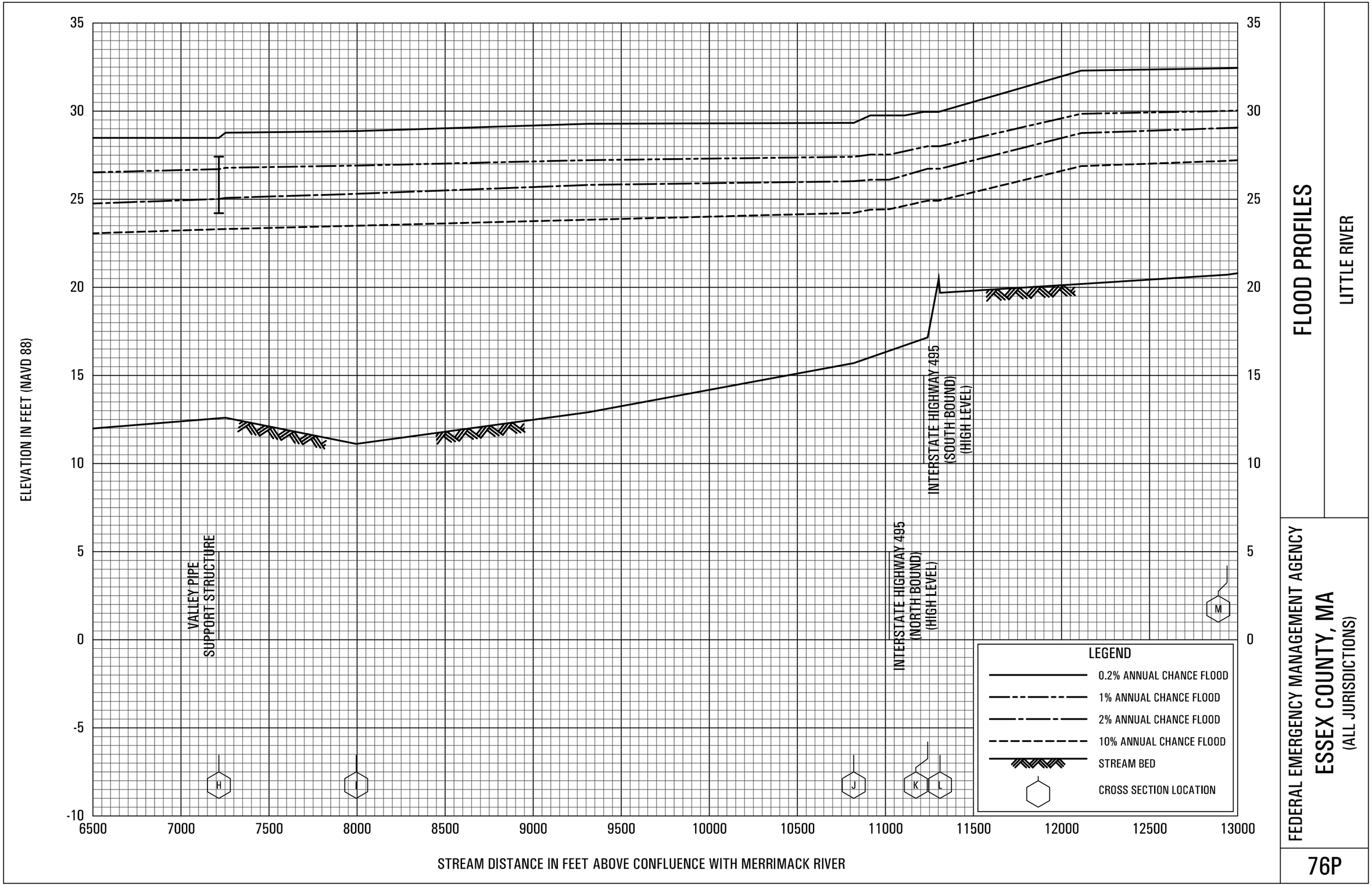
FLOOD PROFILES

LITTLE RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)



FLOOD PROFILES

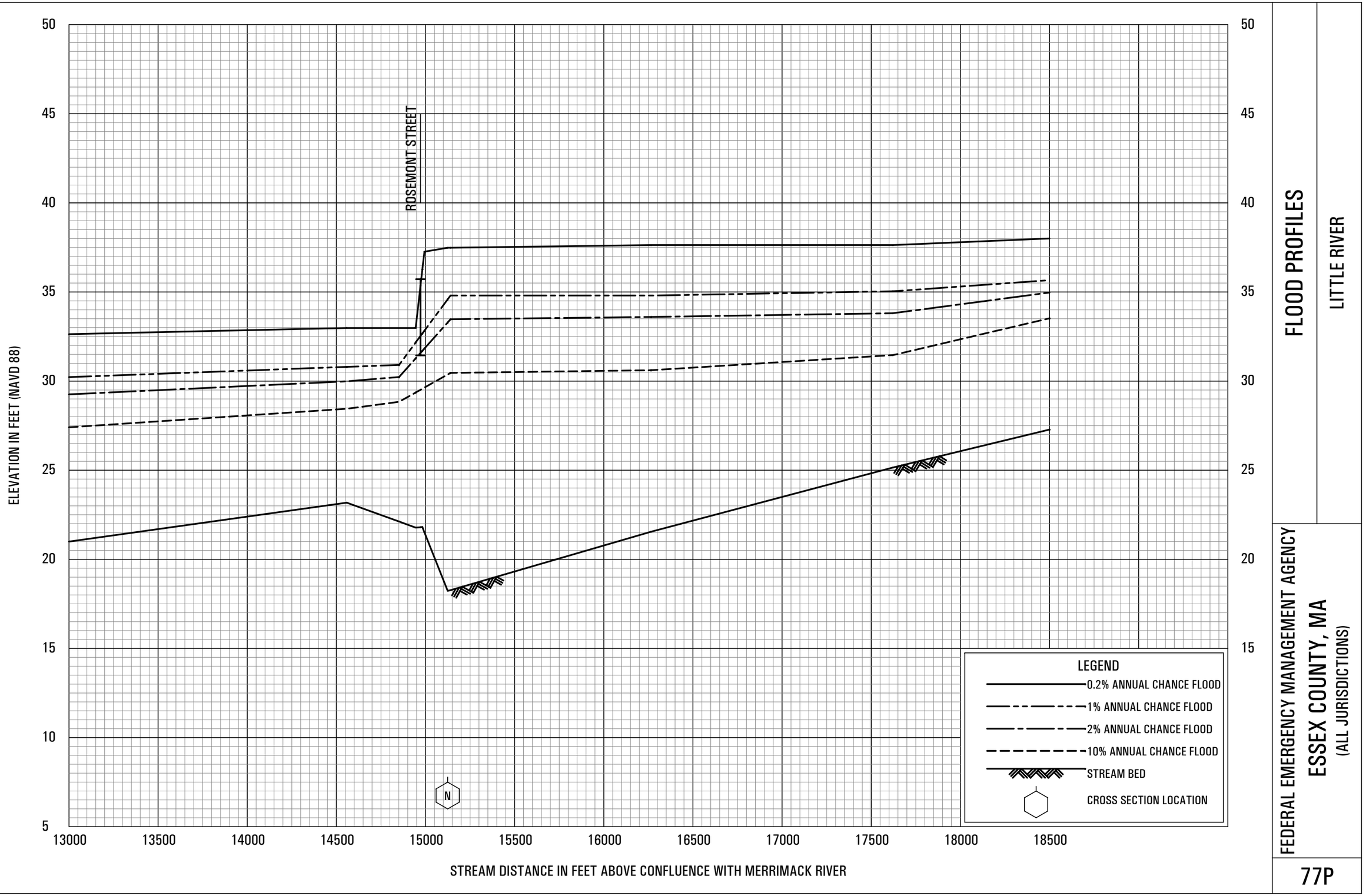
LITTLE RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

76P



FLOOD PROFILES

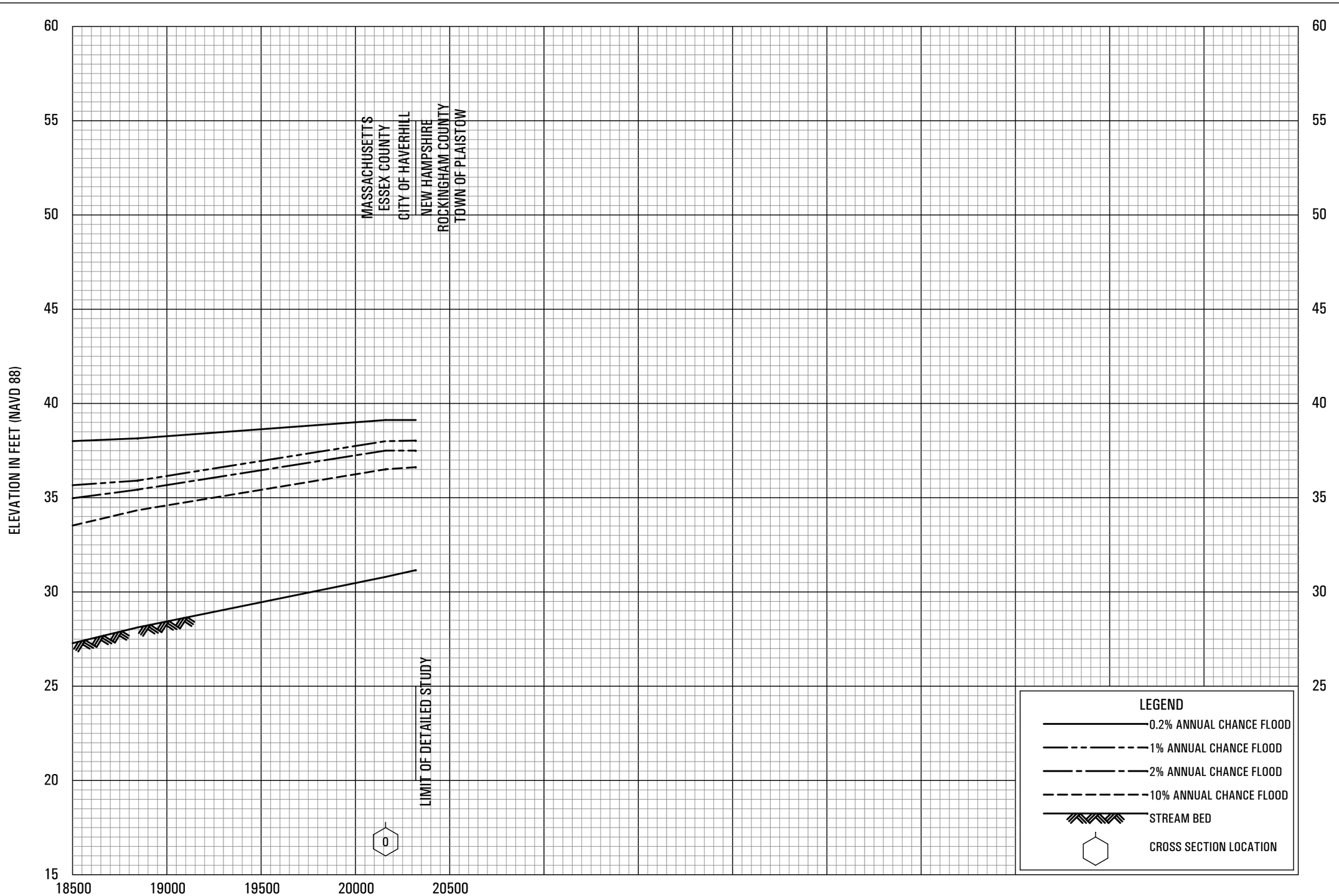
LITTLE RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

77P



FLOOD PROFILES

LITTLE RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

78P

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
A	1775	*	248	9.4	22.4	15.7 [2]	16.2 [2]	0.5
B	1840	51	407	5.7	22.4	16.9 [2]	17.4 [2]	0.5
C	2310	*	259	9.0	22.4	17.0 [2]	17.4 [2]	0.4
D	2,380	*	226	10.3	22.4	17.0 [2]	17.5 [2]	0.5
E	4,025	*	1,121	2.1	24.2	24.2	24.3	0.1
F	5,995	95	785	3.0	26.3	26.3	26.4	0.1
G	6,065	160	1,590	1.5	26.6	26.6	26.7	0.1
H	7,215	197	1,544	1.5	26.9	26.9	27.1	0.2
I	7,995	*	721	3.2	27.1	27.1	27.3	0.2
J	10,820	*	520	4.5	27.6	27.6	28.0	0.4
K	11,240	*	318	7.3	28.2	28.2	28.9	0.7
L	11,310	62	383	6.1	28.2	28.2	29.1	0.9
M	12,940	695	2,997	0.7	30.2	30.2	30.6	0.4
N	15,140	240	2,535	0.8	34.8	34.8	34.9	0.1
O	20,160	45	733	1.7	38.0	38.0	38.2	0.2

[1] FEET ABOVE CONFLUENCE WITH MERRIMACK RIVER

[2] ELEVATIONS COMPUTED WITHOUT CONSIDERING BACKWATER EFFECTS FROM MERRIMACK RIVER

* FLOODWAY COINCIDENT WITH CHANNEL BANKS

TABLE 12

FEDERAL EMERGENCY MANAGEMENT AGENCY

ESSEX COUNTY, MA

(ALL JURISDICTIONS)

FLOODWAY DATA

LITTLE RIVER

Attachment 2

Stream Stats Hydrologic Characteristics for Nearby USGS Gauge Stations and USGS Recorded Flow Data for Base Condition Flow Determination

USGS 01105730 Indian Head River at Hanover, MA

00060, Discharge, cubic feet per second,												
Day of month	50th percentile (median) of daily mean values for each day for water year of record in, ft3/s (Calculation Period 1989-10-01 -> 2021-09-30) Period-of-record for statistical calculation restricted by user											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	71	61	68	88	68	38	19	10	10	15	36	54
2	67	62	80	94	73	35	18	9.2	11	18	35	47
3	66	58	84	117	75	36	17	8.2	12	17	33	46
4	75	55	82	102	67	35	15	8.2	11	14	31	48
5	78	61	74	118	67	36	14	8.6	12	14	33	52
6	69	62	80	99	63	41	16	9.4	12	15	36	52
7	65	64	87	94	62	34	18	9.2	11	15	39	61
8	62	72	82	86	56	35	16	8.8	10	14	40	55
9	57	70	91	93	55	29	14	8.4	9.8	14	39	51
10	59	60	79	86	56	30	14	8.8	11	17	37	58
11	60	64	87	86	48	30	16	10	13	17	39	60
12	65	64	98	88	48	32	14	10	13	20	46	67
13	69	68	98	90	47	38	12	12	11	19	48	59
14	69	68	100	79	45	33	11	12	9.4	19	53	55
15	62	76	114	76	47	29	11	17	11	19	43	64
16	67	84	124	83	49	29	17	18	10	22	42	62
17	59	78	125	84	61	27	15	14	11	26	47	62
18	66	71	102	93	54	28	15	17	13	25	44	61
19	69	72	107	81	52	25	14	17	12	23	43	64
20	66	69	97	73	50	22	13	16	15	26	46	54
21	61	78	97	81	46	22	11	15	13	27	51	48
22	56	78	101	85	41	21	9.7	14	16	25	49	55
23	60	73	90	87	42	25	12	14	19	25	47	68
24	61	80	84	81	48	27	11	12	17	24	47	85
25	62	80	83	84	49	25	11	13	14	23	48	72
26	66	82	86	79	46	23	12	11	16	24	46	68
27	65	84	88	72	44	21	14	11	16	29	56	70
28	62	72	86	72	44	23	14	12	18	30	66	72
29	58	81	92	76	41	21	14	11	16	44	66	64
30	57		97	70	38	21	13	11	18	39	56	80
31	59		93		36		11	10		36		75
MEAN								11.8	13.0			

Indian River StreamStats Report

Region ID: MA
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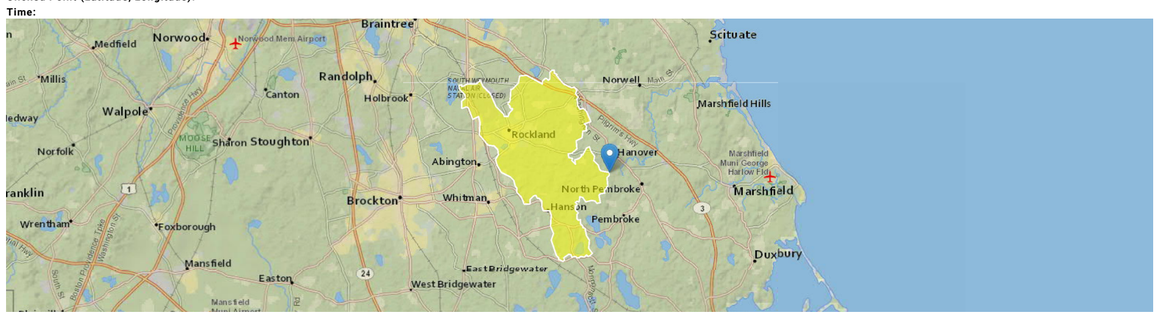
Clicked Point (Latitude, Longitude): 42.10056, -70.82283
Time: 2020-12-22 13:13:30 -0500



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	30.5	square miles
ELEV	Mean Basin Elevation	101	feet
LC06STOR	Percentage of water bodies and wetlands determined from the NLCD 2006	20.33	percent
BSLDEM250	Mean basin slope computed from 1:250K DEM	0.788	percent
DRFTPERSTR	Area of stratified drift per unit of stream length	0.31	square mile per mile
MAREGION	Region of Massachusetts 0 for Eastern 1 for Western	0	dimensionless
BSLDEM10M	Mean basin slope computed from 10 m DEM	2.803	percent
PCTSNDGRV	Percentage of land surface underlain by sand and gravel deposits	68.63	percent
FOREST	Percentage of area covered by forest	26.72	percent
LC11IMP	Average percentage of impervious area determined from NLCD 2011 impervious dataset	17.8	percent
LC11DEV	Percentage of developed (urban) land from NLCD 2011 classes 21-24	50.7	percent

Peak-Flow Statistics Parameters[Peak Statewide 2016 5156]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	30.5	square miles	0.16	512
ELEV	Mean Basin Elevation	101	feet	80.6	1948
LC06STOR	Percent Storage from NLCD2006	20.33	percent	0	32.3

Peak-Flow Statistics Flow Report[Peak Statewide 2016 5156]

PII: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PII	Plu	SEp
50_percent_AEP_flood	404	ft^3/s	207	787	42.3
20_percent_AEP_flood	648	ft^3/s	328	1280	43.4
10_percent_AEP_flood	835	ft^3/s	413	1690	44.7
4_percent_AEP_flood	1100	ft^3/s	527	2300	47.1
2_percent_AEP_flood	1320	ft^3/s	612	2850	49.4
1_percent_AEP_flood	1540	ft^3/s	693	3420	51.8
0_5_percent_AEP_flood	1780	ft^3/s	778	4070	54.1
0_2_percent_AEP_flood	2120	ft^3/s	885	5080	57.6

Peak-Flow Statistics Citations

Zarriello, P.J.,2017, Magnitude of flood flows at selected annual exceedance probabilities for streams in Massachusetts: U.S. Geological Survey Scientific Investigations Report 2016–5156, 99 p. (https://dx.doi.org/10.3133/sir20165156)

Low-Flow Statistics Parameters[Statewide Low Flow WRIR00 4135]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	30.5	square miles	1.61	149
BSLDEM250	Mean Basin Slope from 250K DEM	0.788	percent	0.32	24.6
DRFTPERSTR	Stratified Drift per Stream Length	0.31	square mile per mile	0	1.29
MAREGION	Massachusetts Region	0	dimensionless	0	1

Low-Flow Statistics Flow Report[Statewide Low Flow WRIR00 4135]

PII: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PII	Plu	SE	SEp
7 Day 2 Year Low Flow	3.59	ft^3/s	0.884	14	49.5	49.5
7 Day 10 Year Low Flow	1.35	ft^3/s	0.273	6.23	70.8	70.8

Low-Flow Statistics Citations

Ries, K.G., III,2000, Methods for estimating low-flow statistics for Massachusetts streams: U.S. Geological Survey Water Resources Investigations Report 00-4135, 81 p. (http://pubs.usgs.gov/wri/wri004135/)

Flow-Duration Statistics Parameters[Statewide Low Flow WRIR00 4135]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	30.5	square miles	1.61	149
DRFTPERSTR	Stratified Drift per Stream Length	0.31	square mile per mile	0	1.29
MAREGION	Massachusetts Region	0	dimensionless	0	1
BSLDEM250	Mean Basin Slope from 250K DEM	0.788	percent	0.32	24.6

Flow-Duration Statistics Flow Report[Statewide Low Flow WRIR00 4135]

PII: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PII	Plu	SE	SEp
50 Percent Duration	31.2	ft^3/s	18.6	52.2	17.6	17.6
60 Percent Duration	24.7	ft^3/s	9.79	61.9	19.8	19.8
70 Percent Duration	17.1	ft^3/s	6.96	41.6	23.5	23.5
75 Percent Duration	13.9	ft^3/s	5.77	33.1	25.8	25.8
80 Percent Duration	9.78	ft^3/s	3.09	30.5	28.4	28.4
85 Percent Duration	7.08	ft^3/s	2.25	21.9	31.9	31.9
90 Percent Duration	4.99	ft^3/s	1.53	16	36.6	36.6
95 Percent Duration	2.89	ft^3/s	0.759	10.6	45.6	45.6
98 Percent Duration	2	ft^3/s	0.466	8.13	60.3	60.3
99 Percent Duration	1.53	ft^3/s	0.324	6.8	65.1	65.1

Flow-Duration Statistics Citations

Ries, K.G., III,2000, Methods for estimating low-flow statistics for Massachusetts streams: U.S. Geological Survey Water Resources Investigations Report 00-4135, 81 p. (http://pubs.usgs.gov/wri/wri004135/)

August Flow-Duration Statistics Parameters[Statewide Low Flow WRIR00 4135]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	30.5	square miles	1.61	149
BSLDEM250	Mean Basin Slope from 250K DEM	0.788	percent	0.32	24.6
DRFTPERSTR	Stratified Drift per Stream Length	0.31	square mile per mile	0	1.29
MAREGION	Massachusetts Region	0	dimensionless	0	1

August Flow-Duration Statistics Flow Report[Statewide Low Flow WRIR00 4135]

PII: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PII	Plu	SE	SEp
August 50 Percent Duration	8.27	ft^3/s	2.58	26	33.2	33.2

August Flow-Duration Statistics Citations

Ries, K.G., III,2000, Methods for estimating low-flow statistics for Massachusetts streams: U.S. Geological Survey Water Resources Investigations Report 00-4135, 81 p. (http://pubs.usgs.gov/wri/wri004135/)

Bankfull Statistics Parameters[Bankfull Statewide SIR2013 5155]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	30.5	square miles	0.6	329
BSLDEM10M	Mean Basin Slope from 10m DEM	2.803	percent	2.2	23.9

Bankfull Statistics Flow Report[Bankfull Statewide SIR2013 5155]

PII: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SEp
Bankfull Width	49	ft	21.3
Bankfull Depth	2.24	ft	19.8
Bankfull Area	109	ft^2	29
Bankfull Streamflow	239	ft^3/s	55

Bankfull Statistics Citations

Bent, G.C., and Waite, A.M.,2013, Equations for estimating bankfull channel geometry and discharge for streams in Massachusetts: U.S. Geological Survey Scientific Investigations Report 2013–5155, 62 p., (http://pubs.usgs.gov/sir/2013/5155/)

Probability Statistics Parameters[Perennial Flow Probability]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	30.5	square miles	0.01	1.99
PCTSNDGRV	Percent Underlain By Sand And Gravel	68.63	percent	0	100
FOREST	Percent Forest	26.72	percent	0	100
MAREGION	Massachusetts Region	0	dimensionless	0	1

Probability Statistics Disclaimers[Perennial Flow Probability]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Probability Statistics Flow Report[Perennial Flow Probability]

Statistic	Value	Unit
Probability Stream Flowing Perennially	0.998	dim

Probability Statistics Citations

Bent, G.C., and Steeves, P.A.,2006, A revised logistic regression equation and an automated procedure for mapping the probability of a stream flowing perennially in Massachusetts: U.S. Geological Survey Scientific Investigations Report 2006–5031, 107 p. (http://pubs.usgs.gov/sir/2006/5031/pdfs/SIR_2006-5031rev.pdf)

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Application Version: 4.4.0

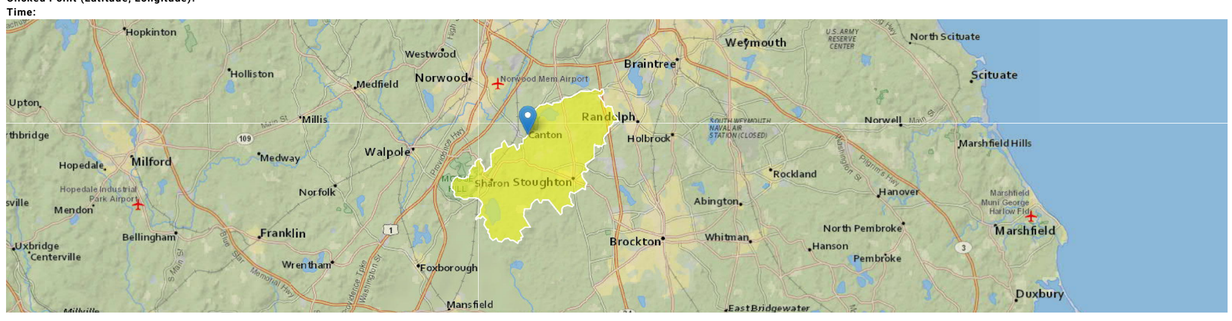
USGS 01105500 EAST BRANCH NEPONSET RIVER AT CANTON, MA

Day of month	50th percentile (median) of daily mean values for each day for water year of record in, ft3/s (Calculation Period 1989-10-01 -> 2021-09-30) Period-of-record for statistical calculation restricted by user											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	59	55	62	80	51	34	18	12	9.1	13	28	42
2	57	51	72	88	52	34	22	12	11	12	29	36
3	58	48	72	87	62	33	18	11	10	13	26	33
4	56	50	76	90	53	34	18	9.9	9.5	12	28	35
5	64	50	64	92	58	32	16	9.7	12	12	23	37
6	56	49	66	81	61	32	17	13	11	13	27	56
7	54	56	64	96	55	34	16	10	12	12	29	49
8	58	57	63	90	52	32	18	11	10	11	29	43
9	55	52	67	86	48	29	15	9.6	9.8	12	28	41
10	54	56	72	88	49	28	15	11	9.3	14	32	47
11	57	54	67	82	43	25	14	14	9.1	12	30	49
12	58	52	71	84	39	29	13	15	8.3	12	29	53
13	57	51	77	80	38	29	16	14	8.8	14	34	54
14	54	61	76	81	38	27	15	16	8.7	14	31	50
15	55	60	94	81	40	24	14	16	11	13	33	52
16	60	70	81	81	43	21	14	20	12	18	34	57
17	59	63	91	79	53	24	14	16	13	21	33	51
18	60	56	87	89	49	20	14	16	11	16	32	61
19	57	58	93	75	57	21	14	14	11	18	39	58
20	57	64	88	72	53	20	14	14	11	19	36	48
21	53	72	80	76	43	20	13	13	9.6	19	37	56
22	52	64	80	78	40	25	12	14	12	20	36	55
23	53	62	76	79	43	25	12	15	13	20	36	60
24	64	69	84	89	45	22	14	13	12	21	33	80
25	59	79	78	77	44	21	14	13	11	20	35	61
26	59	76	74	67	43	18	15	11	12	20	36	60
27	61	72	74	65	39	17	18	11	12	22	52	64
28	56	66	74	62	34	23	16	12	13	27	53	61
29	56	70	78	57	32	20	16	12	14	28	49	60
30	52		79	55	35	18	14	12	13	25	41	62
31	56		78		33		12	10		28		60
MEAN								12.9	11.0			

A study area is needed before viewing the report

East Branch Neponset StreamStats Report

Region ID: MA
Workspace ID: MA20201222184755443000
Clicked Point (Latitude, Longitude): 42.15454, -71.14574
Time: 2020-12-22 13:48:15 -0500



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	27	square miles
ELEV	Mean Basin Elevation	216	feet
LC06STOR	Percentage of water bodies and wetlands determined from the NLCD 2006	15.45	percent
BSLDEM250	Mean basin slope computed from 1:250K DEM	1.461	percent
DRFTPERSTR	Area of stratified drift per unit of stream length	0.27	square mile per mile
MAREGION	Region of Massachusetts 0 for Eastern 1 for Western	0	dimensionless
BSLDEM10M	Mean basin slope computed from 10 m DEM	4.536	percent
PCTSNDGRV	Percentage of land surface underlain by sand and gravel deposits	60.24	percent
FOREST	Percentage of area covered by forest	35.45	percent
LC11IMP	Average percentage of impervious area determined from NLCD 2011 impervious dataset	20.1	percent
LC11DEV	Percentage of developed (urban) land from NLCD 2011 classes 21-24	51	percent
WETLAND	Percentage of Wetlands	12.68	percent

General Disclaimers

Parameter values have been edited, computed flows may not apply.

Upstream regulation was checked for this watershed.

This watershed is percent regulated, computed flows may not apply.

This watershed has been edited, computed flows may not apply.

The resulting delineations are derived from digital elevation data and storm drain vectors that have been processed to enforce drainage through storm drains.

Urban regression equations for peak flows were not developed using streamgages which incorporate storm drain delineations and therefore should be used with caution.

Peak-Flow Statistics Parameters[Peak Statewide 2016 5156]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	27	square miles	0.16	512
ELEV	Mean Basin Elevation	216	feet	80.6	1948
LC06STOR	Percent Storage from NLCD2006	15.45	percent	0	32.3

Peak-Flow Statistics Disclaimers[Peak Statewide 2016 5156]

Peak-Flow Statistics Flow Report[Peak Statewide 2016 5156]

PII: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PII	PIu	SEp
50_percent_AEP_flood	437	ft^3/s	225	851	42.3
20_percent_AEP_flood	704	ft^3/s	357	1390	43.4
10_percent_AEP_flood	910	ft^3/s	451	1840	44.7
4_percent_AEP_flood	1200	ft^3/s	575	2500	47.1
2_percent_AEP_flood	1450	ft^3/s	674	3120	49.4
1_percent_AEP_flood	1700	ft^3/s	766	3770	51.8
0_5_percent_AEP_flood	1970	ft^3/s	863	4500	54.1
0_2_percent_AEP_flood	2360	ft^3/s	987	5640	57.6

Peak-Flow Statistics Citations

Zarriello, P.J.,2017, Magnitude of flood flows at selected annual exceedance probabilities for streams in Massachusetts: U.S. Geological Survey Scientific Investigations Report 2016–5156, 99 p. (https://dx.doi.org/10.3133/sir20165156)

Low-Flow Statistics Parameters[Statewide Low Flow WRIR00 4135]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	27	square miles	1.61	149
BSLDEM250	Mean Basin Slope from 250K DEM	1.461	percent	0.32	24.6
DRFTPERSTR	Stratified Drift per Stream Length	0.27	square mile per mile	0	1.29
MAREGION	Massachusetts Region	0	dimensionless	0	1

Low-Flow Statistics Disclaimers[Statewide Low Flow WRIR00 4135]

Low-Flow Statistics Flow Report[Statewide Low Flow WRIR00 4135]

PII: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PII	PIu	SE	SEp
7 Day 2 Year Low Flow	3.39	ft^3/s	1.07	10.3	49.5	49.5
7 Day 10 Year Low Flow	1.42	ft^3/s	0.361	5.2	70.8	70.8

Low-Flow Statistics Citations

Ries, K.G., III,2000, Methods for estimating low-flow statistics for Massachusetts streams: U.S. Geological Survey Water Resources Investigations Report 00-4135, 81 p. (http://pubs.usgs.gov/wri/wri004135/)

Flow-Duration Statistics Parameters[Statewide Low Flow WRIR00 4135]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	27	square miles	1.61	149
DRFTPERSTR	Stratified Drift per Stream Length	0.27	square mile per mile	0	1.29
MAREGION	Massachusetts Region	0	dimensionless	0	1
BSLDEM250	Mean Basin Slope from 250K DEM	1.461	percent	0.32	24.6

Flow-Duration Statistics Disclaimers[Statewide Low Flow WRIR00 4135]

Flow-Duration Statistics Flow Report[Statewide Low Flow WRIR00 4135]

PII: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PII	PIu	SE	SEp
50 Percent Duration	27.5	ft^3/s	16.5	45.6	17.6	17.6
60 Percent Duration	21.5	ft^3/s	9.34	49.2	19.8	19.8
70 Percent Duration	14.5	ft^3/s	6.28	33.2	23.5	23.5
75 Percent Duration	11.6	ft^3/s	5.09	26.1	25.8	25.8
80 Percent Duration	9	ft^3/s	3.68	21.7	28.4	28.4
85 Percent Duration	6.73	ft^3/s	2.68	16.6	31.9	31.9
90 Percent Duration	5.05	ft^3/s	1.92	13	36.6	36.6
95 Percent Duration	3.02	ft^3/s	1	8.81	45.6	45.6
98 Percent Duration	2.02	ft^3/s	0.585	6.6	60.3	60.3
99 Percent Duration	1.55	ft^3/s	0.417	5.42	65.1	65.1

Flow-Duration Statistics Citations

Ries, K.G., III,2000, Methods for estimating low-flow statistics for Massachusetts streams: U.S. Geological Survey Water Resources Investigations Report 00-4135, 81 p. (http://pubs.usgs.gov/wri/wri004135/)

August Flow-Duration Statistics Parameters[Statewide Low Flow WRIR00 4135]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	27	square miles	1.61	149
BSLDEM250	Mean Basin Slope from 250K DEM	1.461	percent	0.32	24.6
DRFTPERSTR	Stratified Drift per Stream Length	0.27	square mile per mile	0	1.29
MAREGION	Massachusetts Region	0	dimensionless	0	1

August Flow-Duration Statistics Disclaimers[Statewide Low Flow WRIR00 4135]

August Flow-Duration Statistics Flow Report[Statewide Low Flow WRIR00 4135]

PII: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PII	PIu	SE	SEp
August 50 Percent Duration	7.48	ft^3/s	2.95	18.6	33.2	33.2

August Flow-Duration Statistics Citations

Ries, K.G., III,2000, Methods for estimating low-flow statistics for Massachusetts streams: U.S. Geological Survey Water Resources Investigations Report 00-4135, 81 p. (http://pubs.usgs.gov/wri/wri004135/)

Bankfull Statistics Parameters[Bankfull Statewide SIR2013 5155]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	27	square miles	0.6	329
BSLDEM10M	Mean Basin Slope from 10m DEM	4.536	percent	2.2	23.9

Bankfull Statistics Disclaimers[Bankfull Statewide SIR2013 5155]

Bankfull Statistics Flow Report[Bankfull Statewide SIR2013 5155]

PII: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SEp
Bankfull Width	50.8	ft	21.3
Bankfull Depth	2.31	ft	19.8
Bankfull Area	117	ft^2	29
Bankfull Streamflow	316	ft^3/s	55

Bankfull Statistics Citations

Bent, G.C., and Waite, A.M.,2013, Equations for estimating bankfull channel geometry and discharge for streams in Massachusetts: U.S. Geological Survey Scientific Investigations Report 2013–5155, 62 p., (http://pubs.usgs.gov/sir/2013/5155/)

Probability Statistics Parameters[Perennial Flow Probability]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	27	square miles	0.01	1.99
PCTSNDGRV	Percent Underlain By Sand And Gravel	60.24	percent	0	100
FOREST	Percent Forest	35.45	percent	0	100
MAREGION	Massachusetts Region	0	dimensionless	0	1

Probability Statistics Disclaimers[Perennial Flow Probability]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

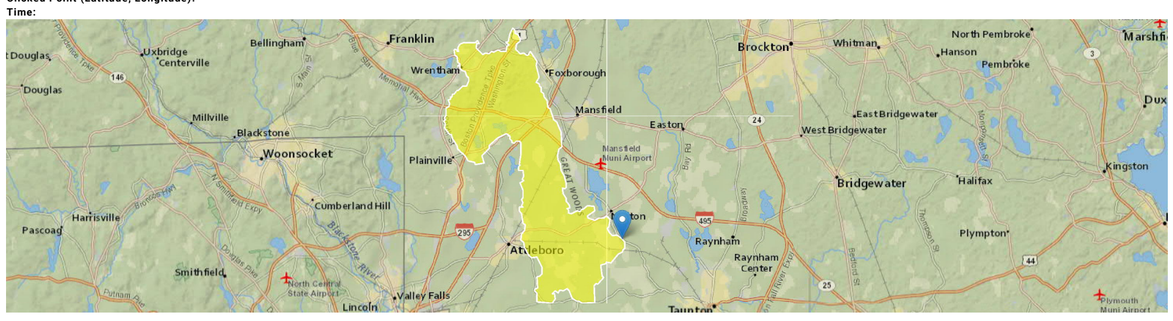
USGS 01109000 WADING RIVER NEAR NORTON, MA

Day of month	50th percentile (median) of daily mean values for each day for water year of record in, ft3/s (Calculation Period 1989-10-01 -> 2021-09-30) Period-of-record for statistical calculation restricted by user											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	91	87	92	133	95	45	18	6.4	8.4	11	30	63
2	87	83	97	139	105	54	16	6.1	7.6	11	29	57
3	87	79	105	133	94	52	15	6.1	7.2	11	34	61
4	92	80	112	151	96	46	16	7.4	7	9.9	31	57
5	98	78	102	148	91	48	16	7.3	7.4	11	31	63
6	94	77	98	139	92	50	18	7.7	6.8	12	39	66
7	97	83	96	143	94	48	19	7.3	6.5	12	40	64
8	90	84	101	143	81	47	20	7.5	6.4	11	35	75
9	82	82	104	131	81	39	18	6.5	6.5	13	32	66
10	75	77	102	129	78	39	15	7.5	6.5	14	31	73
11	80	77	112	132	72	37	13	7.1	6.4	12	36	79
12	86	77	117	128	69	36	13	8.2	8.1	12	40	83
13	100	82	118	127	73	42	14	7.6	8	12	44	86
14	94	91	126	143	66	43	12	8.2	8.2	12	45	77
15	93	104	135	126	62	42	13	8.7	8.3	17	44	76
16	91	104	132	127	64	38	14	8.6	8.8	20	42	81
17	93	103	136	124	70	34	12	12	9.4	23	43	85
18	94	101	150	122	72	30	11	9.9	10	26	45	85
19	95	105	148	122	75	30	12	12	9.8	26	46	85
20	94	104	151	112	71	25	12	10	9	26	41	79
21	88	108	139	117	67	23	12	12	8.7	24	45	78
22	85	103	126	136	61	21	10	12	9.8	24	46	76
23	81	101	136	132	57	21	8.7	12	12	26	50	80
24	89	110	131	133	57	20	10	11	12	23	48	101
25	85	113	131	129	59	24	10	11	12	21	51	100
26	83	107	126	126	55	23	9.3	9.8	10	22	55	94
27	86	104	125	117	55	21	10	8.6	11	22	61	87
28	86	98	129	109	50	19	9.4	10	11	24	69	91
29	83	122	120	107	47	21	8.4	9.9	13	22	67	86
30	79		124	101	53	17	11	11	12	27	64	97
31	89		115		45		8.9	10		29		90
MEAN								9.0	8.9			

A study area is needed before viewing the report

Wading River StreamStats Report

Region ID: MA
Workspace ID: MA20201222212446894000
Clicked Point (Latitude, Longitude): 41.94743, -71.17669
Time: 2020-12-22 16:25:07 -0500



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	43.1	square miles
ELEV	Mean Basin Elevation	181	feet
LC06STOR	Percentage of water bodies and wetlands determined from the NLCD 2006	17.96	percent
BSLDEM250	Mean basin slope computed from 1:250K DEM	1.197	percent
DRFTPERSTR	Area of stratified drift per unit of stream length	0.28	square mile per mile
MAREGION	Region of Massachusetts 0 for Eastern 1 for Western	0	dimensionless
BSLDEM10M	Mean basin slope computed from 10 m DEM	3.844	percent
PCTSNDGRV	Percentage of land surface underlain by sand and gravel deposits	58.17	percent
FOREST	Percentage of area covered by forest	58.13	percent
LC11DEV	Percentage of developed (urban) land from NLCD 2011 classes 21-24	32.4	percent
LC11IMP	Average percentage of impervious area determined from NLCD 2011 impervious dataset	11.3	percent
WETLAND	Percentage of Wetlands	15.62	percent

General Disclaimers

Parameter values have been edited, computed flows may not apply.

Upstream regulation was checked for this watershed.

This watershed is percent regulated, computed flows may not apply.

This watershed has been edited, computed flows may not apply.

The resulting delineations are derived from digital elevation data and storm drain vectors that have been processed to enforce drainage through storm drains.

Urban regression equations for peak flows were not developed using streamgages which incorporate storm drain delineations and therefore should be used with caution.

Peak-Flow Statistics Parameters[Peak Statewide 2016 5156]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	43.1	square miles	0.16	512
ELEV	Mean Basin Elevation	181	feet	80.6	1948
LC06STOR	Percent Storage from NLCD2006	17.96	percent	0	32.3

Peak-Flow Statistics Disclaimers[Peak Statewide 2016 5156]

Peak-Flow Statistics Flow Report[Peak Statewide 2016 5156]

PII: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PII	Plu	SEp
50_percent_AEP_flood	587	ft^3/s	302	1140	42.3
20_percent_AEP_flood	939	ft^3/s	476	1850	43.4
10_percent_AEP_flood	1210	ft^3/s	600	2440	44.7
4_percent_AEP_flood	1590	ft^3/s	762	3320	47.1
2_percent_AEP_flood	1910	ft^3/s	887	4110	49.4
1_percent_AEP_flood	2230	ft^3/s	1010	4950	51.8
0_5_percent_AEP_flood	2590	ft^3/s	1130	5910	54.1
0_2_percent_AEP_flood	3080	ft^3/s	1290	7360	57.6

Peak-Flow Statistics Citations

Zarriello, P.J.,2017, Magnitude of flood flows at selected annual exceedance probabilities for streams in Massachusetts: U.S. Geological Survey Scientific Investigations Report 2016–5156, 99 p. (https://dx.doi.org/10.3133/sir20165156)

Low-Flow Statistics Parameters[Statewide Low Flow WRIR00 4135]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	43.1	square miles	1.61	149
BSLDEM250	Mean Basin Slope from 250K DEM	1.197	percent	0.32	24.6
DRFTPERSTR	Stratified Drift per Stream Length	0.28	square mile per mile	0	1.29
MAREGION	Massachusetts Region	0	dimensionless	0	1

Low-Flow Statistics Disclaimers[Statewide Low Flow WRIR00 4135]

Low-Flow Statistics Flow Report[Statewide Low Flow WRIR00 4135]

PII: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PII	Plu	SE	SEp
7 Day 2 Year Low Flow	5.57	ft^3/s	1.5	19.9	49.5	49.5
7 Day 10 Year Low Flow	2.29	ft^3/s	0.508	9.61	70.8	70.8

Low-Flow Statistics Citations

Ries, K.G., III,2000, Methods for estimating low-flow statistics for Massachusetts streams: U.S. Geological Survey Water Resources Investigations Report 00-4135, 81 p. (http://pubs.usgs.gov/wri/wri004135/)

Flow-Duration Statistics Parameters[Statewide Low Flow WRIR00 4135]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	43.1	square miles	1.61	149
DRFTPERSTR	Stratified Drift per Stream Length	0.28	square mile per mile	0	1.29
MAREGION	Massachusetts Region	0	dimensionless	0	1
BSLDEM250	Mean Basin Slope from 250K DEM	1.197	percent	0.32	24.6

Flow-Duration Statistics Disclaimers[Statewide Low Flow WRIR00 4135]

Flow-Duration Statistics Flow Report[Statewide Low Flow WRIR00 4135]

PII: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PII	Plu	SE	SEp
50 Percent Duration	44.4	ft^3/s	25.3	77.4	17.6	17.6
60 Percent Duration	35.2	ft^3/s	14.1	87.2	19.8	19.8
70 Percent Duration	24.1	ft^3/s	9.51	60.5	23.5	23.5
75 Percent Duration	19.5	ft^3/s	7.8	48.2	25.8	25.8
80 Percent Duration	14.5	ft^3/s	5.04	41.2	28.4	28.4
85 Percent Duration	10.8	ft^3/s	3.77	30.4	31.9	31.9
90 Percent Duration	7.93	ft^3/s	2.65	23.2	36.6	36.6
95 Percent Duration	4.78	ft^3/s	1.38	16	45.6	45.6
98 Percent Duration	3.24	ft^3/s	0.824	12.1	60.3	60.3
99 Percent Duration	2.52	ft^3/s	0.59	10.1	65.1	65.1

Flow-Duration Statistics Citations

Ries, K.G., III,2000, Methods for estimating low-flow statistics for Massachusetts streams: U.S. Geological Survey Water Resources Investigations Report 00-4135, 81 p. (http://pubs.usgs.gov/wri/wri004135/)

August Flow-Duration Statistics Parameters[Statewide Low Flow WRIR00 4135]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	43.1	square miles	1.61	149
BSLDEM250	Mean Basin Slope from 250K DEM	1.197	percent	0.32	24.6
DRFTPERSTR	Stratified Drift per Stream Length	0.28	square mile per mile	0	1.29
MAREGION	Massachusetts Region	0	dimensionless	0	1

August Flow-Duration Statistics Disclaimers[Statewide Low Flow WRIR00 4135]

August Flow-Duration Statistics Flow Report[Statewide Low Flow WRIR00 4135]

PII: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PII	Plu	SE	SEp
August 50 Percent Duration	12.2	ft^3/s	4.22	34.7	33.2	33.2

August Flow-Duration Statistics Citations

Ries, K.G., III,2000, Methods for estimating low-flow statistics for Massachusetts streams: U.S. Geological Survey Water Resources Investigations Report 00-4135, 81 p. (http://pubs.usgs.gov/wri/wri004135/)

Bankfull Statistics Parameters[Bankfull Statewide SIR2013 5155]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	43.1	square miles	0.6	329
BSLDEM10M	Mean Basin Slope from 10m DEM	3.844	percent	2.2	23.9

Bankfull Statistics Disclaimers[Bankfull Statewide SIR2013 5155]

Bankfull Statistics Flow Report[Bankfull Statewide SIR2013 5155]

PII: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SEp
Bankfull Width	59.4	ft	21.3
Bankfull Depth	2.59	ft	19.8
Bankfull Area	153	ft^2	29
Bankfull Streamflow	396	ft^3/s	55

Bankfull Statistics Citations

Bent, G.C., and Waite, A.M.,2013, Equations for estimating bankfull channel geometry and discharge for streams in Massachusetts: U.S. Geological Survey Scientific Investigations Report 2013–5155, 62 p., (http://pubs.usgs.gov/sir/2013/5155/)

Probability Statistics Parameters[Perennial Flow Probability]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	43.1	square miles	0.01	1.99
PCTSNDGRV	Percent Underlain By Sand And Gravel	58.17	percent	0	100
FOREST	Percent Forest	58.13	percent	0	100
MAREGION	Massachusetts Region	0	dimensionless	0	1

Probability Statistics Disclaimers[Perennial Flow Probability]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Attachment 3

USFWS Fish Passage Flow Determination Spreadsheets

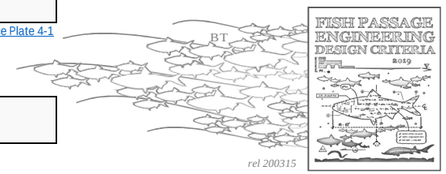
Fish Passage Design Flows

The high & low design flows are used to establish the range of river flows over which a fishway should be functional (if not operational). For proposed facilities, this analysis identifies the flows corresponding to exceedance design criteria (typically, 5% and 95%). For existing facilities, this analysis can be used to verify conformity with design criteria*.

* see USFWS Fish Passage Engineering Design Criteria; Chapter 4 and Reference Plate 4-1

Name : sarruda

Date : 12/22/2020



rel 200315

Site Information

Project Name : Little River Dam Removal

Gage Name : USGS 01105500 EAST BRANCH NEPONSET RIVER AT CANTON, MA [USGS Mapper]

Project Drain. Area (mi^2)** : 27.90

Gage Drain. Area (mi^2) **: 27.20

Empty flow cells in Gage Data were found and treated as zero cfs.

** if Project DA and Gage DA are equal, then the flows are not prorated and the Exceedance Tables (below) will match.

Summary

Available Gage Data	
Start	3/1/1990
End	6/30/2020
No. Days	11,079
No. Years	30.4

Annual Period Analyzed[1]	
Start	3/1/1990
End	6/30/2020
No. Days	11,079
% Gage Data	100.0%

Fish Passage Season[2]	
Start	Mar 1
End	Jun 30
Days/Yr	121
Weeks/Yr	17.3

Design Flows	
Hi. Exc.	5.0%
Low Exc.	95.0%
High Q (cfs)	204
Low Q (cfs)	15

Non-Pass Events	
1 D High	14
> 1 D High	43
1 D Low	6
> 1 D Low	26

Exceedance Table : Project Flows (cfs) prorated by ratio of Project DA to Gage DA. Year and months based on Annual Period Analyzed[1]; Season based on abbreviated Fish Passage Season[2].

	Year[1] →	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Season[2]
FLOOD	0.001	516	371	372	996	450	380	652	276	170	371	712	292	462	759
	0.01	276	257	237	444	334	237	345	154	110	170	257	213	296	355
	0.05	166	155	151	244	226	131	152	78	59	76	131	144	186	204
	0.1	121	123	120	184	186	101	99	50	37	44	83	99	148	156
	0.2	84	95	95	134	150	77	57	30	26	25	49	75	107	109
	0.3	65	79	82	106	117	63	41	23	19	17	33	55	83	83
	0.4	50	68	71	88	98	53	33	18	16	14	24	42	68	69
	0.5	39	58	62	78	81	45	28	15	13	11	16	35	56	57
	0.6	30	51	53	69	69	41	23	12	10	9	13	28	42	47
	0.7	21	45	46	59	59	35	18	10	8	7	11	22	34	38
	0.8	14	39	39	50	47	29	16	8	6	6	9	15	27	29
	0.9	9	32	32	42	34	23	12	6	5	4	7	11	18	19
	0.95	6	28	29	34	26	19	10	5	4	3	6	9	14	15
	0.99	4	21	22	27	17	15	6	4	3	2	4	8	10	9
DROUGHT	0.999	2	13	18	24	15	12	4	3	3	2	3	7	8	5
	MIN	0	12	18	24	15	8	4	2	3	2	3	7	0	4
	MAX	1,003	517	448	1,003	487	384	908	377	178	372	791	307	485	1,003
	MEAN	56	71	72	102	100	57	48	25	19	22	37	49	71	77
	MEAN[95-05]	49	66	67	91	94	52	37	20	16	16	28	43	65	68

--> MEAN[95-05] is the trimmed mean that excludes the upper 5% and lower 5% of all data.

Exceedance Table : Gage Flows (cfs) as recorded by USGS. Year and months based on Annual Period Analyzed[1]; Season based on abbreviated Fish Passage Season[2].

	Year[1] →	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Season[2]
FLOOD	0.001	503	362	362	971	439	370	636	270	166	362	694	285	451	740
	0.01	269	251	231	433	326	231	337	150	107	166	250	208	288	346
	0.05	162	152	147	238	220	128	149	76	58	74	128	140	182	199
	0.1	118	120	117	179	181	98	97	49	36	43	81	97	144	152
	0.2	82	93	93	130	146	75	55	29	25	24	48	73	104	106
	0.3	63	77	80	103	114	61	40	22	19	17	32	54	81	81
	0.4	49	66	69	86	96	52	32	18	16	13	23	41	66	67
	0.5	38	57	60	76	79	44	27	15	13	11	16	34	55	56
	0.6	29	50	52	67	67	40	22	12	10	9	13	27	41	46
	0.7	20	44	45	58	58	34	18	10	8	7	11	21	33	37
	0.8	14	38	38	49	46	28	16	8	6	6	9	15	26	28
	0.9	9	31	31	41	33	22	12	6	5	4	7	11	18	19
	0.95	6	27	28	33	25	19	10	5	4	3	6	9	14	15
	0.99	4	20	21	26	17	15	6	4	3	2	4	8	10	9
DROUGHT	0.999	2	13	18	23	15	12	4	3	3	2	3	7	7	5
	MIN	0	12	18	23	15	8	4	2	3	2	3	7	0	4
	MAX	978	504	437	978	475	374	885	368	174	363	771	299	473	978
	MEAN	55	69	70	99	98	56	46	24	19	21	36	48	70	75
	MEAN[95-05]	48	64	65	88	91	51	36	20	16	15	27	42	63	66

--> MEAN[95-05] is the trimmed mean that excludes the upper 5% and lower 5% of all data.

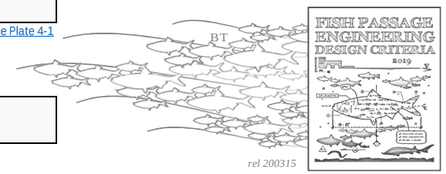
Fish Passage Design Flows

Name : sarruda

Date : 12/22/2020

The high & low design flows are used to establish the range of river flows over which a fishway should be functional (if not operational). For proposed facilities, this analysis identifies the flows corresponding to exceedance design criteria (typically, 5% and 95%). For existing facilities, this analysis can be used to verify conformity with design criteria*.

* see USFWS Fish Passage Engineering Design Criteria; Chapter 4 and Reference Plate 4-1



rel 200315

Site Information

Project Name : Little River Dam Removal

Gage Name : USGS 01105730 INDIAN HEAD RIVER AT HANOVER, MA [USGS Mapper]

Project Drain. Area (mi^2)** : 27.90

Gage Drain. Area (mi^2) **: 30.50

Empty flow cells in Gage Data were found and treated as zero cfs.

** if Project DA and Gage DA are equal, then the flows are not prorated and the Exceedance Tables (below) will match.

Summary

Available Gage Data	
Start	3/1/1990
End	6/30/2020
No. Days	11,079
No. Years	30.4

Annual Period Analyzed[1]	
Start	3/1/1990
End	6/30/2020
No. Days	11,079
% Gage Data	100.0%

Fish Passage Season[2]	
Start	Mar 1
End	Jun 30
Days/Yr	121
Weeks/Yr	17.3

Design Flows	
Hi. Exc.	5.0%
Low Exc.	95.0%
High Q (cfs)	218
Low Q (cfs)	15

Non-Pass Events	
1 D High	19
> 1 D High	47
1 D Low	7
> 1 D Low	22

Exceedance Table : Project Flows (cfs) prorated by ratio of Project DA to Gage DA. Year and months based on Annual Period Analyzed[1]; Season based on abbreviated Fish Passage Season[2].

	Year[1] →	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Season[2]
FLOOD	0.001	741	534	585	1,153	572	662	620	403	461	396	1,054	427	722	846
	0.01	363	327	365	645	437	284	365	178	180	184	326	295	392	450
	0.05	183	187	190	273	252	141	146	73	69	67	149	160	206	218
	0.1	131	138	141	198	192	104	86	50	43	40	100	116	155	161
	0.2	88	102	105	150	138	77	49	28	27	26	49	81	114	113
	0.3	65	83	86	121	112	62	38	21	18	19	34	63	88	85
	0.4	51	68	72	102	92	54	31	16	14	16	25	50	70	69
	0.5	40	58	63	84	78	48	27	14	10	12	20	40	57	56
MEDIAN	0.6	31	50	55	71	67	42	23	11	8	9	15	33	47	47
	0.7	22	44	47	60	57	37	18	8	6	7	11	27	38	38
	0.8	14	38	39	51	47	31	15	6	5	5	8	22	28	29
	0.9	8	31	34	41	35	24	10	5	4	4	6	13	22	20
	0.95	5	27	31	36	28	21	7	4	3	3	5	10	19	15
	0.99	3	16	24	27	19	15	5	2	2	2	4	7	13	7
DROUGHT	0.999	1	12	21	23	15	13	5	2	1	1	4	5	9	5
	MIN	0	0	20	23	14	7	5	2	1	1	4	5	9	5
	MAX	1,153	600	742	1,153	600	722	818	587	503	580	1,079	455	867	1,153
	MEAN	61	77	81	114	101	61	46	23	22	21	43	58	80	81
	MEAN[95-05]	51	70	72	99	92	54	34	18	15	15	30	50	70	69

--> MEAN[95-05] is the trimmed mean that excludes the upper 5% and lower 5% of all data.

Exceedance Table : Gage Flows (cfs) as recorded by USGS. Year and months based on Annual Period Analyzed[1]; Season based on abbreviated Fish Passage Season[2].

	Year[1] →	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Season[2]
FLOOD	0.001	810	584	639	1,260	625	724	678	440	504	433	1,152	467	789	925
	0.01	397	357	399	705	478	310	399	195	197	201	356	323	428	492
	0.05	200	204	208	298	275	154	160	80	76	73	163	175	225	238
	0.1	143	151	154	216	210	114	94	55	47	44	109	127	169	176
	0.2	96	111	115	164	151	84	54	31	29	28	54	88	125	123
	0.3	71	91	94	133	122	68	42	23	20	21	37	69	96	93
MEDIAN	0.4	56	74	79	112	101	59	34	18	15	17	27	54	77	75
	0.5	44	63	69	92	85	52	29	15	11	13	22	44	62	61
	0.6	34	55	60	78	73	46	25	12	9	10	17	36	51	51
	0.7	24	48	51	66	62	40	20	9	7	8	12	30	41	41
	0.8	15	42	43	56	51	34	16	7	6	6	9	24	31	32
	0.9	9	34	37	45	38	26	11	5	4	4	7	14	24	22
	0.95	6	30	34	39	31	23	8	4	3	3	6	11	20	16
DROUGHT	0.99	3	18	26	30	21	17	6	2	2	2	4	8	14	8
	0.999	1	13	23	25	16	15	5	2	1	1	4	6	10	5
	MIN	0	0	22	25	15	8	5	2	1	1	4	6	10	5
	MAX	1,260	656	811	1,260	656	789	894	642	550	634	1,180	497	948	1,260
	MEAN	66	85	89	125	111	67	50	26	24	23	46	63	87	88
	MEAN[95-05]	56	76	79	108	100	59	37	20	17	17	33	55	77	76

--> MEAN[95-05] is the trimmed mean that excludes the upper 5% and lower 5% of all data.

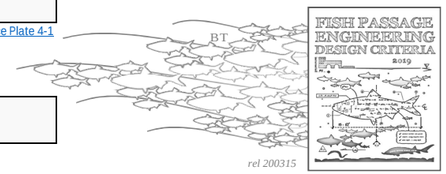
Fish Passage Design Flows

The high & low design flows are used to establish the range of river flows over which a fishway should be functional (if not operational). For proposed facilities, this analysis identifies the flows corresponding to exceedance design criteria (typically, 5% and 95%). For existing facilities, this analysis can be used to verify conformity with design criteria*.

Name : sarruda

Date : 12/22/2020

* see USFWS Fish Passage Engineering Design Criteria; Chapter 4 and Reference Plate 4-1



rel 200315

Site Information

Project Name : Little River Dam Removal

Gage Name : USGS 01109000 WADING RIVER NEAR NORTON, MA [USGS Mapper]

Project Drain. Area (mi^2)** : 27.90

Gage Drain. Area (mi^2) **: 43.10

enter notes

** if Project DA and Gage DA are equal, then the flows are not prorated and the Exceedance Tables (below) will match.

Summary

Available Gage Data	
Start	3/1/1990
End	6/30/2020
No. Days	11,079
No. Years	30.4

Annual Period Analyzed[1]	
Start	3/1/1990
End	6/30/2020
No. Days	11,079
% Gage Data	100.0%

Fish Passage Season[2]	
Start	Mar 1
End	Jun 30
Days/Yr	121
Weeks/Yr	17.3

Design Flows	
Hi. Exc.	5.0%
Low Exc.	95.0%
High Q (cfs)	183
Low Q (cfs)	10

Non-Pass Events	
1 D High	10
> 1 D High	39
1 D Low	3
> 1 D Low	19

Exceedance Table : Project Flows (cfs) prorated by ratio of Project DA to Gage DA. Year and months based on Annual Period Analyzed[1]; Season based on abbreviated Fish Passage Season[2].

	Year[1] →	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Season[2]
FLOOD	0.001	468	373	305	724	457	259	694	382	174	161	425	272	412	682
	0.01	247	228	235	369	290	179	358	129	79	109	191	230	252	310
	0.05	150	155	148	207	204	112	134	61	44	47	107	128	163	183
	0.1	113	126	116	174	166	94	75	38	28	29	69	98	133	142
	0.2	80	95	95	134	131	74	47	23	17	15	34	66	102	102
	0.3	61	79	79	104	108	61	37	16	12	10	21	48	79	82
	0.4	47	67	69	88	94	53	28	12	8	8	15	37	65	67
	0.5	36	57	60	78	82	47	22	8	6	6	11	28	52	56
	0.6	24	49	52	67	70	40	17	6	5	5	8	22	43	45
	0.7	15	42	44	59	60	35	14	5	3	3	6	16	32	36
MEDIAN	0.8	8	36	38	50	48	28	10	3	2	3	4	10	21	27
	0.9	4	27	30	39	36	21	6	3	1	1	2	6	14	16
	0.95	3	22	25	33	28	16	5	2	1	1	1	5	10	10
	0.99	1	16	20	23	11	13	3	1	1	0	1	3	6	5
DROUGHT	0.999	0	7	17	18	8	9	1	1	1	0	1	3	4	2
	MIN	0	7	16	17	8	8	1	1	1	0	1	2	4	1
	MAX	880	388	343	880	590	285	719	500	195	180	619	293	469	880
	MEAN	50	69	70	96	94	54	41	17	12	12	26	43	66	71
	MEAN[95-05]	44	64	65	88	89	50	29	13	9	9	19	37	60	64

--> MEAN[95-05] is the trimmed mean that excludes the upper 5% and lower 5% of all data.

Exceedance Table : Gage Flows (cfs) as recorded by USGS. Year and months based on Annual Period Analyzed[1]; Season based on abbreviated Fish Passage Season[2].

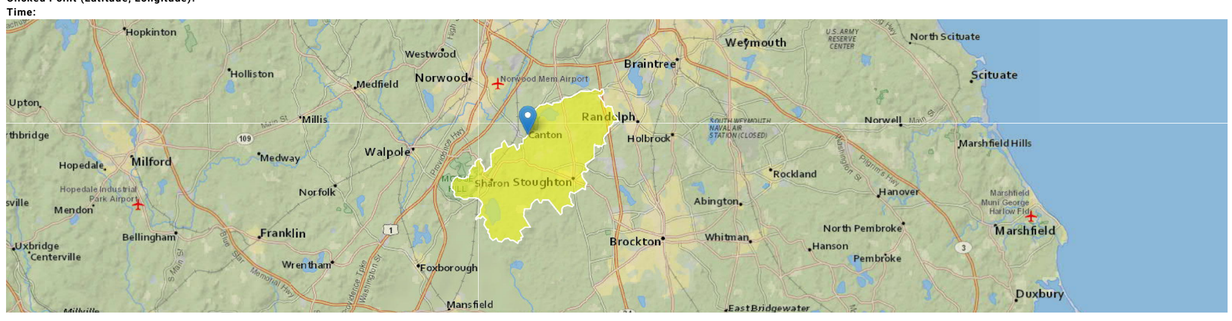
	Year[1] →	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Season[2]
FLOOD	0.001	724	577	471	1,118	707	401	1,073	590	268	248	657	421	636	1,054
	0.01	381	353	362	570	447	276	552	200	123	168	294	356	390	479
	0.05	232	240	229	320	316	173	207	95	68	73	165	198	252	283
	0.1	175	195	179	269	256	145	115	59	44	45	106	151	206	220
	0.2	124	147	146	206	202	114	73	36	26	23	52	102	157	157
	0.3	95	122	122	161	167	95	57	24	18	16	33	74	122	126
	0.4	73	103	107	136	145	82	43	18	13	12	23	57	100	104
MEDIAN	0.5	55	88	93	121	127	72	34	12	9	9	17	43	81	86
	0.6	37	76	80	104	108	62	27	9	7	7	12	34	66	70
	0.7	23	65	68	91	92	54	21	7	5	5	9	25	50	56
	0.8	12	55	58	77	74	44	16	5	3	4	6	15	33	41
	0.9	6	42	46	60	55	32	10	4	2	1	3	9	21	24
DROUGHT	0.95	4	34	39	51	43	25	7	3	1	1	2	7	16	16
	0.99	1	24	31	35	17	20	4	2	1	0	1	5	9	7
	0.999	0	11	27	28	13	14	2	1	1	0	1	4	7	3
	MIN	0	11	25	27	13	13	2	1	1	0	1	3	6	2
	MAX	1,360	599	530	1,360	911	440	1,110	772	301	278	957	452	724	1,360
	MEAN	77	107	108	149	145	83	63	27	18	19	41	66	102	110
	MEAN[95-05]	67	99	101	136	137	78	45	20	14	14	30	57	93	99

--> MEAN[95-05] is the trimmed mean that excludes the upper 5% and lower 5% of all data.

A study area is needed before viewing the report

East Branch Neponset StreamStats Report

Region ID: MA
Workspace ID: MA20201222184755443000
Clicked Point (Latitude, Longitude): 42.15454, -71.14574
Time: 2020-12-22 13:48:15 -0500



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	27	square miles
ELEV	Mean Basin Elevation	216	feet
LC06STOR	Percentage of water bodies and wetlands determined from the NLCD 2006	15.45	percent
BSLDEM250	Mean basin slope computed from 1:250K DEM	1.461	percent
DRFTPERSTR	Area of stratified drift per unit of stream length	0.27	square mile per mile
MAREGION	Region of Massachusetts 0 for Eastern 1 for Western	0	dimensionless
BSLDEM10M	Mean basin slope computed from 10 m DEM	4.536	percent
PCTSNDGRV	Percentage of land surface underlain by sand and gravel deposits	60.24	percent
FOREST	Percentage of area covered by forest	35.45	percent
LC11IMP	Average percentage of impervious area determined from NLCD 2011 impervious dataset	20.1	percent
LC11DEV	Percentage of developed (urban) land from NLCD 2011 classes 21-24	51	percent
WETLAND	Percentage of Wetlands	12.68	percent

General Disclaimers

Parameter values have been edited, computed flows may not apply.

Upstream regulation was checked for this watershed.

This watershed is percent regulated, computed flows may not apply.

This watershed has been edited, computed flows may not apply.

The resulting delineations are derived from digital elevation data and storm drain vectors that have been processed to enforce drainage through storm drains.

Urban regression equations for peak flows were not developed using streamgages which incorporate storm drain delineations and therefore should be used with caution.

Peak-Flow Statistics Parameters[Peak Statewide 2016 5156]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	27	square miles	0.16	512
ELEV	Mean Basin Elevation	216	feet	80.6	1948
LC06STOR	Percent Storage from NLCD2006	15.45	percent	0	32.3

Peak-Flow Statistics Disclaimers[Peak Statewide 2016 5156]

Peak-Flow Statistics Flow Report[Peak Statewide 2016 5156]

PII: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PII	PIu	SEp
50_percent_AEP_flood	437	ft^3/s	225	851	42.3
20_percent_AEP_flood	704	ft^3/s	357	1390	43.4
10_percent_AEP_flood	910	ft^3/s	451	1840	44.7
4_percent_AEP_flood	1200	ft^3/s	575	2500	47.1
2_percent_AEP_flood	1450	ft^3/s	674	3120	49.4
1_percent_AEP_flood	1700	ft^3/s	766	3770	51.8
0_5_percent_AEP_flood	1970	ft^3/s	863	4500	54.1
0_2_percent_AEP_flood	2360	ft^3/s	987	5640	57.6

Peak-Flow Statistics Citations

Zarriello, P.J.,2017, Magnitude of flood flows at selected annual exceedance probabilities for streams in Massachusetts: U.S. Geological Survey Scientific Investigations Report 2016–5156, 99 p. (https://dx.doi.org/10.3133/sir20165156)

Low-Flow Statistics Parameters[Statewide Low Flow WRIR00 4135]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	27	square miles	1.61	149
BSLDEM250	Mean Basin Slope from 250K DEM	1.461	percent	0.32	24.6
DRFTPERSTR	Stratified Drift per Stream Length	0.27	square mile per mile	0	1.29
MAREGION	Massachusetts Region	0	dimensionless	0	1

Low-Flow Statistics Disclaimers[Statewide Low Flow WRIR00 4135]

Low-Flow Statistics Flow Report[Statewide Low Flow WRIR00 4135]

PII: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PII	PIu	SE	SEp
7 Day 2 Year Low Flow	3.39	ft^3/s	1.07	10.3	49.5	49.5
7 Day 10 Year Low Flow	1.42	ft^3/s	0.361	5.2	70.8	70.8

Low-Flow Statistics Citations

Ries, K.G., III,2000, Methods for estimating low-flow statistics for Massachusetts streams: U.S. Geological Survey Water Resources Investigations Report 00-4135, 81 p. (http://pubs.usgs.gov/wri/wri004135/)

Flow-Duration Statistics Parameters[Statewide Low Flow WRIR00 4135]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	27	square miles	1.61	149
DRFTPERSTR	Stratified Drift per Stream Length	0.27	square mile per mile	0	1.29
MAREGION	Massachusetts Region	0	dimensionless	0	1
BSLDEM250	Mean Basin Slope from 250K DEM	1.461	percent	0.32	24.6

Flow-Duration Statistics Disclaimers[Statewide Low Flow WRIR00 4135]

Flow-Duration Statistics Flow Report[Statewide Low Flow WRIR00 4135]

PII: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PII	PIu	SE	SEp
50 Percent Duration	27.5	ft^3/s	16.5	45.6	17.6	17.6
60 Percent Duration	21.5	ft^3/s	9.34	49.2	19.8	19.8
70 Percent Duration	14.5	ft^3/s	6.28	33.2	23.5	23.5
75 Percent Duration	11.6	ft^3/s	5.09	26.1	25.8	25.8
80 Percent Duration	9	ft^3/s	3.68	21.7	28.4	28.4
85 Percent Duration	6.73	ft^3/s	2.68	16.6	31.9	31.9
90 Percent Duration	5.05	ft^3/s	1.92	13	36.6	36.6
95 Percent Duration	3.02	ft^3/s	1	8.81	45.6	45.6
98 Percent Duration	2.02	ft^3/s	0.585	6.6	60.3	60.3
99 Percent Duration	1.55	ft^3/s	0.417	5.42	65.1	65.1

Flow-Duration Statistics Citations

Ries, K.G., III,2000, Methods for estimating low-flow statistics for Massachusetts streams: U.S. Geological Survey Water Resources Investigations Report 00-4135, 81 p. (http://pubs.usgs.gov/wri/wri004135/)

August Flow-Duration Statistics Parameters[Statewide Low Flow WRIR00 4135]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	27	square miles	1.61	149
BSLDEM250	Mean Basin Slope from 250K DEM	1.461	percent	0.32	24.6
DRFTPERSTR	Stratified Drift per Stream Length	0.27	square mile per mile	0	1.29
MAREGION	Massachusetts Region	0	dimensionless	0	1

August Flow-Duration Statistics Disclaimers[Statewide Low Flow WRIR00 4135]

August Flow-Duration Statistics Flow Report[Statewide Low Flow WRIR00 4135]

PII: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PII	PIu	SE	SEp
August 50 Percent Duration	7.48	ft^3/s	2.95	18.6	33.2	33.2

August Flow-Duration Statistics Citations

Ries, K.G., III,2000, Methods for estimating low-flow statistics for Massachusetts streams: U.S. Geological Survey Water Resources Investigations Report 00-4135, 81 p. (http://pubs.usgs.gov/wri/wri004135/)

Bankfull Statistics Parameters[Bankfull Statewide SIR2013 5155]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	27	square miles	0.6	329
BSLDEM10M	Mean Basin Slope from 10m DEM	4.536	percent	2.2	23.9

Bankfull Statistics Disclaimers[Bankfull Statewide SIR2013 5155]

Bankfull Statistics Flow Report[Bankfull Statewide SIR2013 5155]

PII: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SEp
Bankfull Width	50.8	ft	21.3
Bankfull Depth	2.31	ft	19.8
Bankfull Area	117	ft^2	29
Bankfull Streamflow	316	ft^3/s	55

Bankfull Statistics Citations

Bent, G.C., and Waite, A.M.,2013, Equations for estimating bankfull channel geometry and discharge for streams in Massachusetts: U.S. Geological Survey Scientific Investigations Report 2013–5155, 62 p., (http://pubs.usgs.gov/sir/2013/5155/)

Probability Statistics Parameters[Perennial Flow Probability]

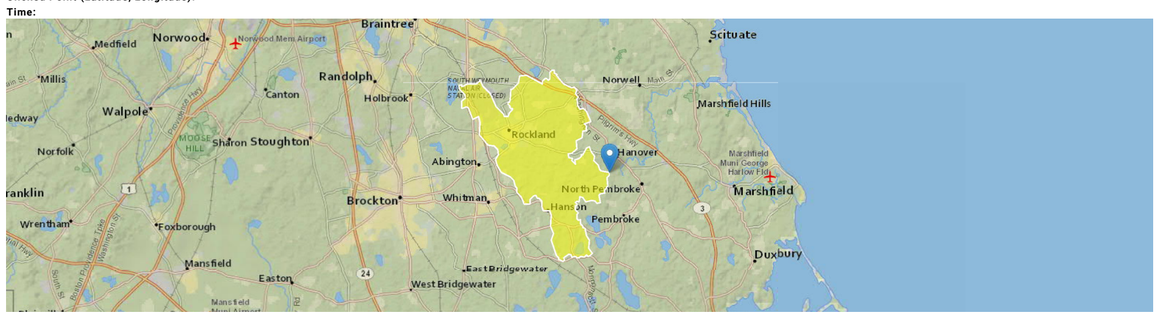
Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	27	square miles	0.01	1.99
PCTSNDGRV	Percent Underlain By Sand And Gravel	60.24	percent	0	100
FOREST	Percent Forest	35.45	percent	0	100
MAREGION	Massachusetts Region	0	dimensionless	0	1

Probability Statistics Disclaimers[Perennial Flow Probability]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Indian River StreamStats Report

Region ID: MA
Workspace ID: MA20201222181310376000
Clicked Point (Latitude, Longitude): 42.10056, -70.82283
Time: 2020-12-22 13:13:30 -0500



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	30.5	square miles
ELEV	Mean Basin Elevation	101	feet
LC06STOR	Percentage of water bodies and wetlands determined from the NLCD 2006	20.33	percent
BSLDEM250	Mean basin slope computed from 1:250K DEM	0.788	percent
DRFTPERSTR	Area of stratified drift per unit of stream length	0.31	square mile per mile
MAREGION	Region of Massachusetts 0 for Eastern 1 for Western	0	dimensionless
BSLDEM10M	Mean basin slope computed from 10 m DEM	2.803	percent
PCTSNDGRV	Percentage of land surface underlain by sand and gravel deposits	68.63	percent
FOREST	Percentage of area covered by forest	26.72	percent
LC11IMP	Average percentage of impervious area determined from NLCD 2011 impervious dataset	17.8	percent
LC11DEV	Percentage of developed (urban) land from NLCD 2011 classes 21-24	50.7	percent

Peak-Flow Statistics Parameters[Peak Statewide 2016 5156]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	30.5	square miles	0.16	512
ELEV	Mean Basin Elevation	101	feet	80.6	1948
LC06STOR	Percent Storage from NLCD2006	20.33	percent	0	32.3

Peak-Flow Statistics Flow Report[Peak Statewide 2016 5156]

PII: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PII	Plu	SEp
50_percent_AEP_flood	404	ft^3/s	207	787	42.3
20_percent_AEP_flood	648	ft^3/s	328	1280	43.4
10_percent_AEP_flood	835	ft^3/s	413	1690	44.7
4_percent_AEP_flood	1100	ft^3/s	527	2300	47.1
2_percent_AEP_flood	1320	ft^3/s	612	2850	49.4
1_percent_AEP_flood	1540	ft^3/s	693	3420	51.8
0_5_percent_AEP_flood	1780	ft^3/s	778	4070	54.1
0_2_percent_AEP_flood	2120	ft^3/s	885	5080	57.6

Peak-Flow Statistics Citations

Zarriello, P.J.,2017, Magnitude of flood flows at selected annual exceedance probabilities for streams in Massachusetts: U.S. Geological Survey Scientific Investigations Report 2016–5156, 99 p. (https://dx.doi.org/10.3133/sir20165156)

Low-Flow Statistics Parameters[Statewide Low Flow WRIR00 4135]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	30.5	square miles	1.61	149
BSLDEM250	Mean Basin Slope from 250K DEM	0.788	percent	0.32	24.6
DRFTPERSTR	Stratified Drift per Stream Length	0.31	square mile per mile	0	1.29
MAREGION	Massachusetts Region	0	dimensionless	0	1

Low-Flow Statistics Flow Report[Statewide Low Flow WRIR00 4135]

PII: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PII	Plu	SE	SEp
7 Day 2 Year Low Flow	3.59	ft^3/s	0.884	14	49.5	49.5
7 Day 10 Year Low Flow	1.35	ft^3/s	0.273	6.23	70.8	70.8

Low-Flow Statistics Citations

Ries, K.G., III,2000, Methods for estimating low-flow statistics for Massachusetts streams: U.S. Geological Survey Water Resources Investigations Report 00-4135, 81 p. (http://pubs.usgs.gov/wri/wri004135/)

Flow-Duration Statistics Parameters[Statewide Low Flow WRIR00 4135]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	30.5	square miles	1.61	149
DRFTPERSTR	Stratified Drift per Stream Length	0.31	square mile per mile	0	1.29
MAREGION	Massachusetts Region	0	dimensionless	0	1
BSLDEM250	Mean Basin Slope from 250K DEM	0.788	percent	0.32	24.6

Flow-Duration Statistics Flow Report[Statewide Low Flow WRIR00 4135]

PII: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PII	Plu	SE	SEp
50 Percent Duration	31.2	ft^3/s	18.6	52.2	17.6	17.6
60 Percent Duration	24.7	ft^3/s	9.79	61.9	19.8	19.8
70 Percent Duration	17.1	ft^3/s	6.96	41.6	23.5	23.5
75 Percent Duration	13.9	ft^3/s	5.77	33.1	25.8	25.8
80 Percent Duration	9.78	ft^3/s	3.09	30.5	28.4	28.4
85 Percent Duration	7.08	ft^3/s	2.25	21.9	31.9	31.9
90 Percent Duration	4.99	ft^3/s	1.53	16	36.6	36.6
95 Percent Duration	2.89	ft^3/s	0.759	10.6	45.6	45.6
98 Percent Duration	2	ft^3/s	0.466	8.13	60.3	60.3
99 Percent Duration	1.53	ft^3/s	0.324	6.8	65.1	65.1

Flow-Duration Statistics Citations

Ries, K.G., III,2000, Methods for estimating low-flow statistics for Massachusetts streams: U.S. Geological Survey Water Resources Investigations Report 00-4135, 81 p. (http://pubs.usgs.gov/wri/wri004135/)

August Flow-Duration Statistics Parameters[Statewide Low Flow WRIR00 4135]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	30.5	square miles	1.61	149
BSLDEM250	Mean Basin Slope from 250K DEM	0.788	percent	0.32	24.6
DRFTPERSTR	Stratified Drift per Stream Length	0.31	square mile per mile	0	1.29
MAREGION	Massachusetts Region	0	dimensionless	0	1

August Flow-Duration Statistics Flow Report[Statewide Low Flow WRIR00 4135]

PII: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PII	Plu	SE	SEp
August 50 Percent Duration	8.27	ft^3/s	2.58	26	33.2	33.2

August Flow-Duration Statistics Citations

Ries, K.G., III,2000, Methods for estimating low-flow statistics for Massachusetts streams: U.S. Geological Survey Water Resources Investigations Report 00-4135, 81 p. (http://pubs.usgs.gov/wri/wri004135/)

Bankfull Statistics Parameters[Bankfull Statewide SIR2013 5155]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	30.5	square miles	0.6	329
BSLDEM10M	Mean Basin Slope from 10m DEM	2.803	percent	2.2	23.9

Bankfull Statistics Flow Report[Bankfull Statewide SIR2013 5155]

PII: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SEp
Bankfull Width	49	ft	21.3
Bankfull Depth	2.24	ft	19.8
Bankfull Area	109	ft^2	29
Bankfull Streamflow	239	ft^3/s	55

Bankfull Statistics Citations

Bent, G.C., and Waite, A.M.,2013, Equations for estimating bankfull channel geometry and discharge for streams in Massachusetts: U.S. Geological Survey Scientific Investigations Report 2013–5155, 62 p., (http://pubs.usgs.gov/sir/2013/5155/)

Probability Statistics Parameters[Perennial Flow Probability]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	30.5	square miles	0.01	1.99
PCTSNDGRV	Percent Underlain By Sand And Gravel	68.63	percent	0	100
FOREST	Percent Forest	26.72	percent	0	100
MAREGION	Massachusetts Region	0	dimensionless	0	1

Probability Statistics Disclaimers[Perennial Flow Probability]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Probability Statistics Flow Report[Perennial Flow Probability]

Statistic	Value	Unit
Probability Stream Flowing Perennially	0.998	dim

Probability Statistics Citations

Bent, G.C., and Steeves, P.A.,2006, A revised logistic regression equation and an automated procedure for mapping the probability of a stream flowing perennially in Massachusetts: U.S. Geological Survey Scientific Investigations Report 2006–5031, 107 p. (http://pubs.usgs.gov/sir/2006/5031/pdfs/SIR_2006-5031rev.pdf)

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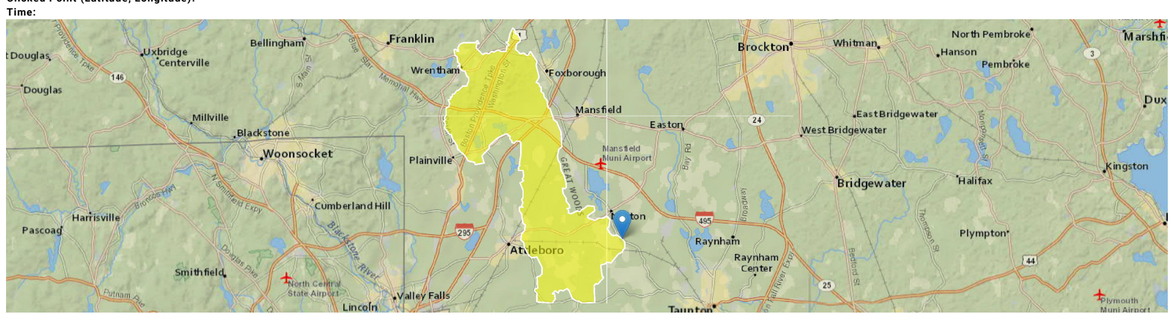
Application Version: 4.4.0

A study area is needed before viewing the report

Wading River StreamStats Report

Region ID: MA
Workspace ID: MA20201222212446894000
Clicked Point (Latitude, Longitude): 41.94743, -71.17669
Time: 2020-12-22 16:25:07 -0500



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	43.1	square miles
ELEV	Mean Basin Elevation	181	feet
LC06STOR	Percentage of water bodies and wetlands determined from the NLCD 2006	17.96	percent
BSLDEM250	Mean basin slope computed from 1:250K DEM	1.197	percent
DRFTPERSTR	Area of stratified drift per unit of stream length	0.28	square mile per mile
MAREGION	Region of Massachusetts 0 for Eastern 1 for Western	0	dimensionless
BSLDEM10M	Mean basin slope computed from 10 m DEM	3.844	percent
PCTSNDGRV	Percentage of land surface underlain by sand and gravel deposits	58.17	percent
FOREST	Percentage of area covered by forest	58.13	percent
LC11DEV	Percentage of developed (urban) land from NLCD 2011 classes 21-24	32.4	percent
LC11IMP	Average percentage of impervious area determined from NLCD 2011 impervious dataset	11.3	percent
WETLAND	Percentage of Wetlands	15.62	percent

General Disclaimers

Parameter values have been edited, computed flows may not apply.

Upstream regulation was checked for this watershed.

This watershed is percent regulated, computed flows may not apply.

This watershed has been edited, computed flows may not apply.

The resulting delineations are derived from digital elevation data and storm drain vectors that have been processed to enforce drainage through storm drains.

Urban regression equations for peak flows were not developed using streamgages which incorporate storm drain delineations and therefore should be used with caution.

Peak-Flow Statistics Parameters[Peak Statewide 2016 5156]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	43.1	square miles	0.16	512
ELEV	Mean Basin Elevation	181	feet	80.6	1948
LC06STOR	Percent Storage from NLCD2006	17.96	percent	0	32.3

Peak-Flow Statistics Disclaimers[Peak Statewide 2016 5156]

Peak-Flow Statistics Flow Report[Peak Statewide 2016 5156]

PII: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PII	Plu	SEp
50_percent_AEP_flood	587	ft^3/s	302	1140	42.3
20_percent_AEP_flood	939	ft^3/s	476	1850	43.4
10_percent_AEP_flood	1210	ft^3/s	600	2440	44.7
4_percent_AEP_flood	1590	ft^3/s	762	3320	47.1
2_percent_AEP_flood	1910	ft^3/s	887	4110	49.4
1_percent_AEP_flood	2230	ft^3/s	1010	4950	51.8
0_5_percent_AEP_flood	2590	ft^3/s	1130	5910	54.1
0_2_percent_AEP_flood	3080	ft^3/s	1290	7360	57.6

Peak-Flow Statistics Citations

Zarriello, P.J.,2017, Magnitude of flood flows at selected annual exceedance probabilities for streams in Massachusetts: U.S. Geological Survey Scientific Investigations Report 2016–5156, 99 p. (https://dx.doi.org/10.3133/sir20165156)

Low-Flow Statistics Parameters[Statewide Low Flow WRIR00 4135]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	43.1	square miles	1.61	149
BSLDEM250	Mean Basin Slope from 250K DEM	1.197	percent	0.32	24.6
DRFTPERSTR	Stratified Drift per Stream Length	0.28	square mile per mile	0	1.29
MAREGION	Massachusetts Region	0	dimensionless	0	1

Low-Flow Statistics Disclaimers[Statewide Low Flow WRIR00 4135]

Low-Flow Statistics Flow Report[Statewide Low Flow WRIR00 4135]

PII: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PII	Plu	SE	SEp
7 Day 2 Year Low Flow	5.57	ft^3/s	1.5	19.9	49.5	49.5
7 Day 10 Year Low Flow	2.29	ft^3/s	0.508	9.61	70.8	70.8

Low-Flow Statistics Citations

Ries, K.G., III,2000, Methods for estimating low-flow statistics for Massachusetts streams: U.S. Geological Survey Water Resources Investigations Report 00-4135, 81 p. (http://pubs.usgs.gov/wri/wri004135/)

Flow-Duration Statistics Parameters[Statewide Low Flow WRIR00 4135]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	43.1	square miles	1.61	149
DRFTPERSTR	Stratified Drift per Stream Length	0.28	square mile per mile	0	1.29
MAREGION	Massachusetts Region	0	dimensionless	0	1
BSLDEM250	Mean Basin Slope from 250K DEM	1.197	percent	0.32	24.6

Flow-Duration Statistics Disclaimers[Statewide Low Flow WRIR00 4135]

Flow-Duration Statistics Flow Report[Statewide Low Flow WRIR00 4135]

PII: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PII	Plu	SE	SEp
50 Percent Duration	44.4	ft^3/s	25.3	77.4	17.6	17.6
60 Percent Duration	35.2	ft^3/s	14.1	87.2	19.8	19.8
70 Percent Duration	24.1	ft^3/s	9.51	60.5	23.5	23.5
75 Percent Duration	19.5	ft^3/s	7.8	48.2	25.8	25.8
80 Percent Duration	14.5	ft^3/s	5.04	41.2	28.4	28.4
85 Percent Duration	10.8	ft^3/s	3.77	30.4	31.9	31.9
90 Percent Duration	7.93	ft^3/s	2.65	23.2	36.6	36.6
95 Percent Duration	4.78	ft^3/s	1.38	16	45.6	45.6
98 Percent Duration	3.24	ft^3/s	0.824	12.1	60.3	60.3
99 Percent Duration	2.52	ft^3/s	0.59	10.1	65.1	65.1

Flow-Duration Statistics Citations

Ries, K.G., III,2000, Methods for estimating low-flow statistics for Massachusetts streams: U.S. Geological Survey Water Resources Investigations Report 00-4135, 81 p. (http://pubs.usgs.gov/wri/wri004135/)

August Flow-Duration Statistics Parameters[Statewide Low Flow WRIR00 4135]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	43.1	square miles	1.61	149
BSLDEM250	Mean Basin Slope from 250K DEM	1.197	percent	0.32	24.6
DRFTPERSTR	Stratified Drift per Stream Length	0.28	square mile per mile	0	1.29
MAREGION	Massachusetts Region	0	dimensionless	0	1

August Flow-Duration Statistics Disclaimers[Statewide Low Flow WRIR00 4135]

August Flow-Duration Statistics Flow Report[Statewide Low Flow WRIR00 4135]

PII: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PII	Plu	SE	SEp
August 50 Percent Duration	12.2	ft^3/s	4.22	34.7	33.2	33.2

August Flow-Duration Statistics Citations

Ries, K.G., III,2000, Methods for estimating low-flow statistics for Massachusetts streams: U.S. Geological Survey Water Resources Investigations Report 00-4135, 81 p. (http://pubs.usgs.gov/wri/wri004135/)

Bankfull Statistics Parameters[Bankfull Statewide SIR2013 5155]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	43.1	square miles	0.6	329
BSLDEM10M	Mean Basin Slope from 10m DEM	3.844	percent	2.2	23.9

Bankfull Statistics Disclaimers[Bankfull Statewide SIR2013 5155]

Bankfull Statistics Flow Report[Bankfull Statewide SIR2013 5155]

PII: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SEp
Bankfull Width	59.4	ft	21.3
Bankfull Depth	2.59	ft	19.8
Bankfull Area	153	ft^2	29
Bankfull Streamflow	396	ft^3/s	55

Bankfull Statistics Citations

Bent, G.C., and Waite, A.M.,2013, Equations for estimating bankfull channel geometry and discharge for streams in Massachusetts: U.S. Geological Survey Scientific Investigations Report 2013–5155, 62 p., (http://pubs.usgs.gov/sir/2013/5155/)

Probability Statistics Parameters[Perennial Flow Probability]

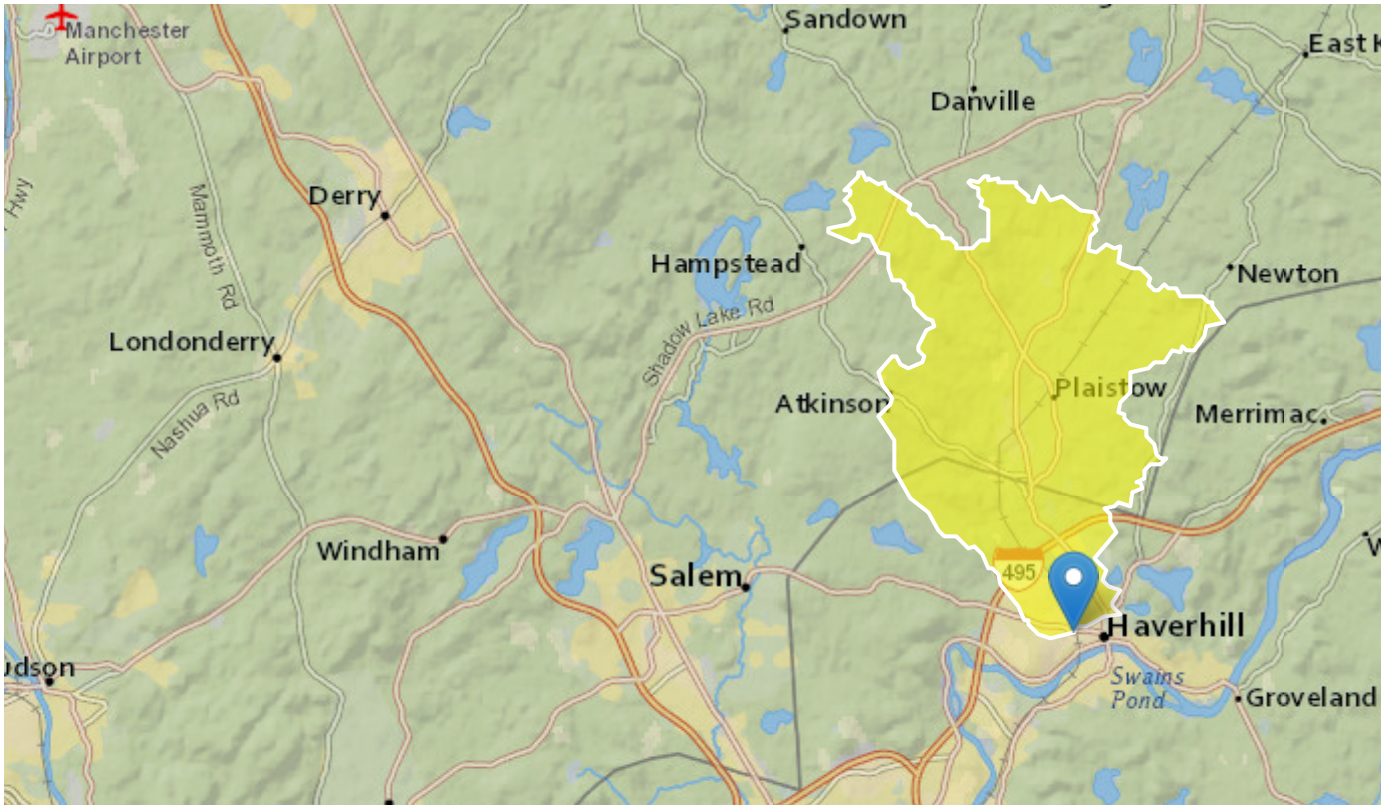
Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	43.1	square miles	0.01	1.99
PCTSNDGRV	Percent Underlain By Sand And Gravel	58.17	percent	0	100
FOREST	Percent Forest	58.13	percent	0	100
MAREGION	Massachusetts Region	0	dimensionless	0	1

Probability Statistics Disclaimers[Perennial Flow Probability]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

StreamStats Report

Region ID: MA
Workspace ID: MA20210128143326605000
Clicked Point (Latitude, Longitude): 42.77744, -71.08841
Time: 2021-01-28 09:33:44 -0500



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	27.9	square miles
ELEV	Mean Basin Elevation	154	feet
LC06STOR	Percentage of water bodies and wetlands determined from the NLCD 2006	10.24	percent
BSLDEM250	Mean basin slope computed from 1:250K DEM	2.213	percent
DRFTPERSTR	Area of stratified drift per unit of stream length	0.2	square mile per mile
MAREGION	Region of Massachusetts 0 for Eastern 1 for Western	0	dimensionless

Parameter Code	Parameter Description	Value	Unit
BSLDEM10M	Mean basin slope computed from 10 m DEM	5.551	percent
PCTSNDGRV	Percentage of land surface underlain by sand and gravel deposits	33.37	percent
FOREST	Percentage of area covered by forest	51.04	percent

Peak-Flow Statistics Parameters[Peak Statewide 2016 5156]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	27.9	square miles	0.16	512
ELEV	Mean Basin Elevation	154	feet	80.6	1948
LC06STOR	Percent Storage from NLCD2006	10.24	percent	0	32.3

Peak-Flow Statistics Flow Report[Peak Statewide 2016 5156]

PII: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PII	PIu	SEp
50_percent_AEP_flood	501	ft^3/s	257	978	42.3
20_percent_AEP_flood	805	ft^3/s	407	1590	43.4
10_percent_AEP_flood	1040	ft^3/s	514	2110	44.7
4_percent_AEP_flood	1370	ft^3/s	654	2870	47.1
2_percent_AEP_flood	1640	ft^3/s	759	3540	49.4
1_percent_AEP_flood	1930	ft^3/s	867	4300	51.8
0_5_percent_AEP_flood	2240	ft^3/s	977	5140	54.1
0_2_percent_AEP_flood	2680	ft^3/s	1120	6440	57.6

Peak-Flow Statistics Citations

Zarriello, P.J.,2017, Magnitude of flood flows at selected annual exceedance probabilities for streams in Massachusetts: U.S. Geological Survey Scientific Investigations Report 2016–5156, 99 p. (https://dx.doi.org/10.3133/sir20165156)

Low-Flow Statistics Parameters[Statewide Low Flow WRIR00 4135]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	27.9	square miles	1.61	149
BSLDEM250	Mean Basin Slope from 250K DEM	2.213	percent	0.32	24.6
DRFTPERSTR	Stratified Drift per Stream Length	0.2	square mile per mile	0	1.29
MAREGION	Massachusetts Region	0	dimensionless	0	1

Low-Flow Statistics Flow Report[Statewide Low Flow WRIR00 4135]

PII: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PII	PIu	SE	SEp
7 Day 2 Year Low Flow	3.29	ft^3/s	1.13	9.2	49.5	49.5
7 Day 10 Year Low Flow	1.43	ft^3/s	0.392	4.86	70.8	70.8

Low-Flow Statistics Citations

Ries, K.G., III,2000, Methods for estimating low-flow statistics for Massachusetts streams: U.S. Geological Survey Water Resources Investigations Report 00-4135, 81 p. (http://pubs.usgs.gov/wri/wri004135/)

Flow-Duration Statistics Parameters[Statewide Low Flow WRIR00 4135]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	27.9	square miles	1.61	149
DRFTPERSTR	Stratified Drift per Stream Length	0.2	square mile per mile	0	1.29
MAREGION	Massachusetts Region	0	dimensionless	0	1
BSLDEM250	Mean Basin Slope from 250K DEM	2.213	percent	0.32	24.6

Flow-Duration Statistics Flow Report[Statewide Low Flow WRIR00 4135]

PII: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	Plu	SE	SEp
50 Percent Duration	28.5	ft^3/s	17.1	47.3	17.6	17.6
60 Percent Duration	21.7	ft^3/s	10.8	43.2	19.8	19.8
70 Percent Duration	13.9	ft^3/s	6.33	30.2	23.5	23.5
75 Percent Duration	11	ft^3/s	5.02	23.8	25.8	25.8
80 Percent Duration	8.73	ft^3/s	3.86	19.4	28.4	28.4
85 Percent Duration	6.63	ft^3/s	2.84	15.2	31.9	31.9
90 Percent Duration	5.01	ft^3/s	2.03	12.1	36.6	36.6
95 Percent Duration	3.07	ft^3/s	1.1	8.28	45.6	45.6
98 Percent Duration	2	ft^3/s	0.618	6.12	60.3	60.3
99 Percent Duration	1.55	ft^3/s	0.451	5.02	65.1	65.1

Flow-Duration Statistics Citations

Ries, K.G., III,2000, Methods for estimating low-flow statistics for Massachusetts streams: U.S. Geological Survey Water Resources Investigations Report 00-4135, 81 p. (http://pubs.usgs.gov/wri/wri004135/)

August Flow-Duration Statistics Parameters[Statewide Low Flow WRIR00 4135]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	27.9	square miles	1.61	149
BSLDEM250	Mean Basin Slope from 250K DEM	2.213	percent	0.32	24.6
DRFTPERSTR	Stratified Drift per Stream Length	0.2	square mile per mile	0	1.29
MAREGION	Massachusetts Region	0	dimensionless	0	1

August Flow-Duration Statistics Flow Report[Statewide Low Flow WRIR00 4135]

PIl: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	Plu	SE	SEp
August 50 Percent Duration	7.13	ft^3/s	3.03	16.5	33.2	33.2

August Flow-Duration Statistics Citations

Ries, K.G., III,2000, Methods for estimating low-flow statistics for Massachusetts streams: U.S. Geological Survey Water Resources Investigations Report 00-4135, 81 p. (http://pubs.usgs.gov/wri/wri004135/)

Bankfull Statistics Parameters[Bankfull Statewide SIR2013 5155]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	27.9	square miles	0.6	329
BSLDEM10M	Mean Basin Slope from 10m DEM	5.551	percent	2.2	23.9

Bankfull Statistics Flow Report[Bankfull Statewide SIR2013 5155]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SEp
Bankfull Width	53.3	ft	21.3
Bankfull Depth	2.4	ft	19.8
Bankfull Area	127	ft^2	29
Bankfull Streamflow	378	ft^3/s	55

Bankfull Statistics Citations

Bent, G.C., and Waite, A.M.,2013, Equations for estimating bankfull channel geometry and discharge for streams in Massachusetts: U.S. Geological Survey Scientific Investigations Report 2013–5155, 62 p., (http://pubs.usgs.gov/sir/2013/5155/)

Probability Statistics Parameters[Perennial Flow Probability]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	27.9	square miles	0.01	1.99
PCTSNDGRV	Percent Underlain By Sand And Gravel	33.37	percent	0	100
FOREST	Percent Forest	51.04	percent	0	100
MAREGION	Massachusetts Region	0	dimensionless	0	1

Probability Statistics Disclaimers[Perennial Flow Probability]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Probability Statistics Flow Report[Perennial Flow Probability]

Statistic	Value	Unit
Probability Stream Flowing Perennially	0.995	dim

Probability Statistics Citations

Bent, G.C., and Steeves, P.A.,2006, A revised logistic regression equation and an automated procedure for mapping the probability of a stream flowing perennially in Massachusetts: U.S. Geological Survey Scientific Investigations Report 2006–5031, 107 p. (http://pubs.usgs.gov/sir/2006/5031/pdfs/SIR_2006-5031rev.pdf)

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Application Version: 4.4.0

Attachment 4

NOAA Tide Data for Merrimack River

Datums for 8440889, RIVERSIDE, MERRIMACK RIVER MA

NOTICE: All data values are relative to the NAVD88.

Elevations on NAVD88

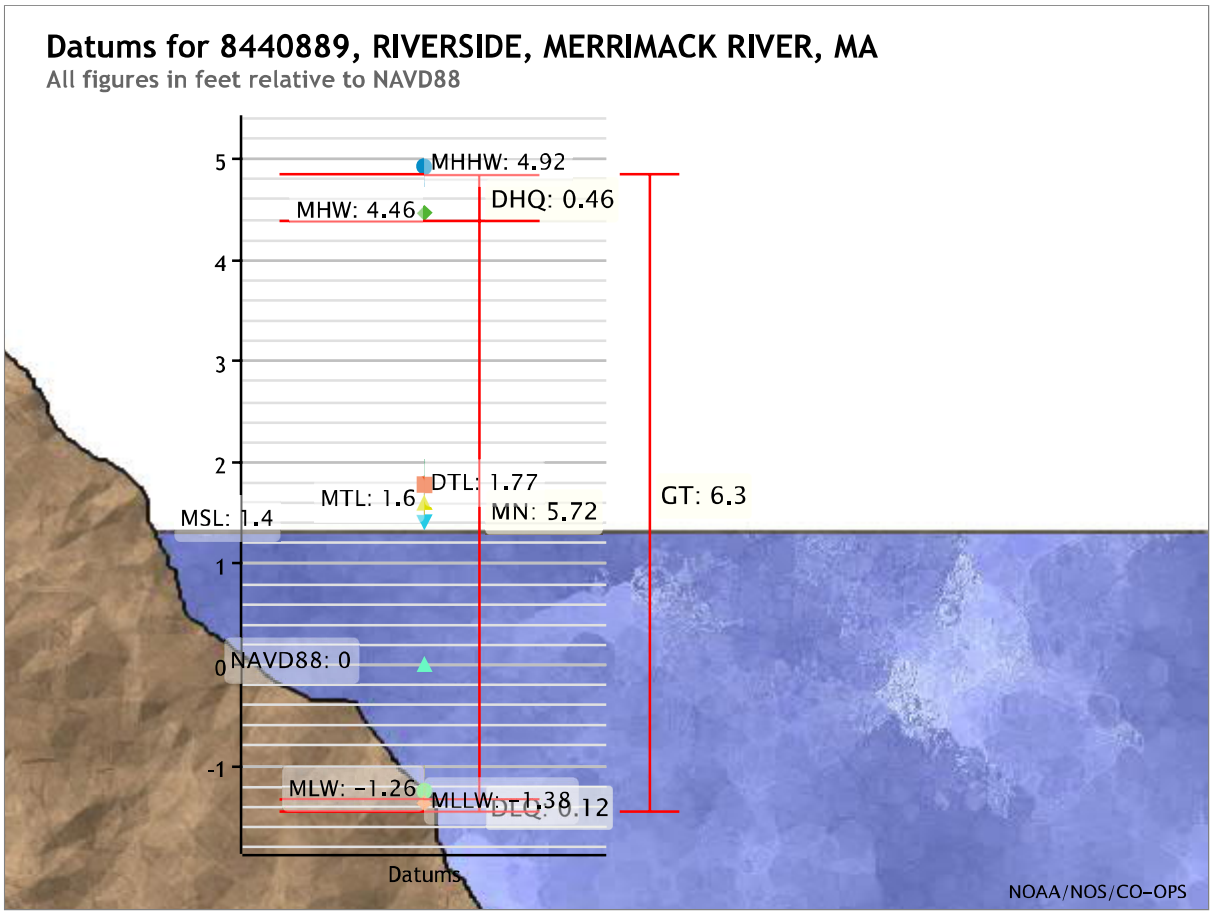
Station: 8440889, RIVERSIDE, MERRIMACK RIVER, MA
Status: Accepted (Sep 8 2003)
Units: Feet
Control Station: 8440466 NEWBURYPORT, MERRIMACK RIVER, MA
T.M.: 75
Epoch: (/datum_options.html#NTDE) 1983-2001
Datum: NAVD88

Datum	Value	Description
MHHW (/datum_options.html#MHHW)	4.92	Mean Higher-High Water
MHW (/datum_options.html#MHW)	4.46	Mean High Water
MTL (/datum_options.html#MTL)	1.60	Mean Tide Level
MSL (/datum_options.html#MSL)	1.40	Mean Sea Level
DTL (/datum_options.html#DTL)	1.77	Mean Diurnal Tide Level
MLW (/datum_options.html#MLW)	-1.26	Mean Low Water
MLLW (/datum_options.html#MLLW)	-1.38	Mean Lower-Low Water
NAVD88 (/datum_options.html)	0.00	North American Vertical Datum of 1988
STND (/datum_options.html#STND)	-4.88	Station Datum
GT (/datum_options.html#GT)	6.30	Great Diurnal Range
MN (/datum_options.html#MN)	5.72	Mean Range of Tide
DHQ (/datum_options.html#DHQ)	0.46	Mean Diurnal High Water Inequality
DLQ (/datum_options.html#DLQ)	0.12	Mean Diurnal Low Water Inequality

Datum	Value	Description
HWI (/datum_options.html#HWI)	5.52	Greenwich High Water Interval (in hours)
LWI (/datum_options.html#LWI)	0.84	Greenwich Low Water Interval (in hours)
Max Tide (/datum_options.html#MAXTIDE)		Highest Observed Tide
Max Tide Date & Time (/datum_options.html#MAXTIDEDT)		Highest Observed Tide Date & Time
Min Tide (/datum_options.html#MINTIDE)		Lowest Observed Tide
Min Tide Date & Time (/datum_options.html#MINTIDEDT)		Lowest Observed Tide Date & Time
HAT (/datum_options.html#HAT)		Highest Astronomical Tide
HAT Date & Time		HAT Date and Time
LAT (/datum_options.html#LAT)		Lowest Astronomical Tide
LAT Date & Time		LAT Date and Time

Tidal Datum Analysis Periods

07/01/1989 - 09/30/1989



Showing datums for

8440889 RIVERSIDE, MERR...

^

Datum

NAVD88

Data Units ◉ Feet
○ Meters

Epoch ◉ Present (1983-2001)
○ Superseded (1960-1978)

Submit

Show nearby stations

Products available at 8440889 RIVERSIDE, MERRIMACK RIVER, MA

TIDES/WATER LEVELS

Water Levels

NOAA Tide Predictions (/noaatidepredictions.html?id=8440889)

Harmonic Constituents (/harcon.html?id=8440889)

Sea Level Trends

Datums (/datums.html?id=8440889)

Bench Mark Sheets (/benchmarks.html?id=8440889)

Extreme Water Levels

Reports (/reports.html?id=8440889)

METEOROLOGICAL/OTHER

Meteorological Observations

Water Temp/Conductivity

PORTS®

This station is not a member of PORTS®

OPERATIONAL FORECAST SYSTEMS

This station is not a member of OFS

INFORMATION

Station Home Page (/stationhome.html?id=8440889)

Data Inventory (/inventory.html?id=8440889)

Measurement Specifications (/measure.html)

^

Website Owner: Center for Operational Oceanographic Products and Services

National Oceanic and Atmospheric Administration (http://www.noaa.gov)
National Ocean Service (http://oceanservice.noaa.gov)
Privacy Policy (/privacy.html)
Disclaimer (/disclaimers.html)
Take Our Survey (/survey.html)
Freedom of Information Act (https://www.noaa.gov/foia-freedom-of-information-act)
Contact Us (/contact.html)

Attachment 5

FEMA Duplicate Effective Model Hydraulic Back-up Data

```
**********                                                    THIS RUN EXECUTED 05/07/81  10.25.07
 HEC2 RELEASE DATED NOV 76 UPDATED JULY 1979
 ERRER CORE = 01,02,03
 MODIFICATION - 50,51,52,53, *, *, *, *,98
**********

C
T1    HAVERHILL
T2    LITTLE RIVER
T3    ENCROACHMENT  ANALYSIS

J1  ICHECK      INQ        NINV       IDIR       STRT       METRIC     HVINS      Q          WSEL       FQ
              0.         4.         0.         0.  0.0        C.0        0.0        0.         1.600      0.0
J2  NPROF       IPLOT      PRFVS      XSECV      XSECH      FN         ALLDC      IBW        CHNIM      ITRACE
              0.0        0.0        -1.000     0.0        0.0        0.0        0.0        0.0        0.0        0.0
J3  VARIABLE CODES FOR SUMMARY PRINTOUT
            110.000    200.000    0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0

NC            0.029      0.029      0.029      0.300      0.000      0.0        0.0        0.0        0.0        0.0
QT            9.000   1160.000   1920.000   2330.000   3520.000   2330.000   2330.000   2330.000   2330.000   2330.000

      APPROXIMATED SECTION AT CONFLUENCE WITH MERRIMACK RIVER

X1      8225.000      5.000   1984.000   2016.000      0.0        0.0        0.0        0.0        0.0        0.0
GR        10.000   1000.000   -1.400     1984.000   -1.400     2000.000   -1.200     2016.000   10.000     3000.000
NC            0.025      0.025      0.029      0.0        0.0        0.0        0.0        0.0        0.0        0.0
ET            0.0        0.0        0.0        0.0        0.0        0.0        8.110   1984.000   2016.000      0.0

      APPROXIMATED SECTION

X1      8235.000      5.000   1984.000   2016.000   10.000     10.000     10.000     0.0        0.0        0.0
GR        10.000      0.0        0.0        0.0        0.0        0.0        0.0        20.000     20.000     0.0
GR        10.000   1000.000   -1.200     1984.000   -1.200     2000.000   -1.200     2016.000   10.000     3000.000
SB        1.250      1.250      1.250      0.0        31.200     0.0        303.000    0.0        0.0        0.0
ET        0.0        0.0        0.0        0.0        0.0        0.0        8.110   1983.000   2017.000      0.0

      LETTERS IN PARENTHESIS DENOTE SURVEYED SECTIONS CORRESPONDING
      TO THE FREM.
      (A) SURVEYED SECTION AT FACE OF WALL AT CULVERT ENTRANCE     LR1-S

X1    10000.000     13.000   1983.400   2016.600   1765.000   1765.000   1765.000      0.0        0.3        0.0
XS        0.0        0.0        1.000     21.400     33.000     0.2        0.0        0.0        0.0        0.0
XT        10.000     0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
RT        13.000   1540.000     43.000     0.0        0.0        0.0        0.0        33.000     35.000     0.0
RT     1983.400      39.200     7.700   1988.900     1967.000   33.000     0.0        1569.000   39.600     0.0
RT        38.800     21.400   2005.500     38.600     39.100     15.600   1994.500     39.900     21.000   2000.000
RT         7.700   2027.800     38.500     0.0     2030.000   2011.100     38.500     15.000   2016.600     38.300
GR        43.000   1840.000     33.000   1967.000     39.600   1969.400     0.0        1540.000   50.000     0.0
GR        50.000   1840.000     33.000   1967.000     39.600   1969.400     7.700   1983.400      7.400   1388.900
```

GR	38.000	2027.600	35.000	2030.000	[illegible]	[illegible]	2540.000	0.0	0.0	0.0	0.0
ET	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.110	1973.000	2024.200	0.0

(B) SURVEYED SECTION U/S OF LR1-S

X1	10050.000	15.000	1984.000	2014.000	35.000	60.000	50.000	0.0	0.0	0.0	0.0
GR	41.900	1880.000	35.600	1980.000	34.000	1930.000	24.800	1754.000	20.000	1970.000	0.0
GR	8.100	1984.000	27.000	2000.000	8.100	2013.000	16.000	2320.000	8.400	2130.000	0.0
GR	26.100	2034.000	28.400	2040.000	29.000	2050.000	30.000	2090.000	50.000	2101.000	0.0
NC	0.0	0.0	0.0	0.300	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ET	0.0	0.0	0.0	0.0	0.0	0.0	8.110	1972.000	2020.500	0.0	

SCALED SECTION D/S OF LR2-S

X1	10486.000	10.000	1972.000	2020.000	430.000	430.000	430.000	0.0	0.0	0.0	0.0
GR	56.000	1779.000	30.000	1780.000	25.000	1909.000	25.000	1972.000	8.500	1973.000	0.0
GR	8.100	2019.000	20.000	2020.000	20.000	2045.000	30.000	2125.000	50.000	2126.000	0.0
NC	0.0	0.0	0.0	0.300	0.500	0.0	0.0	0.0	0.0	0.0	0.0
NH	4.000	0.025	1973.100	0.029	2018.900	0.025	2019.000	0.040	2430.000	0.0	
ET	0.0	0.0	0.0	0.0	0.0	0.0	8.110	1986.000	2014.000	0.0	

(C) SURVEYED SECTION D/S FACE OF LR2-S

X1	10530.000	16.000	1986.000	2014.000	50.000	50.000	50.000	0.0	0.0	0.0	0.0
X2	10.000	0.0	0.0	0.0	0.0	0.0	0.0	22.700	22.700	0.0	
GR	30.000	1560.000	25.700	1666.000	25.100	1756.000	24.700	1806.000	24.500	1856.000	
GR	24.900	1960.000	27.000	1994.000	24.800	1973.000	9.000	1973.100	9.000	1984.000	
GR	9.000	2000.000	9.000	2014.000	9.000	2018.900	24.800	2019.000	27.800	2256.000	
GR	30.000	2430.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
GR	0.250	14.500	0.500	0.0	28.000	0.0	220.000	0.0	9.000	7.000	
ET	0.0	0.0	0.0	0.0	0.0	0.0	8.110	1986.000	2014.000	0.0	

(D) SURVEYED SECTION U/S FACE OF LR2-S

X1	10605.000	15.000	1986.000	2014.000	75.000	75.000	75.000	0.0	0.0	0.0	0.0
X2	0.0	0.0	1.000	20.600	24.800	0.0	0.0	0.0	0.0	0.0	0.0
X3	10.000	0.0	0.0	0.0	0.0	0.0	0.0	24.800	24.800	0.0	
BT	7.000	1973.000	24.800	24.800	1986.000	24.800	9.000	1993.000	24.800	18.000	
BT	2000.000	24.800	26.000	2007.000	24.800	18.000	2019.000	24.800	9.000	2014.000	
BT	24.800	24.800	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
GR	56.000	1906.000	56.000	1972.900	24.800	1973.000	9.000	1973.100	9.000	1986.000	
GR	9.000	1993.000	9.000	2000.000	9.000	2007.000	9.000	2014.000	9.000	2014.900	
GR	24.800	2019.000	26.500	2206.000	27.400	2235.000	27.800	2256.000	30.000	2430.000	
GR	0.030	0.0	0.030	0.0	0.500	0.0	0.0	0.0	0.0	0.0	
ET	0.0	0.0	0.0	0.0	0.0	0.0	8.110	1972.000	2039.000	0.0	

APPROXIMATED SECTION U/S OF LR2-S

X1	10640.000	7.000	1972.900	2038.100	35.000	35.000	35.000	0.0	0.0	0.0	0.0
GR	54.000	1972.900	9.200	1973.000	9.200	2038.000	25.500	2038.100	28.000	2250.000	
GR	30.000	2430.000	50.000	2450.000	0.0	0.0	0.0	0.0	0.0	0.0	
NC	0.0	0.0	0.0	0.100	0.300	0.0	0.0	0.0	0.0	0.0	
NH	6.000	0.065	1680.000	0.025	1740.000	0.065	1790.000	0.025	1959.900	0.029	
NH	2035.100	0.065	2229.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
ET	0.0	0.0	0.0	0.0	0.0	0.0	8.110	1959.000	2036.000	0.0	

SCALED SECTION AT SPILLWAY D/S

X1	10674.000	18.000	1959.900	2035.100	34.000	34.000	34.000	0.0	0.0	0.0	0.0
GR	40.000	1570.000	35.000	1680.000	50.000	1680.100	50.000	1739.900	30.000	1740.000	
GR	30.000	1740.000	54.000	1790.100	54.000	1959.900	54.000	1960.000	54.000	2035.000	

GR	27.800	2229.000	30.000	2425.000	35.000	2560.000	0.0	0.0	0.0	0.0	
ET	0.0	0.0	0.0	0.0	0.0	0.0	8.110	1959.000	2036.000	0.0	

SCALED SECTION AT SPILLWAY ON

X1	10675.000	18.000	1959.900	2035.100	1.000	1.000	1.000	0.0	0.0	0.0	
GR	40.000	1570.000	35.000	1680.000	50.000	1680.100	50.000	1739.900	30.000	1740.000	
GR	30.000	1790.000	54.000	1790.100	54.000	1959.900	19.300	1960.000	19.300	2035.000	
GR	26.200	2035.100	45.600	2037.000	25.300	2106.000	24.700	2113.000	27.600	2208.000	
GR	27.800	2229.000	30.000	2425.000	35.000	2560.000	0.0	0.0	0.0	0.0	
ET	0.0	0.0	0.0	0.0	0.0	0.0	8.110	1959.000	2036.000	0.0	

SCALED SECTION AT SPILLWAY U/S

X1	10676.000	18.000	1959.900	2035.100	1.000	1.000	1.000	0.0	0.0	0.0	
GR	40.000	1570.000	35.000	1680.000	50.000	1680.100	50.000	1739.900	30.000	1740.000	
GR	30.000	1790.000	54.000	1790.100	54.000	1959.900	19.300	1960.000	19.300	2035.000	
GR	26.200	2035.100	45.600	2037.000	25.300	2106.000	24.700	2113.000	27.600	2208.000	
GR	27.800	2229.000	30.000	2425.000	35.000	2560.000	0.0	0.0	0.0	0.0	
ET	0.0	0.0	0.0	0.0	0.0	0.0	8.110	1959.000	2036.000	0.0	

COMPUTED SECTION 100'U/S OF SPILLWAY

X1	10775.000	0.0	0.0	0.0	99.000	99.000	99.000	0.0	0.150	0.0	
NM	4.000	0.112	1790.000	0.025	1960.000	0.065	2030.000	0.112	2580.000	0.0	
ET	0.0	0.0	0.0	0.0	0.0	0.0	8.110	1960.000	2085.000	0.0	

SCALED SECTION

X1	11000.000	10.000	1960.000	2030.000	225.000	225.000	225.000	0.0	0.0	0.0	
GR	40.000	1570.000	35.000	1670.000	30.000	1790.000	54.000	1790.100	54.000	1959.900	
GR	17.000	1960.000	9.800	2000.000	17.000	2030.000	30.000	2420.000	40.000	2580.000	
NC	4.112	0.112	0.065	0.160	0.360	0.0	0.0	0.0	0.0	0.0	
ET	0.0	0.0	0.0	0.0	0.0	0.0	8.110	1940.000	2085.000	0.0	

SCALED SECTION

X1	11600.000	11.000	1940.000	2060.000	600.000	600.000	600.000	0.0	0.0	0.0	
GR	40.000	1590.000	35.000	1670.000	35.000	1860.000	30.000	1920.300	25.000	1930.000	
GR	18.000	1940.000	10.800	2000.000	18.000	2060.000	25.000	2080.200	30.000	2550.000	
GR	40.000	2660.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
ET	0.0	0.0	0.0	0.0	0.0	0.0	8.110	1920.000	2045.000	0.0	

(E) SURVEYED SECTION LR3

X1	12255.000	15.000	1920.000	2045.000	655.000	655.000	655.000	0.0	0.0	0.0	
GR	33.100	1766.000	34.100	1808.000	33.400	1866.000	33.400	1885.000	20.600	1914.000	
GR	20.000	1920.000	12.400	1966.000	33.400	2000.000	17.900	2014.000	40.000	2040.000	
GR	24.700	2080.000	26.800	2085.000	29.000	2394.000	30.000	2448.000	40.000	2934.000	
ET	0.0	0.0	0.0	0.0	0.0	0.0	8.110	1920.000	2045.000	0.0	

COMPUTED SECTION

X1	13100.000	0.0	0.0	0.0	845.000	845.000	845.000	0.0	1.000	0.0	
ET	0.0	0.0	0.0	0.0	0.0	0.0	8.110	1860.000	2055.000	0.0	

SCALED SECTION D/S OF BEND

X1	14000.000	15.000	1960.000	2040.000	900.000	900.000	900.000	0.0	0.0	0.0	

GR	17.300	1983.000	16.900	1988.000	13.900	2000.000	14.900	2012.000	17.200	2025.000	
GR	19.560	2040.000	20.000	2050.000	25.000	2060.000	30.000	2070.000	40.000	2090.000	
ET	0.0	0.0	0.0	0.0	0.0	0.0	8.110	1693.000	2083.000	0.0	

SCALED SECTION D/S OF LR4-S U/S OF BENC

XI	14200.000	12.000	1925.000	2075.000	125.000	250.000	200.000	0.0	0.0	0.0	
GR	40.000	1600.000	30.000	1640.000	25.000	1870.000	20.000	1920.000	19.800	1925.000	
GR	18.600	1840.000	14.200	2000.000	17.500	2060.000	16.800	2075.000	20.000	2080.000	
GR	24.000	2160.000	45.000	2165.000	0.0	0.0	0.0	0.0	0.0	0.0	
NC	0.0	0.0	0.0	0.300	0.500	0.0	0.0	0.0	0.0	0.0	
ET	0.0	0.0	0.0	0.0	0.0	0.0	8.110	1950.000	2045.000	0.0	

COMPUTED SECTION D/S FACE OF LR4-S

XI	14300.000	16.000	1983.000	2018.170	50.000	140.000	100.000	0.0	-0.300	0.0	
GR	35.000	1770.000	27.500	1920.000	21.000	1970.000	20.200	1978.000	19.000	1981.000	
GR	17.300	1988.200	14.400	2000.000	15.600	2012.400	16.800	2018.100	17.900	2025.600	
GR	20.200	2030.100	27.600	2070.000	27.900	2120.000	28.100	2170.000	30.000	2230.000	
GR	35.000	2270.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
GR	1.050	1.560	2.600	0.0	35.100	2.000	316.000	0.0	14.600	14.300	
ET	0.0	0.0	0.0	0.0	0.0	0.0	8.110	1950.000	2045.000	0.0	

(F) SURVEYED SECTION U/S FACE OF LR4-S

XI	14340.000	0.0	0.0	0.0	40.000	40.000	40.000	0.0	0.300	0.0	
XS	0.0	0.0	1.000	25.700	27.500	0.0	0.0	0.0	0.0	0.0	
BT	10.000	1450.000	24.800	0.0	1930.000	27.500	0.0	1970.000	27.600	0.0	
BT	1981.000	27.500	27.600	2000.000	27.600	24.600	2010.100	27.700	25.700	2030.100	
BT	27.700	0.0	2070.000	27.600	0.0	2120.000	27.900	0.0	2170.000	28.100	
ET	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
ET	0.0	0.0	0.0	0.0	0.0	0.0	8.110	1944.000	2104.000	0.0	

(G) SURVEYED SECTION U/S OF LR4-S

XI	14420.000	15.000	1944.000	2051.000	80.000	80.000	80.000	0.0	0.0	0.0	
GR	40.000	1815.000	30.000	1854.000	26.900	1885.000	22.500	1920.000	21.900	1941.000	
GR	20.100	2134.000	15.000	2060.000	20.100	2051.000	19.900	2074.000	20.300	2125.000	
GR	23.400	2134.200	25.000	2146.000	27.100	2177.000	26.100	2225.000	35.000	2475.000	
NC	0.0	0.0	0.0	0.100	0.300	0.0	0.0	0.0	0.0	0.0	
ET	3.000	0.112	1970.000	0.065	2025.000	0.112	2195.000	0.0	0.0	0.0	
ET	0.0	0.0	0.0	0.0	0.0	0.0	8.110	1950.000	2150.000	0.0	

COMPUTED SECTION D/S OF LR5-S

XI	15677.000	23.000	1964.000	2025.000	1257.000	1257.000	1257.000	0.0	0.0	0.0	
GR	35.000	1760.000	29.800	1895.000	28.900	1945.000	29.900	1948.000	27.700	1952.000	
GR	21.000	2033.000	13.000	1987.000	16.100	2000.000	14.800	2011.000	19.700	2025.000	
GR	21.000	2038.000	21.000	2036.000	20.200	2045.000	19.600	2048.000	20.800	2117.000	
GR	28.100	2150.000	31.500	2154.000	32.100	2164.000	30.100	2172.000	28.800	2184.000	
GR	29.000	2190.000	30.000	2230.000	35.000	2240.000	0.0	0.0	0.0	0.0	
NC	0.0	0.0	0.0	0.300	0.0	0.0	0.0	0.0	0.0	0.0	
ET	0.0	0.0	0.0	0.0	0.0	0.0	0.410	8.110	1950.000	2150.000	0.0

(H) SURVEYED SECTION D/S FACE OF LR5-S

XI	15697.000	0.0	0.0	0.0	20.000	20.000	20.000	0.0	0.0	0.0	
XS	10.000	0.0	0.0	0.0	0.0	0.0	0.0	27.000	27.000	0.0	
SB	1.250	1.560	2.600	0.0	165.000	15.000	951.000	18.000	15.100	15.100	
ET	0.0	0.0	0.0	0.0	0.0	0.0	8.110	1950.000	2150.000	0.0	

COMPUTED SECTION U/S FACE OF LR5-S

X1	15703.000	0.0	0.0	0.0	6.000	6.000	6.000	0.0	0.0	0.0
X2	0.0	0.0	1.000	25.900	28.100	0.0	0.0	2.000	0.0	0.0
GR	110.000	0.0	0.0	0.0	0.0	0.6	0.0	28.500	21.000	0.0
BT	17.000	1850.000	31.900	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ET	1948.000	29.900	0.0	1952.000	28.600	29.800	0.0	1948.000	28.900	0.0
BT	28.400	29.300	2035.000	28.400	28.600	0.0	1964.000	28.400	25.400	2000.000
BT	25.600	2150.000	28.100	0.0	28.300	2036.000	28.400	25.900	2149.000	28.100
BT	2122.000	30.100	0.0	2184.000	28.500	31.500	0.0	2184.000	32.100	0.0
BT	50.000	0.0	0.0	0.0	0.0	0.0	2195.000	29.300	0.0	2600.000
ET	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
							8.110	1950.000	2150.000	0.0

COMPUTED SECTION U/S OF LR5-S

X1	15713.000	0.0	0.0	0.0	10.000	10.000	10.000	0.0	0.0	0.0
NT	0.0	0.0	0.0	0.100	0.300	0.0	0.0	0.0	0.0	0.0
ET	0.0	0.0	0.0	0.0	0.0	8.410	8.110	1692.000	2032.000	0.0

SCALED SECTION AT WIDENING OF FLOOD PLAIN

X1	16175.000	10.000	1973.000	2031.000	465.000	465.000	462.000	0.0	0.0	0.0
GR	30.000	1630.000	20.200	1684.000	20.000	1690.200	20.200	1725.000	21.000	1850.000
GR	20.500	1973.000	12.700	2000.000	20.200	2031.000	35.000	2065.000	50.000	2077.000
ET	0.0	0.0	0.0	0.0	0.0	0.0	8.110	1972.000	2032.000	0.0

(I) SURVEYED SECTION LR6

X1	16410.000	11.000	1973.000	2031.000	240.000	230.000	235.000	0.0	0.0	0.0
GR	34.300	1811.000	30.900	1831.000	29.800	1881.000	34.000	1931.000	25.100	1963.000
GR	37.100	1971.000	12.200	2000.000	19.700	2031.000	54.000	2059.000	50.100	2073.000
GR	31.100	2081.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NM	5.000	0.112	1973.000	0.050	2031.000	0.112	2100.000	0.050	2150.000	0.112
NM	2360.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ET	0.0	0.0	0.0	0.0	0.0	0.0	8.110	1805.000	2160.000	0.0

SCALED SECTION

X1	17680.000	13.000	1973.000	2031.000	1500.000	1170.000	1270.000	0.0	0.0	0.0
GR	35.000	1140.000	30.300	1280.000	25.000	1760.000	21.400	1973.000	25.000	2000.000
GR	21.400	2031.000	14.400	2100.000	17.000	2125.000	21.400	2150.000	25.000	2260.000
GR	30.000	2280.000	34.000	2320.000	30.000	2360.000	0.0	0.0	0.0	0.0
NM	5.000	0.112	1984.000	0.050	2016.000	0.112	2079.000	0.0	0.0	0.0
ET	0.0	0.0	0.0	0.0	0.0	0.0	8.110	1965.000	2050.000	0.0

(J) SURVEYED SECTION D/S OF LR7-S (RTE 495) FULLY EXPANDED

X1	19140.000	10.000	1967.000	2046.000	1460.000	1460.000	1460.000	0.0	0.0	0.0
X2	10.000	0.0	0.0	0.0	0.0	0.0	0.0	65.000	65.000	0.0
GR	35.000	1150.000	30.200	1550.000	26.700	1839.000	29.200	1967.000	34.900	1984.000
GR	19.600	2000.000	19.300	2016.000	32.500	2048.000	33.300	2073.000	34.400	2079.000
NC	0.112	0.112	0.042	0.300	0.500	0.0	0.0	0.0	0.0	0.0
ET	0.0	0.0	0.0	0.0	0.0	0.0	8.110	1965.000	2050.000	0.0

COMPUTED SECTION D/S OF RTE 495 FULLY EXPANDED

X1	19225.000	0.0	0.0	0.0	85.000	85.000	85.000	0.0	0.250	0.0
ET	0.0	0.0	0.0	0.0	0.0	0.0	8.110	1984.000	2016.000	0.0

SCALED SECTION D/S FACE OF RTE 495 EMBANKMENT

XI	19310.000	13.000	1984.000	2016.000	55.000	85.000	85.000	0.0	0.0	0.0	
GR	55.000	1930.000	21.000	1980.000	20.400	1984.000	174.400	2000.000	21.400	2016.000	
GR	33.000	2040.000	34.900	2065.000	34.600	2070.000	34.900	2075.000	33.000	2076.000	
GR	34.000	2084.000	40.000	2116.000	55.000	2150.000	0.0	0.0	0.0	0.0	
ET	0.0	0.0	0.0	0.0	0.0	0.0	8.110	1984.000	2016.000	0.0	

COMPUTED SECTION APPROX MIDPOINT OF CONSTRICTION UNDER RTE 495.

XI	19430.000	0.0	0.0	0.0	120.000	120.000	120.000	0.0	0.450	0.0	
ET	0.0	0.0	0.0	0.0	0.0	0.0	8.110	1984.000	2016.000	0.0	

(K) SURVEYED SECTION U/S FACE OF RTE 495 EMBANKMENT LR7-S

XI	19550.000	0.0	0.0	0.0	120.000	120.000	120.000	0.0	0.450	0.0	
ET	0.0	0.0	0.0	0.0	0.0	0.410	8.110	1971.000	2036.000	0.0	

COMPUTED SECTION-ELMIN SURVEYED-D/S TOE OF RIPRAP OBSTRUCTION

XI	19600.000	7.000	1985.000	2015.000	50.000	50.000	50.000	0.0	0.0	0.0	
GR	55.000	1930.000	21.000	1980.000	19.600	1985.000	19.600	2000.000	19.000	2015.000	
GR	33.000	2040.000	36.000	2065.000	0.0	0.0	0.0	0.0	0.0	0.0	
ET	0.0	0.0	0.0	0.0	0.0	0.0	8.110	1971.000	2036.000	0.0	

(L) COMPUTED SECTION-ELMIN SURVEYED-HIGH PT. OF RIPRAP OBSTRUCTION

XI	19606.000	7.000	1985.000	2015.000	6.000	6.000	6.000	0.0	0.0	0.0	
GR	55.000	1930.000	21.000	1980.000	21.600	1985.000	21.600	2000.000	21.600	2015.000	
GR	33.000	2040.000	36.000	2065.000	0.0	0.0	0.0	0.0	0.0	0.0	
ET	0.0	0.0	0.0	0.0	0.0	0.0	8.110	1971.000	2036.000	0.0	

COMPUTED SECTION-ELMIN SURVEYED-H/S TOE OF RIPRAP OBSTRUCTION

XI	19612.000	7.000	1985.000	2/15.000	6.000	6.000	6.000	0.0	0.0	0.0	
GR	55.000	1930.000	21.000	1980.000	21.100	1985.000	20.800	2000.000	21.300	2015.000	
GR	33.000	2040.000	36.000	2065.000	0.0	0.0	0.0	0.0	0.0	0.0	
NC	0.112	0.112	0.244	0.244	0.200	0.200	0.0	0.0	0.0	0.0	
GT	0.000	980.000	1640.000	1990.000	3030.000	1990.000	1990.000	1990.000	1990.000	1990.000	
ET	0.0	0.0	0.0	0.0	0.0	0.0	8.110	1327.000	2052.000	0.0	

COMPUTED SECTION

XI	20612.000	10.000	1981.000	2020.000	800.000	800.000	800.000	0.0	-0.500	0.0	
GR	55.000	320.000	34.000	1910.000	33.000	1835.000	30.000	1970.000	22.400	1981.000	
GR	21.700	2000.000	22.800	2020.000	30.000	2030.000	35.000	2080.000	46.000	2096.000	
ET	0.0	0.0	0.0	0.0	0.0	0.0	8.110	1348.000	2048.000	0.0	

(M) SURVEYED SECTION LRB

XI	21212.000	0.0	0.0	0.0	800.000	800.000	800.000	0.0	0.500	0.0	
ET	0.0	0.0	0.0	0.0	0.0	0.0	8.110	1902.000	2422.000	0.0	

APPROXIMATED SECTION

XI	23012.000	16.000	1982.000	2018.000	1800.000	1800.000	1800.000	0.0	0.0	0.0	
GR	55.000	1640.000	48.000	1910.000	46.000	1750.000	35.000	1830.000	22.000	1838.000	
GR	35.000	1890.000	30.000	1918.000	24.000	1962.000	24.000	2000.000	22.000	2018.000	
GR	30.000	2000.000	30.000	2340.000	56.000	2540.000	40.000	2570.000	45.000	2695.000	
GR	50.000	2975.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
ET	0.0	0.0	0.0	0.0	0.0	0.0	8.110	1886.000	2051.000	0.0	

APPROXIMATED SECTION D/S OF LR9-S

XI	23332.000	7.000	1975.000	2025.000	320.000	320.000	320.000	0.0	0.0	0.0
GR	40.000	1555.000	35.000	1835.000	27.000	1975.000	23.500	2000.000	27.000	2025.000
GR	30.000	2040.000	40.000	2095.000	0.0	0.0	0.0	0.0	0.0	0.0
NC	0.125	0.125	0.042	0.360	0.500	0.0	0.0	0.0	0.0	0.0
ET	0.0	0.0	0.0	0.0	0.0	0.0	8.110	1992.000	2008.000	0.0

COMPUTED SECTION D/S FACE LR9-S

XI	23432.000	19.000	1992.000	2008.000	100.000	100.000	100.000	0.0	0.0	0.0
XS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	34.300	34.300	0.0
GR	50.800	1770.000	45.000	1850.000	40.000	1900.000	30.500	1987.000	30.500	1981.100
GR	26.900	1970.000	22.800	2000.000	22.800	2008.000	29.700	2012.900	29.700	2013.000
GR	22.900	2020.000	30.000	2025.000	30.000	2070.000	32.200	2115.000	32.200	2170.000
GR	35.000	2310.000	40.000	2500.000	45.000	2650.000	50.000	2715.000	0.0	0.0
GR	0.000	11.500	0.0	0.0	16.000	0.0	152.000	0.0	22.800	22.800
ET	0.0	0.0	0.0	0.0	0.0	0.0	8.110	1992.000	2008.000	0.0

(N) SURVEYED SECTION U/S FACE LR9-S

XI	23466.000	0.0	0.0	0.0	34.000	34.000	34.000	0.0	0.0	0.0
XS	0.0	0.0	1.000	32.300	34.400	0.0	0.0	0.0	0.0	0.0
GR	10.000	0.0	0.0	0.0	0.0	0.0	32.300	34.300	34.300	0.0
BT	13.000	1900.000	40.000	0.0	1987.000	32.300	0.0	1987.100	34.400	0.0
BT	1992.000	36.700	32.300	2000.000	36.600	32.300	2008.000	36.400	32.300	2012.900
BT	32.400	0.0	2012.900	32.900	32.900	2070.000	32.300	2120.000	2070.000	32.400
BT	0.0	2120.000	34.400	0.0	2170.000	32.900	0.0	2310.000	35.000	0.0
ET	0.0	0.0	0.0	0.0	0.0	8.410	8.110	1770.000	2010.000	0.0

(O) SURVEYED SECTION U/S LR9-S

XI	23566.000	15.000	1990.000	2010.000	100.000	100.000	100.000	0.0	0.0	0.0
GR	50.000	1635.000	40.000	1705.000	30.000	1745.000	25.200	1780.000	25.200	1820.000
GR	25.200	1856.000	26.400	1923.000	25.200	1990.000	16.200	2000.000	26.200	2010.000
GR	30.000	2030.000	35.000	2050.000	40.000	2130.000	45.000	2380.000	50.000	2470.000
NC	0.080	0.080	0.040	0.100	0.300	0.0	0.0	0.0	0.0	0.0
ET	0.0	0.0	0.0	0.0	0.0	0.0	8.110	1775.000	2130.000	0.0

SCALED SECTION

XI	24666.000	10.000	1985.000	2015.000	1000.000	1150.000	1100.000	0.0	0.0	0.0
GR	60.000	1525.000	45.000	1665.000	40.000	1635.000	30.000	1665.000	30.000	1755.000
GR	28.400	1985.000	22.400	2000.000	28.400	2015.000	25.000	2175.000	40.000	2195.000
GR	0.000	660.000	1065.000	1275.000	1865.000	1275.000	1275.000	1275.000	1275.000	1275.000
ET	0.0	0.0	0.0	0.0	0.0	0.0	8.110	1588.000	2128.000	0.0

SCALED SECTION

XI	25966.000	9.000	1988.000	2012.000	1200.000	1300.000	1300.000	0.0	0.0	0.0
GR	50.000	1938.000	32.000	1988.000	26.000	2000.000	32.000	2012.000	30.000	2140.000
GR	35.000	2200.000	40.000	2210.000	48.000	2300.000	50.000	2450.000	0.0	0.0
ET	0.0	0.0	0.0	0.0	0.0	0.0	8.110	1940.000	2080.000	0.0

SCALED SECTION

XI	27116.000	7.000	1989.000	2011.000	1250.000	1100.000	1150.000	0.0	0.0	0.0
GR	50.000	1835.000	35.000	1910.000	34.900	1989.000	28.900	2000.000	34.900	2010.000
GR	35.000	2110.000	50.000	2220.000	0.0	0.0	0.0	0.0	0.0	0.0
ET	0.0	0.0	0.0	0.0	0.0	0.0	8.110	1900.000	2040.000	0.0

(P) SURVEYED SECTION AT DAM LR10

X1	28266.000	15.000	1987.500	2013.500	1200.000	1400.000	1110.000	0.0	0.0	0.0	
GR	45.800	1862.000	42.400	1984.500	35.500	1827.500	34.100	1932.500	33.200	194.500	
GR	34.100	1873.500	34.700	1985.500	33.500	1847.500	33.700	1600.000	33.500	1011.500	
GR	33.800	2016.500	33.400	2035.000	41.600	2057.500	41.000	1984.500	39.000	2180.000	
ET	0.0	0.0	0.0	0.0	0.0	0.0	8.110	1977.500	2022.500	0.0	

SCALED SECTION AT CITY LIMITS

X1	28406.000	9.000	1965.000	2035.000	130.000	150.000	190.000	0.0	0.0	0.0	
GR	50.000	1872.000	45.000	1965.000	40.000	1945.000	35.000	1965.000	32.000	2000.000	
GR	35.000	2035.000	40.000	2055.000	45.000	2085.000	50.000	2135.000	0.0	0.0	
ET	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

THIS RUN EXECUTED 05/07/81 16.15.30

```
HEC2 RELEASE DATED NOV 76 UPDATED JULY 1979
ERROR CODE =  01 02 03
MODIFICATION = 40 41 42 43 * * * * * 48
```

T1 HAVERHILL
T2 LITTLE RIVER
T3 ENCROACHMENT ANALYSIS

J1	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q		WSEL	FQ
	0.	6.	0.	0.	0.0	0.0	0.0	0.		1.600	0.0
J2	NPROF	IPLOT	PRFVS	XSECV	XSECH	FN	ALLDC	IBW		CHNIM	ITRACE
	2.000	0.0	-1.000	0.0	0.0	0.0	0.0	0.0		0.0	0.0

THIS RUN EXECUTED 05/07/81 16.15.39

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HEC2 RELEASE DATED NOV 76 UPDATED JULY 1979
ERROR CORR - 01.02.03
MODIFICATION - 50.51.52.53.*.*.*.*.*
```

T1 HAVERHILL
T2 LITTLE RIVER
T3 ENCROACHMENT ANALYSIS

J1	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
	0.	7.	0.	0.	0.0	0.0	0.0	0.	1.600	0.0
J2	NPROF	IPLOT	PRFVS	XSECV	XSECH	FN	ALLDC	IBW	CHNIM	ITRACE
	15.000	0.0	-1.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0

THIS RUN EXECUTED 05/07/81 16.15.53

HEC2 RELEASE DATED NOV 76 UPDATED JULY 1979
ENDDK CODE - 01,02,03
MODIFICATION - 50,51,52,53, *, *, *, *,98

NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

ENCROACHMENT ANALYSIS

SUMMARY PRINTOUT TABLE 110

	SECNO	CWSEL	DIFKWS	EG	TOPWID	QLOB	QCH	QROB	PERENC	STENCL	STCHL	STCHR	STENCR
*	8225.000	1.60	0.0	1.75	524.00	960.68	408.64	960.68	0.0	0.0	1984.00	2016.00	0.0
	8225.000	1.60	0.0	1.75	524.00	960.68	408.64	960.68	0.0	0.0	1984.00	2016.00	0.0
	8225.000	1.60	0.0	1.75	524.00	960.68	408.64	960.68	0.0	0.0	1984.00	2016.00	0.0
*	8235.000	4.22	0.0	6.97	33.00	0.0	2330.00	0.0	0.0	0.0	1984.00	2016.00	0.0
*	8235.000	4.22	0.0	6.97	33.00	0.0	2330.00	0.0	0.0	0.0	1984.00	2016.00	0.0
*	8235.000	4.22	0.00	6.97	32.00	0.0	2330.00	0.0	32.00	1984.00	1984.00	2016.00	2016.00
	10000.000	16.47	0.0	17.95	33.20	0.0	2330.00	0.0	0.0	0.0	1983.40	2016.60	0.0
	10000.000	16.47	0.0	17.95	33.20	0.0	2330.00	0.0	0.0	0.0	1983.40	2016.60	0.0
	10000.000	17.00	0.53	18.37	33.20	0.0	2330.00	0.0	33.00	1983.00	1983.40	2016.60	2017.00
	10050.000	17.66	0.0	18.29	50.31	216.79	1986.53	132.98	0.0	0.0	1984.00	2014.00	0.0
	10050.000	17.66	0.0	18.29	50.31	216.79	1986.53	132.98	0.0	0.0	1984.00	2014.00	0.0
	10050.000	18.12	0.46	18.68	50.42	227.31	1961.09	131.60	51.00	1973.00	1984.00	2014.00	2024.00
	10480.000	18.33	0.0	18.67	47.42	0.0	2330.00	0.0	0.0	0.0	1972.00	2020.00	0.0
	10480.000	18.33	0.0	18.67	47.42	0.0	2330.00	0.0	0.0	0.0	1972.00	2020.00	0.0
	10480.000	18.80	0.47	19.00	47.48	0.0	2330.00	0.0	48.00	1972.00	1972.00	2020.00	2020.00
	10530.000	17.82	0.0	19.20	28.00	0.0	2330.00	0.0	0.0	0.0	1986.00	2014.00	0.0
	10530.000	17.85	0.0	19.20	28.00	0.0	2330.00	0.0	0.0	0.0	1986.00	2014.00	0.0
	10530.000	18.23	0.41	19.49	28.00	0.0	2330.00	0.0	28.00	1986.00	1986.00	2014.00	2014.00
	10605.000	17.57	0.0	19.29	28.00	0.0	2330.00	0.0	0.0	0.0	1986.00	2014.00	0.0
	10605.000	17.57	0.0	19.29	28.00	0.0	2330.00	0.0	0.0	0.0	1986.00	2014.00	0.0
	10605.000	18.30	0.73	19.94	28.00	0.0	2330.00	0.0	28.00	1986.00	1986.00	2014.00	2014.00
	10640.000	20.54	0.0	20.69	65.09	0.0	2330.00	0.0	0.0	0.0	1972.90	2038.10	0.0
	10640.000	20.54	0.0	20.69	65.09	0.0	2330.00	0.0	0.0	0.0	1972.90	2038.10	0.0
	10640.000	20.25	-0.29	20.41	65.09	0.0	2330.00	0.0	67.00	1972.00	1972.90	2038.10	2039.00
	10674.000	20.58	0.0	20.70	75.09	0.0	2330.00	0.0	0.0	0.0	1959.90	2035.10	0.0
	10674.000	20.58	0.0	20.70	75.09	0.0	2330.00	0.0	0.0	0.0	1959.90	2035.10	0.0
	10674.000	20.36	-0.29	20.42	75.09	0.0	2330.00	0.0	77.00	1959.00	1959.90	2035.10	2036.00
*	10675.000	22.60	0.0	24.16	75.05	0.0	2330.00	0.0	0.0	0.0	1959.90	2035.10	0.0
*	10675.000	22.60	0.0	24.16	75.05	0.0	2330.00	0.0	0.0	0.0	1959.90	2035.10	0.0
*	10675.000	22.60	0.00	24.16	75.05	0.0	2330.00	0.0	77.00	1959.00	1959.90	2035.10	2036.00

SECND	CWSEL	DIFKWS	EG	TOPWID	QLOB	QCH	QROB	PERENC	STENCL	STCHL	STCHR	STENCR
10676.000	23.76	0.0	24.27	75.08	0.0	2330.00	0.0	0.0	0.0	1959.90	2035.10	0.0
10676.000	23.76	-0.0	24.27	75.08	0.0	2330.00	0.0	0.0	0.0	1959.90	2035.10	0.0
10676.000	23.76	-0.00	24.27	75.08	0.0	2330.00	0.0	77.0c	1959.00	1959.90	2035.10	2036.00
10775.000	23.92	-0.0	24.42	75.08	0.0	2330.00	0.0	0.0	0.0	1959.90	2035.10	0.0
10775.000	23.92	-0.00	24.42	75.08	0.0	2330.00	0.0	0.0	1959.90	1959.90	2035.10	0.0
10775.000	23.92	-0.00	24.42	75.08	0.0	2330.00	0.0	77.0c	1959.00	1959.90	2035.10	2036.00
11000.000	24.56	0.0	24.62	296.80	0.00	1773.63	556.36	0.0	0.0	1960.00	2030.00	0.0
11000.000	24.57	0.01	24.64	173.87	0.0	1735.96	667.67	0.02	1960.00	1960.00	2030.00	0.0
11000.000	24.57	0.01	24.66	125.00	0.0	1949.53	380.47	125.00	1960.00	1960.00	2030.00	2135.87
11600.000	24.78	0.0	24.83	149.04	14.56	2283.45	32.00	0.0	0.0	1940.00	2060.00	0.0
11600.000	24.81	0.03	24.87	132.76	0.0	2323.47	6.53	0.02	1940.00	1940.00	2060.00	0.0
11600.000	24.81	0.08	24.90	125.00	0.0	2315.89	14.11	125.00	1940.00	1940.00	2060.00	2089.00
12255.000	25.00	0.0	25.06	151.01	32.09	2292.05	5.86	0.0	0.0	1920.00	2045.00	0.0
12255.000	25.06	0.06	25.13	132.83	0.0	2333.00	0.0	0.02	1920.00	1920.00	2045.00	0.0
12255.000	25.09	0.10	25.16	125.00	0.0	2330.00	0.0	125.00	1920.00	1920.00	2045.00	2045.00
13100.000	25.42	0.0	25.49	144.35	27.58	2297.91	4.51	0.0	0.0	1920.00	2045.00	0.0
13100.000	25.46	0.11	25.59	125.00	0.0	2330.00	0.0	0.01	1920.00	1920.00	2045.00	0.0
13100.000	25.53	0.13	25.63	125.00	0.0	2330.00	0.0	125.00	1920.00	1920.00	2045.00	2045.00
14000.000	25.96	0.0	26.04	276.40	416.52	1815.99	95.19	0.0	0.0	1960.00	2040.00	0.0
14000.000	26.08	0.13	26.18	190.07	405.19	1824.80	79.11	0.02	1868.24	1960.00	2040.00	2082.31
14000.000	26.10	0.14	26.18	193.00	411.98	1836.94	87.08	193.00	1868.00	1960.00	2040.00	2082.31
14200.000	26.07	0.0	26.11	282.62	103.43	2174.89	51.68	0.0	0.0	1925.00	2075.00	0.0
14200.000	26.40	0.12	26.45	197.45	86.93	2213.80	20.27	0.02	1892.84	1925.00	2075.00	2084.30
14200.000	26.52	0.14	26.59	190.00	87.03	2212.51	26.05	190.00	1893.00	1925.00	2075.00	2083.00
14300.000	26.01	0.0	26.27	133.86	266.40	1698.39	348.21	0.0	0.0	1983.00	2018.10	0.0
14300.000	26.13	0.12	26.40	92.00	272.66	1722.67	330.92	99.02	1952.75	1983.00	2018.10	2044.75
14300.000	26.15	0.14	26.41	95.00	262.81	1711.69	330.52	95.00	1950.00	1983.00	2018.10	2045.00
14340.000	27.11	0.0	27.21	144.31	320.94	1642.24	366.82	0.0	0.0	1983.00	2018.10	0.0
14340.000	27.31	0.19	27.43	92.00	292.88	1698.45	341.67	95.02	1952.75	1983.00	2018.10	2045.75
14340.000	27.33	0.19	27.43	95.00	305.38	1683.28	341.34	95.00	1950.00	1983.00	2018.10	2045.00
14420.000	27.36	0.0	27.39	293.69	90.96	1809.29	429.75	0.0	0.0	1944.00	2051.00	0.0
14420.000	27.48	0.12	27.52	161.69	0.0	2031.69	268.31	0.02	1944.00	1944.00	2051.00	0.0
14420.000	27.50	0.14	27.54	160.00	0.0	2038.87	261.13	160.00	1944.00	1944.00	2051.00	2105.00
15677.000	27.68	0.0	27.74	196.06	18.26	1535.55	776.19	0.0	0.0	1964.00	2025.00	0.0
15677.000	27.87	0.18	27.93	169.36	19.58	1714.66	615.34	0.02	1964.00	1964.00	2025.00	0.0
15677.000	27.88	0.20	27.95	169.36	19.58	1622.04	784.37	200.00	1950.00	1964.00	2025.00	2150.00
15697.000	27.69	0.0	27.75	196.10	18.39	1535.24	776.36	0.0	0.0	1964.00	2025.00	0.0
15697.000	27.92	0.23	27.98	169.40	19.23	1715.91	784.86	0.02	1964.00	1964.00	2025.00	0.0
15697.000	27.88	0.19	27.94	197.34	19.23	1555.91	784.86	200.00	1950.00	1964.00	2025.00	2150.00
15703.000	27.76	0.0	27.83	184.54	0.0	1543.34	784.66	0.0	0.0	1964.00	2025.00	0.0
15703.000	28.01	0.24	28.07	183.61	0.0	1532.99	797.01	0.02	1964.00	1964.00	2025.00	0.0
15703.000	27.97	0.20	28.03	185.43	0.0	1534.66	795.34	200.00	1950.00	1964.00	2025.00	2150.00

SECNO	CWSEL	DIFKWS	EG	TOPWID	QLOB	QCH	QROB	PERENC	STENCL	STCHL	STCHR	STENCR
15713.000	27.78	0.0	27.84	196.70	18.33	1530.62	780.46	0.0	0.0	1964.00	2025.00	0.0
15713.000	28.07	0.24	28.07	198.72	20.37	1610.83	740.17	0.0	0.0	1964.00	2025.00	0.0
15713.000	27.98	0.20	28.03	197.96	20.24	1621.15	788.24	200.00	1950.00	1964.00	2025.00	2150.00
16175.000	27.93	0.0	27.94	436.74	1385.07	860.34	84.58	0.0	0.0	1973.00	2031.00	0.0
16175.000	28.17	0.24	28.19	336.83	1392.75	937.52	0.0	0.14	1694.37	1973.00	2031.00	2031.00
16175.000	28.13	0.20	28.14	340.00	1348.51	980.28	1.21	340.00	1642.00	1973.00	2031.00	2032.00
16410.000	27.90	0.0	28.04	131.46	79.20	2162.19	88.60	0.0	0.0	1973.00	2031.00	0.0
16410.000	28.18	0.24	28.31	68.00	0.81	2320.92	0.84	0.09	1972.00	1973.00	2031.00	2031.00
16410.000	28.16	0.19	28.26	66.00	0.81	2320.92	0.84	66.00	1971.00	1973.00	2031.00	2032.00
17680.000	28.29	0.0	28.31	829.28	501.59	834.25	994.15	0.0	0.0	1973.00	2031.00	0.0
17680.000	28.63	0.34	28.66	354.79	430.94	961.31	437.65	0.17	1805.79	1973.00	2031.00	2160.26
17680.000	28.56	0.26	28.58	355.00	429.45	964.32	436.24	355.00	1803.00	1973.00	2031.00	2160.26
19140.000	28.44	0.0	28.78	69.77	0.0	2330.00	0.0	0.0	0.0	1967.00	2048.00	0.0
19140.000	28.76	0.32	29.16	71.57	0.0	2330.00	0.0	0.0	1967.00	1967.00	2048.00	2048.00
19140.000	28.69	0.26	29.10	71.57	0.0	2330.00	0.0	65.00	1965.00	1967.00	2048.00	2050.00
19225.000	28.62	0.0	28.94	279.29	61.36	2268.64	0.0	0.0	0.0	1967.00	2048.00	0.0
19225.000	28.99	0.37	29.50	71.02	0.0	2330.00	0.0	0.07	1967.00	1967.00	2048.00	2048.00
19225.000	28.93	0.31	29.25	70.77	0.0	2330.00	0.0	65.00	1965.00	1967.00	2048.00	2050.00
19310.000	28.52	0.0	29.29	57.43	42.13	2199.88	87.99	0.0	0.0	1984.00	2016.00	0.0
19310.000	28.90	0.38	29.73	32.00	0.0	2330.00	0.0	0.06	1984.00	1984.00	2016.00	2016.00
19310.000	28.84	0.32	29.67	32.00	0.0	2330.00	0.0	32.00	1984.00	1984.00	2016.00	2016.00
19430.000	28.78	0.0	29.55	56.64	40.32	2204.54	85.14	0.0	0.0	1984.00	2016.00	0.0
19430.000	29.32	0.54	30.14	32.00	0.0	2330.00	0.0	0.06	1984.00	1984.00	2016.00	2016.00
19430.000	29.27	0.49	30.09	32.00	0.0	2330.00	0.0	32.00	1984.00	1984.00	2016.00	2016.00
19550.000	29.02	0.0	29.84	55.92	36.70	2208.78	82.55	0.0	0.0	1984.00	2016.00	0.0
19550.000	29.74	0.71	30.57	32.00	0.0	2330.00	0.0	0.06	1984.00	1984.00	2016.00	2016.00
19550.000	29.69	0.67	30.52	32.00	0.0	2330.00	0.0	32.00	1984.00	1984.00	2016.00	2016.00
19600.000	29.31	0.0	29.98	60.60	66.09	2122.63	141.28	0.0	0.0	1985.00	2015.00	0.0
19600.000	30.18	0.88	30.74	63.66	74.51	2103.51	151.99	0.0	0.0	1985.00	2015.00	0.0
19600.000	30.16	0.83	30.71	63.48	74.01	2104.22	151.36	65.00	1971.00	1985.00	2015.00	2036.00
19606.000	29.04	0.0	30.28	58.05	92.69	2111.36	125.96	0.0	0.0	1985.00	2015.00	0.0
19606.000	30.00	0.96	30.98	61.77	103.61	2084.56	140.72	0.0	0.0	1985.00	2015.00	0.0
19606.000	29.92	0.92	30.92	61.70	103.30	2086.16	140.09	65.00	1971.00	1985.00	2015.00	2036.00
19612.000	29.39	0.0	30.39	59.63	99.46	2113.47	126.87	0.0	0.0	1985.00	2015.00	0.0
19612.000	30.30	0.91	31.01	62.66	98.22	2093.02	138.76	0.0	0.0	1985.00	2015.00	0.0
19612.000	30.16	0.77	30.98	62.54	97.89	2093.86	138.28	65.00	1971.00	1985.00	2015.00	2036.00
20415.000	30.88	0.0	30.91	688.85	1202.27	763.49	24.24	0.0	0.0	1981.00	2020.00	0.0
20415.000	31.36	0.49	31.38	713.51	1238.83	727.17	24.01	0.0	0.0	1981.00	2020.00	0.0
20415.000	31.36	0.47	31.38	714.89	1239.09	725.80	24.01	725.00	1327.00	1981.00	2020.00	2052.00
21212.000	31.04	0.0	31.08	666.27	1173.88	792.94	23.17	0.0	0.0	1981.00	2020.00	0.0
21212.000	31.51	0.46	31.53	696.79	1211.62	755.74	24.04	0.0	0.0	1981.00	2020.00	0.0
21212.000	31.48	0.44	31.51	695.00	1209.54	756.91	24.55	700.00	1348.00	1981.00	2020.00	2048.00

	SECNO	CWSEL	DIFKWS	EG	TOPWID	QLOB	QCH	QROB	PERENC	STENCL	STCHL	STCHR	STENCR
	23012.000	31.66	0.0	31.74	503.06	265.65	870.62	853.73	0.0	0.0	1982.00	2018.00	0.0
	23013.000	31.98	0.32	32.05	517.23	268.74	934.86	886.40	0.0	0.0	1982.00	2018.00	0.0
	23012.000	31.96	0.30	32.03	516.37	268.57	836.92	884.51	520.00	1902.00	1982.00	2018.00	2422.00
	23332.000	31.79	0.0	32.14	158.79	193.67	1733.83	62.50	0.0	0.0	1975.00	2025.00	0.0
	23332.000	32.07	0.28	32.43	160.91	201.77	1814.80	64.34	0.0	0.0	1975.00	2025.00	0.0
	23332.000	32.06	0.26	32.38	160.47	200.47	1716.93	64.13	165.00	1880.00	1975.00	2025.00	2051.00
*	23432.000	30.58	0.0	34.52	16.00	0.0	1990.00	0.0	0.0	0.0	1992.00	2008.00	0.0
*	23432.000	30.59	0.01	34.52	16.00	0.0	1990.00	0.0	0.0	0.0	1992.00	2008.00	0.0
	23432.000	30.63	0.05	34.51	16.00	0.0	1990.00	0.0	16.00	1992.00	1992.00	2008.00	2008.00
	23466.000	31.24	0.0	34.60	16.00	0.0	1990.00	0.0	0.0	0.0	1992.00	2008.00	0.0
	23466.000	31.27	0.03	34.59	16.00	0.0	1990.00	0.0	0.0	0.0	1992.00	2008.00	0.0
	23466.000	31.63	0.39	34.58	16.00	0.0	1990.00	0.0	16.00	1992.00	1992.00	2008.00	2008.00
	23566.000	35.61	0.0	35.62	339.14	1402.51	495.06	92.43	0.0	0.0	1990.00	2010.00	0.0
	23566.000	35.63	0.02	35.64	259.07	1225.44	464.56	0.0	0.12	1770.93	1990.00	2010.00	2010.00
	23566.000	35.67	0.07	35.69	240.00	1527.52	462.48	0.0	240.00	1770.00	1990.00	2010.00	2010.00
	24666.000	35.71	0.0	35.72	508.49	931.93	455.37	602.70	0.0	0.0	1985.00	2015.00	0.0
	24666.000	35.76	0.05	35.77	360.10	936.76	453.47	525.17	177.85	1775.00	1985.00	2015.00	2132.04
	24666.000	35.80	0.09	35.82	355.00	925.73	536.98	520.29	359.00	1775.00	1985.00	2015.00	2130.00
	25966.000	35.85	0.0	35.89	224.38	11.56	416.34	847.10	0.0	0.0	1988.00	2012.00	0.0
	25966.000	35.95	0.10	36.02	144.90	0.0	490.66	784.34	0.22	1988.00	1988.00	2012.00	2132.50
	25966.000	35.99	0.15	36.07	140.00	0.0	505.83	769.17	140.00	1988.00	1988.00	2012.00	2128.50
	27116.000	36.72	0.0	37.09	221.26	261.24	684.55	329.21	0.0	0.0	1989.00	2011.00	0.0
	27116.000	37.17	0.44	37.20	80.00	110.00	729.57	284.18	0.36	1968.48	1989.00	2011.00	2028.45
	27116.000	37.29	0.57	37.37	140.00	220.42	742.26	312.31	140.00	1940.00	1989.00	2011.00	2020.00
	28266.000	38.71	0.0	38.80	154.42	951.36	532.85	190.79	0.0	0.0	1987.50	2013.50	0.0
	28266.000	39.61	0.90	39.73	99.58	549.88	655.11	70.00	0.22	1923.60	1987.50	2013.50	2023.18
	28266.000	39.04	0.32	39.12	140.00	550.65	537.26	187.09	140.00	1900.00	1987.50	2013.50	2040.00
	28406.000	38.77	0.0	38.94	100.16	23.42	1226.16	23.42	0.0	0.0	1965.00	2035.00	0.0
	28406.000	39.49	0.72	39.63	79.00	0.0	1274.00	0.0	0.03	1969.00	1969.00	2035.00	2035.00
	28406.000	39.99	0.22	39.34	47.00	0.0	1275.00	0.0	45.00	1977.50	1965.00	2035.00	2022.50

SUMMARY OF ERRORS

CAUTION SECNO= 8225.000 PROFILE= 1 BRIDGE DECK DEFINITION ERROR

CAUTION SECNO= 8235.000 PROFILE= 1 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 8235.000 PROFILE= 1 PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO= 8235.000 PROFILE= 1 20 TRIALS ATTEMPTED TO BALANCE WSEL
CAUTION SECNO= 8235.000 PROFILE= 2 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 8235.000 PROFILE= 2 PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO= 8235.000 PROFILE= 2 20 TRIALS ATTEMPTED TO BALANCE WSEL
CAUTION SECNO= 8235.000 PROFILE= 3 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 8235.000 PROFILE= 3 PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO= 8235.000 PROFILE= 3 20 TRIALS ATTEMPTED TO BALANCE WSEL

CAUTION SECNO=10675.000 PROFILE= 1 CRITICAL DEPTH ASSUMED
CAUTION SECNO=10675.000 PROFILE= 1 PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=10675.000 PROFILE= 1 20 TRIALS ATTEMPTED TO BALANCE WSEL

FLOODWAY DATA
PROFILE NO. 2 ENCROACHMENT ANALYSIS

STATION	WIDTH (FT)	FLOODWAY SECTION AREA	MEAN VELOCITY	WATER SURFACE ELEVATION WITH FLOODWAY	WITHOUT FLOODWAY	DIFFERENCE
8225.000	524.	780.	3.0	1.6	1.6	0.0
8235.000	32.	175.	13.3	4.2	4.2	0.0
10000.000	33.	138.	7.8	16.5	16.5	0.0
10040.000	50.	584.	1.1	17.1	17.1	0.0
10480.000	47.	441.	5.3	16.2	16.2	0.0
10530.000	28.	247.	12.4	17.8	17.8	0.0
10605.000	28.	187.	12.5	17.8	17.8	0.0
10640.000	65.	737.	3.2	17.0	17.0	0.0
10674.000	79.	847.	3.8	20.2	20.2	0.0
10675.000	79.	232.	16.0	20.6	20.6	0.0
10676.000	79.	410.	9.7	22.6	22.6	0.0
10775.000	76.	410.	9.7	23.8	23.8	0.0
11000.000	176.	1397.	1.7	23.9	23.9	0.0
11600.000	123.	1266.	1.8	24.8	24.8	0.0
12255.000	158.	1116.	1.9	25.1	25.0	0.1
13100.000	150.	1048.	1.9	25.6	25.4	0.1
14005.000	166.	1260.	1.6	26.2	26.0	0.1
14200.000	191.	1687.	1.4	26.2	26.0	0.1
14300.000	92.	700.	3.3	26.1	26.0	0.1
14350.000	92.	771.	3.0	27.5	27.1	0.1
14450.000	161.	1566.	1.5	27.5	27.1	0.1
15677.000	133.	1336.	1.5	28.0	27.7	0.2
16097.000	168.	1569.	1.5	27.9	27.7	0.2
16703.000	180.	1557.	1.5	28.0	27.8	0.2
16715.000	186.	1591.	1.5	28.0	27.8	0.2
16775.000	337.	2604.	0.8	28.1	27.9	0.2
16910.000	69.	778.	0.8	28.1	27.9	0.2
17680.000	358.	2702.	0.8	28.1	27.9	0.2
18150.000	77.	505.	4.4	28.6	28.3	0.3
18225.000	71.	516.	4.3	28.6	28.4	0.3
19310.000	32.	332.	7.5	28.6	28.6	0.4
19430.000	32.	332.	7.5	28.9	28.5	0.4
19480.000	32.	321.	7.8	29.3	28.8	0.5
19560.000	32.	320.	7.8	29.5	29.0	0.5
19600.000	64.	508.	4.9	30.2	29.5	0.7
19606.000	63.	416.	6.0	30.0	29.4	0.6
19615.000	63.	416.	6.0	30.0	29.4	0.6
20515.000	760.	3284.	0.6	31.4	30.9	0.5
21274.000	700.	3016.	0.7	32.0	31.5	0.5
23015.000	617.	1825.	1.1	33.0	32.5	0.5
23335.000	165.	698.	2.7	32.0	31.7	0.3
23435.000	16.	128.	3.4	32.1	31.8	0.3
23466.000	16.	136.	14.7	31.9	31.9	0.0
23566.000	230.	2615.	0.8	32.5	32.5	0.0
24666.000	550.	2605.	0.8	32.5	32.5	0.0
25066.000	144.	757.	1.7	35.9	35.7	0.2
27116.000	86.	267.	4.7	36.0	35.8	0.2
28266.000	100.	607.	2.1	39.1	38.7	0.4
28406.000	70.	434.	2.9	39.7	38.8	0.9

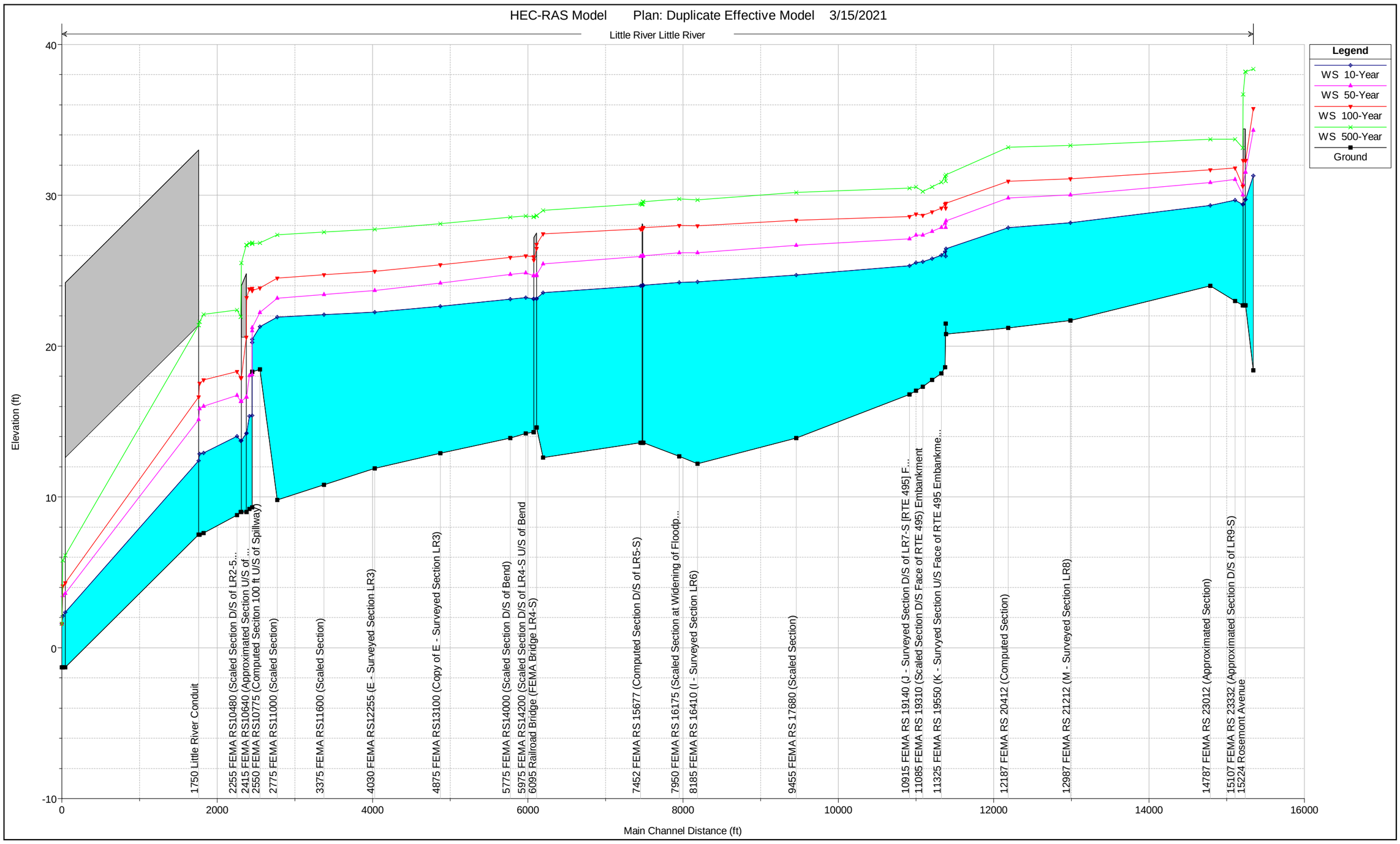
FLOODWAY DATA - ENCROACHMENT ANALYSIS
PROFILE NO. 3

STATION	FLOODWAY WIDTH (FT)	FLOODWAY SECTION AREA	MEAN VELOCITY	WATER SURFACE ELEVATION WITH FLOODWAY	WITHOUT FLOODWAY	DIFFERENCE
8225.000	*24.	780.	3.0	1.6	1.6	0.0
8236.000	33.	175.	13.3	4.2	4.2	0.0
10000.000	35.	248.	9.4	17.5	16.5	0.9
10007.000	51.	407.	5.7	18.2	17.7	0.5
10486.000	27.	456.	5.1	18.6	18.2	0.4
10530.000	26.	256.	9.0	18.2	17.8	0.4
10605.000	28.	476.	10.3	18.3	17.6	0.7
10640.000	63.	719.	4.5	20.3	20.4	-0.2
10674.000	76.	825.	3.8	20.4	20.6	-0.2
10675.000	75.	253.	10.0	25.6	25.6	0.0
10676.000	75.	410.	5.7	25.6	25.6	0.0
10738.000	75.	411.	5.7	23.9	23.9	0.0
11000.000	125.	1148.	1.6	24.6	24.6	0.0
11600.000	136.	1264.	1.8	24.9	24.8	0.1
11986.000	126.	1151.	1.7	25.1	25.0	0.1
13100.000	158.	1053.	1.5	25.9	25.8	0.1
14000.000	196.	1293.	1.8	26.1	26.0	0.1
14200.000	196.	1684.	1.3	26.2	26.1	0.1
14300.000	99.	714.	1.5	26.2	26.1	0.1
14320.000	99.	788.	1.3	26.4	26.3	0.1
14420.000	160.	1540.	1.0	27.2	27.1	0.1
15677.000	197.	1563.	1.6	27.5	27.4	0.1
15907.000	197.	1624.	1.5	27.9	27.7	0.2
16203.000	189.	1524.	1.6	28.0	27.8	0.2
16713.000	198.	1563.	1.6	28.0	27.8	0.2
16776.000	340.	2817.	0.9	28.1	27.9	0.2
16810.000	60.	761.	3.9	28.1	27.9	0.2
17680.000	357.	2628.	0.8	28.6	28.3	0.3
18154.000	71.	920.	4.3	28.8	28.4	0.4
18235.000	71.	612.	4.5	28.9	28.6	0.3
18310.000	35.	330.	7.3	28.8	28.5	0.3
18430.000	35.	330.	7.3	28.8	28.5	0.3
18480.000	34.	316.	7.3	29.7	29.0	0.7
18660.000	63.	605.	4.1	30.1	29.8	0.3
15606.000	62.	383.	6.6	29.6	29.0	0.6
19015.000	60.	417.	6.6	30.2	29.4	0.8
20411.000	720.	3266.	0.6	31.4	30.9	0.5
21215.000	698.	3997.	0.7	31.4	31.0	0.4
23010.000	216.	1012.	2.1	32.0	31.7	0.3
23335.000	104.	640.	3.1	32.1	31.8	0.3
23432.000	14.	146.	15.8	30.6	30.6	0.0
23464.000	14.	146.	15.8	30.6	30.6	0.0
23566.000	240.	2536.	0.8	34.7	33.9	0.8
24666.000	150.	2456.	0.8	35.8	35.7	0.1
25966.000	140.	734.	1.7	38.9	38.7	0.2
27116.000	140.	367.	3.5	37.3	36.7	0.6
28026.000	140.	733.	1.7	39.0	38.7	0.3
28406.000	48.	271.	4.7	39.0	38.8	0.2

Attachment 6

Duplicate Effective Model HEC-RAS Profile and Output Summary

HEC-RAS Model Plan: Duplicate Effective Model 3/15/2021



HEC-RAS Plan: DuplicateEffModel River: Little River Reach: Little River

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Vel Chnl
			(cfs)	(ft)	(ft)	(ft)	(ft/s)
Little River	15341	10-Year	980.00	18.40	31.31	12.91	1.47
Little River	15341	50-Year	1640.00	18.40	34.31	15.91	1.61
Little River	15341	100-Year	1990.00	18.40	35.75	17.35	1.66
Little River	15341	500-Year	3030.00	18.40	38.37	19.97	1.97
Little River	15241	10-Year	980.00	22.70	29.73	7.03	8.81
Little River	15241	50-Year	1640.00	22.70	31.54	8.84	11.70
Little River	15241	100-Year	1990.00	22.70	32.30	9.60	13.05
Little River	15241	500-Year	3030.00	22.70	38.18	15.48	4.81
Little River	15224		Bridge				
Little River	15207	10-Year	980.00	22.70	29.40	6.70	9.24
Little River	15207	50-Year	1640.00	22.70	30.03	7.33	14.12
Little River	15207	100-Year	1990.00	22.70	30.61	7.91	15.88
Little River	15207	500-Year	3030.00	22.70	33.15	10.45	18.25
Little River	15107	10-Year	980.00	23.00	29.68	6.68	3.97
Little River	15107	50-Year	1640.00	23.00	31.06	8.06	4.86
Little River	15107	100-Year	1990.00	23.00	31.81	8.81	5.09
Little River	15107	500-Year	3030.00	23.00	33.71	10.71	5.61
Little River	14787	10-Year	980.00	24.00	29.32	5.32	3.43
Little River	14787	50-Year	1640.00	24.00	30.84	6.84	3.54
Little River	14787	100-Year	1990.00	24.00	31.69	7.69	3.35
Little River	14787	500-Year	3030.00	24.00	33.73	9.73	3.17
Little River	12987	10-Year	980.00	21.70	28.17	6.47	2.42
Little River	12987	50-Year	1640.00	21.70	30.04	8.34	2.40
Little River	12987	100-Year	1990.00	21.70	31.09	9.39	2.26
Little River	12987	500-Year	3030.00	21.70	33.31	11.61	2.23
Little River	12187	10-Year	980.00	21.20	27.86	6.66	2.28
Little River	12187	50-Year	1640.00	21.20	29.83	8.63	2.23
Little River	12187	100-Year	1990.00	21.20	30.94	9.74	2.10
Little River	12187	500-Year	3030.00	21.20	33.20	12.00	2.09
Little River	11387	10-Year	1160.00	20.80	26.45	5.65	6.67
Little River	11387	50-Year	1920.00	20.80	28.31	7.51	8.05
Little River	11387	100-Year	2330.00	20.80	29.48	8.68	8.30
Little River	11387	500-Year	3520.00	20.80	31.36	10.56	10.03
Little River	11381	10-Year	1160.00	21.50	25.96	4.46	8.27
Little River	11381	50-Year	1920.00	21.50	27.87	6.37	9.32
Little River	11381	100-Year	2330.00	21.50	29.15	7.65	9.24
Little River	11381	500-Year	3520.00	21.50	30.95	9.45	11.04
Little River	11375	10-Year	1160.00	18.60	26.26	7.66	5.02
Little River	11375	50-Year	1920.00	18.60	28.17	9.57	6.45
Little River	11375	100-Year	2330.00	18.60	29.41	10.81	6.80
Little River	11375	500-Year	3520.00	18.60	31.26	12.66	8.56
Little River	11325	10-Year	1160.00	18.20	26.03	7.83	5.62
Little River	11325	50-Year	1920.00	18.20	27.87	9.67	7.08
Little River	11325	100-Year	2330.00	18.20	29.14	10.94	7.34
Little River	11325	500-Year	3520.00	18.20	30.87	12.67	9.21

HEC-RAS Plan: DuplicateEffModel River: Little River Reach: Little River (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Vel Chnl
			(cfs)	(ft)	(ft)	(ft)	(ft/s)
Little River	11205	10-Year	1160.00	17.75	25.80	8.05	5.42
Little River	11205	50-Year	1920.00	17.75	27.60	9.85	6.91
Little River	11205	100-Year	2330.00	17.75	28.90	11.15	7.17
Little River	11205	500-Year	3520.00	17.75	30.56	12.81	9.09
Little River	11085	10-Year	1160.00	17.30	25.59	8.29	5.22
Little River	11085	50-Year	1920.00	17.30	27.35	10.05	6.74
Little River	11085	100-Year	2330.00	17.30	28.68	11.38	6.98
Little River	11085	500-Year	3520.00	17.30	30.26	12.96	8.95
Little River	11000	10-Year	1160.00	17.05	25.54	8.49	3.90
Little River	11000	50-Year	1920.00	17.05	27.36	10.31	4.72
Little River	11000	100-Year	2330.00	17.05	28.76	11.71	4.50
Little River	11000	500-Year	3520.00	17.05	30.56	13.51	4.69
Little River	10915	10-Year	1160.00	16.80	25.34	8.54	3.87
Little River	10915	50-Year	1920.00	16.80	27.11	10.31	4.72
Little River	10915	100-Year	2330.00	16.80	28.59	11.79	4.27
Little River	10915	500-Year	3520.00	16.80	30.47	13.67	3.78
Little River	9455	10-Year	1160.00	13.90	24.72	10.82	1.46
Little River	9455	50-Year	1920.00	13.90	26.69	12.79	1.52
Little River	9455	100-Year	2330.00	13.90	28.36	14.46	1.34
Little River	9455	500-Year	3520.00	13.90	30.19	16.29	1.48
Little River	8185	10-Year	1160.00	12.20	24.25	12.05	2.35
Little River	8185	50-Year	1920.00	12.20	26.18	13.98	3.09
Little River	8185	100-Year	2330.00	12.20	27.97	15.77	3.10
Little River	8185	500-Year	3520.00	12.20	29.70	17.50	3.91
Little River	7950	10-Year	1160.00	12.70	24.22	11.52	1.29
Little River	7950	50-Year	1920.00	12.70	26.19	13.49	1.41
Little River	7950	100-Year	2330.00	12.70	28.00	15.30	1.28
Little River	7950	500-Year	3520.00	12.70	29.77	17.07	1.54
Little River	7488	10-Year	1160.00	13.60	24.03	10.43	1.91
Little River	7488	50-Year	1920.00	13.60	25.99	12.39	2.28
Little River	7488	100-Year	2330.00	13.60	27.86	14.26	2.16
Little River	7488	500-Year	3520.00	13.60	29.58	15.98	2.67
Little River	7478	10-Year	1160.00	13.60	24.02	10.42	1.92
Little River	7478	50-Year	1920.00	13.60	25.99	12.39	2.29
Little River	7478	100-Year	2330.00	13.60	27.85	14.25	2.16
Little River	7478	500-Year	3520.00	13.60	29.57	15.97	2.67
Little River	7475		Bridge				
Little River	7472	10-Year	1160.00	13.60	24.01	10.41	1.92
Little River	7472	50-Year	1920.00	13.60	25.95	12.35	2.30
Little River	7472	100-Year	2330.00	13.60	27.77	14.17	2.18
Little River	7472	500-Year	3520.00	13.60	29.44	15.84	2.71
Little River	7452	10-Year	1160.00	13.60	24.00	10.40	1.92
Little River	7452	50-Year	1920.00	13.60	25.94	12.34	2.30
Little River	7452	100-Year	2330.00	13.60	27.76	14.16	2.18

HEC-RAS Plan: DuplicateEffModel River: Little River Reach: Little River (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Vel Chnl
			(cfs)	(ft)	(ft)	(ft)	(ft/s)
Little River	7452	500-Year	3520.00	13.60	29.42	15.82	2.72
Little River	6195	10-Year	1160.00	12.60	23.55	10.95	1.33
Little River	6195	50-Year	1920.00	12.60	25.46	12.86	1.62
Little River	6195	100-Year	2330.00	12.60	27.44	14.84	1.52
Little River	6195	500-Year	3520.00	12.60	29.00	16.40	1.92
Little River	6115	10-Year	1160.00	14.60	23.15	8.55	4.43
Little River	6115	50-Year	1920.00	14.60	24.74	10.14	6.00
Little River	6115	100-Year	2330.00	14.60	26.75	12.15	5.93
Little River	6115	500-Year	3520.00	14.60	28.65	14.05	5.14
Little River	6095		Bridge				
Little River	6075	10-Year	1160.00	14.30	23.13	8.83	4.26
Little River	6075	50-Year	1920.00	14.30	24.68	10.38	5.84
Little River	6075	100-Year	2330.00	14.30	25.92	11.62	4.77
Little River	6075	500-Year	3520.00	14.30	28.57	14.27	4.97
Little River	5975	10-Year	1160.00	14.20	23.21	9.01	1.11
Little River	5975	50-Year	1920.00	14.20	24.87	10.67	1.44
Little River	5975	100-Year	2330.00	14.20	25.99	11.79	1.52
Little River	5975	500-Year	3520.00	14.20	28.64	14.44	1.69
Little River	5775	10-Year	1160.00	13.90	23.12	9.22	1.87
Little River	5775	50-Year	1920.00	13.90	24.75	10.85	2.35
Little River	5775	100-Year	2330.00	13.90	25.89	11.99	2.38
Little River	5775	500-Year	3520.00	13.90	28.55	14.65	2.46
Little River	4875	10-Year	1160.00	12.90	22.64	9.74	1.68
Little River	4875	50-Year	1920.00	12.90	24.18	11.28	2.16
Little River	4875	100-Year	2330.00	12.90	25.38	12.48	2.23
Little River	4875	500-Year	3520.00	12.90	28.12	15.22	2.48
Little River	4030	10-Year	1160.00	11.90	22.25	10.35	1.51
Little River	4030	50-Year	1920.00	11.90	23.68	11.78	2.01
Little River	4030	100-Year	2330.00	11.90	24.96	13.06	2.08
Little River	4030	500-Year	3520.00	11.90	27.76	15.86	2.33
Little River	3375	10-Year	1160.00	10.80	22.08	11.28	1.25
Little River	3375	50-Year	1920.00	10.80	23.43	12.63	1.75
Little River	3375	100-Year	2330.00	10.80	24.73	13.93	1.84
Little River	3375	500-Year	3520.00	10.80	27.56	16.76	2.10
Little River	2775	10-Year	1160.00	9.80	21.92	12.12	1.68
Little River	2775	50-Year	1920.00	9.80	23.17	13.37	2.29
Little River	2775	100-Year	2330.00	9.80	24.51	14.71	2.29
Little River	2775	500-Year	3520.00	9.80	27.38	17.58	2.40
Little River	2550	10-Year	1160.00	18.45	21.29	2.84	5.45
Little River	2550	50-Year	1920.00	18.45	22.23	3.78	6.76
Little River	2550	100-Year	2330.00	18.45	23.85	5.40	5.75
Little River	2550	500-Year	3520.00	18.45	26.85	8.40	5.39
Little River	2451	10-Year	1160.00	18.30	20.45	2.15	7.20
Little River	2451	50-Year	1920.00	18.30	21.23	2.93	8.74

HEC-RAS Plan: DuplicateEffModel River: Little River Reach: Little River (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Vel Chnl
			(cfs)	(ft)	(ft)	(ft)	(ft/s)
Little River	2451	100-Year	2330.00	18.30	23.70	5.40	5.75
Little River	2451	500-Year	3520.00	18.30	26.78	8.48	5.32
Little River	2450	10-Year	1160.00	18.30	20.25	1.95	7.93
Little River	2450	50-Year	1920.00	18.30	21.02	2.72	9.40
Little River	2450	100-Year	2330.00	18.30	23.69	5.39	5.76
Little River	2450	500-Year	3520.00	18.30	26.78	8.48	5.32
Little River	2449	10-Year	1160.00	9.30	15.40	6.10	2.53
Little River	2449	50-Year	1920.00	9.30	18.11	8.81	2.90
Little River	2449	100-Year	2330.00	9.30	23.83	14.53	2.14
Little River	2449	500-Year	3520.00	9.30	26.87	17.57	2.63
Little River	2415	10-Year	1160.00	9.20	15.36	6.16	2.90
Little River	2415	50-Year	1920.00	9.20	18.06	8.86	3.33
Little River	2415	100-Year	2330.00	9.20	23.80	14.60	2.45
Little River	2415	500-Year	3520.00	9.20	26.83	17.63	3.06
Little River	2380	10-Year	1160.00	9.00	14.23	5.23	7.92
Little River	2380	50-Year	1920.00	9.00	16.62	7.62	9.00
Little River	2380	100-Year	2330.00	9.00	23.22	14.22	5.85
Little River	2380	500-Year	3520.00	9.00	26.70	17.70	4.16
Little River	2342.5		Bridge				
Little River	2305	10-Year	1160.00	9.00	13.71	4.71	8.80
Little River	2305	50-Year	1920.00	9.00	16.33	7.33	9.36
Little River	2305	100-Year	2330.00	9.00	17.91	8.91	9.34
Little River	2305	500-Year	3520.00	9.00	21.94	12.94	9.72
Little River	2255	10-Year	1160.00	8.80	14.03	5.23	4.78
Little River	2255	50-Year	1920.00	8.80	16.73	7.93	5.20
Little River	2255	100-Year	2330.00	8.80	18.32	9.52	5.24
Little River	2255	500-Year	3520.00	8.80	22.40	13.60	5.47
Little River	1825	10-Year	1160.00	7.60	12.93	5.33	7.04
Little River	1825	50-Year	1920.00	7.60	16.01	8.41	6.89
Little River	1825	100-Year	2330.00	7.60	17.76	10.16	6.64
Little River	1825	500-Year	3520.00	7.60	22.10	14.50	6.33
Little River	1775 FEMA Section A	10-Year	1160.00	7.50	12.86	5.36	6.56
Little River	1775 FEMA Section A	50-Year	1920.00	7.50	15.86	8.36	6.95
Little River	1775 FEMA Section A	100-Year	2330.00	7.50	17.53	10.03	7.02
Little River	1775 FEMA Section A	500-Year	3520.00	7.50	21.62	14.12	7.53
Little River	1750		Bridge				
Little River	0010	10-Year	1160.00	-1.30	2.11	3.41	10.41
Little River	0010	50-Year	1920.00	-1.30	3.46	4.76	12.30
Little River	0010	100-Year	2330.00	-1.30	4.10	5.40	13.13
Little River	0010	500-Year	3520.00	-1.30	5.80	7.10	15.05
Little River	0	10-Year	1160.00	-1.30	1.60	2.90	2.23
Little River	0	50-Year	1920.00	-1.30	1.60	2.90	3.69
Little River	0	100-Year	2330.00	-1.30	1.60	2.90	4.48
Little River	0	500-Year	3520.00	-1.30	1.60	2.90	6.77

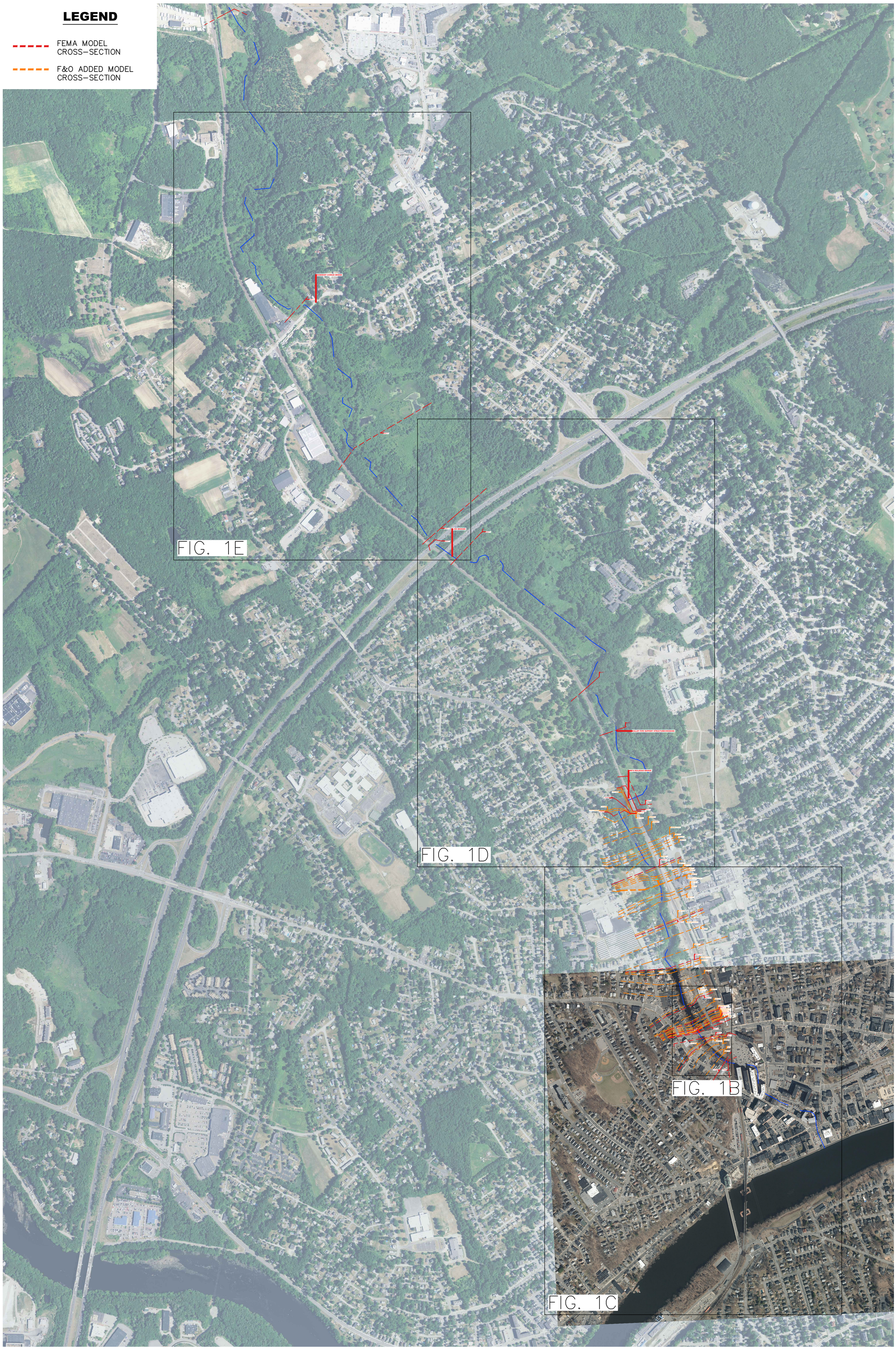
Attachment 7

Hydraulic Cross-Section Location Plans Including Bathymetric Topographic Information (Spot Elevations) Obtained from Field Investigations

LEGEND

FEMA MODEL CROSS–SECTION

F&O ADDED MODEL CROSS–SECTION



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MS VIEW: LAYER STATE: Plotter: NONE CTB File: FO.STB

PROJ. No.: 20170390U30
DATE: JUNE 2022

FIG. 1A

TOWN OF HAVERHILL

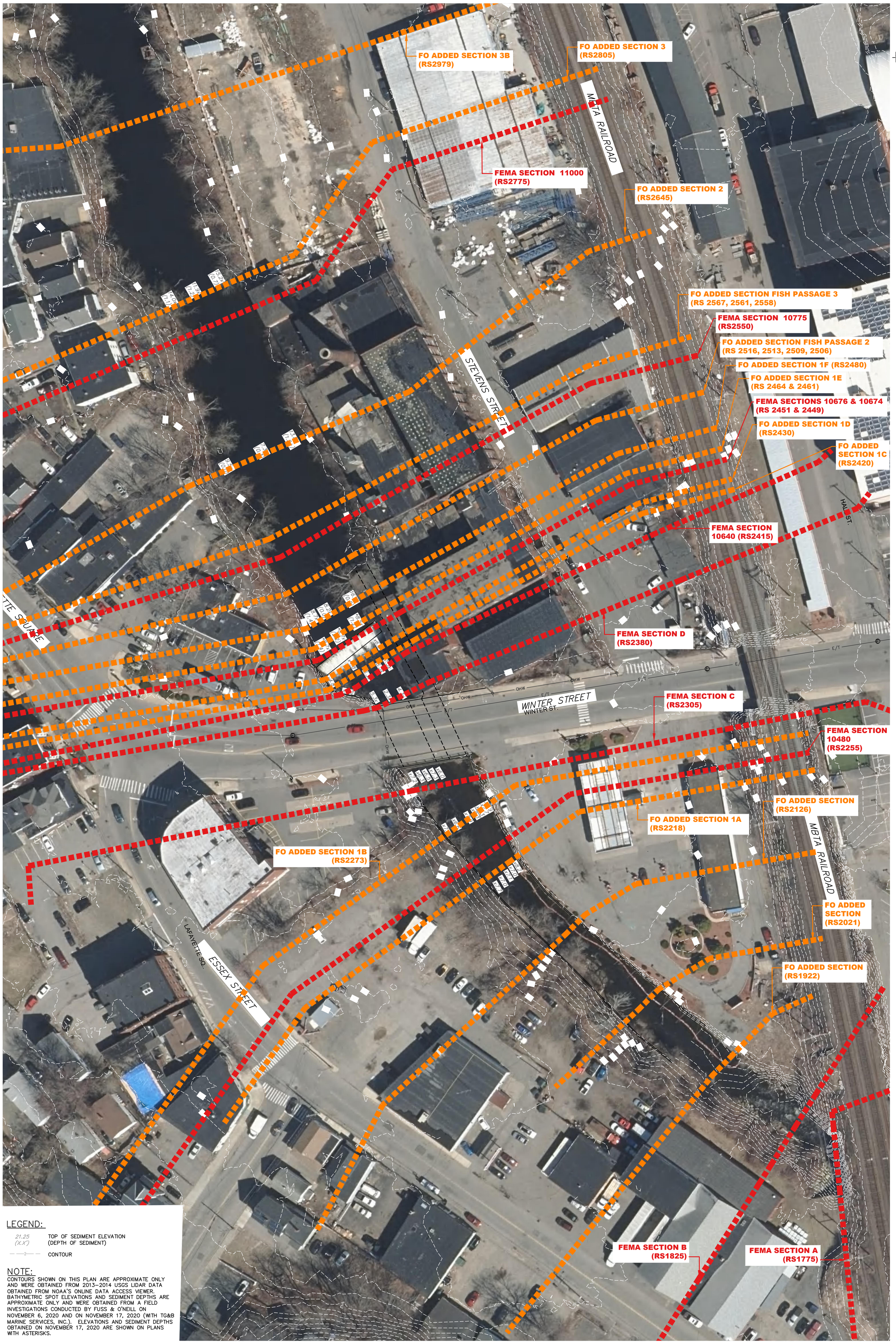
INDEX PLAN

HAVERHILL MASSACHUSETTS

FUSS & O'NEILL
317 IRON HORSE WAY, SUITE 204
PROVIDENCE, RI 02908
401.861.3070
www.fando.com

SCALE:
HORZ.: 1"= 600'
VERT.:
DATUM:
HORZ.:
VERT.:
600 300 0 600
GRAPHIC SCALE

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER



LEGEND:

21.25 (X.X') — TOP OF SEDIMENT ELEVATION (DEPTH OF SEDIMENT)

— —2— — CONTOUR

NOTE:

CONTOURS SHOWN ON THIS PLAN ARE APPROXIMATE ONLY AND WERE OBTAINED FROM 2013–2014 USGS LIDAR DATA OBTAINED FROM NOAA'S ONLINE DATA ACCESS VIEWER. BATHYMETRIC SPOT ELEVATIONS AND SEDIMENT DEPTHS ARE APPROXIMATE ONLY AND WERE OBTAINED FROM A FIELD INVESTIGATIONS CONDUCTED BY FUSS & O'NEILL ON NOVEMBER 6, 2020 AND ON NOVEMBER 17, 2020 (WITH TG&B MARINE SERVICES, INC.). ELEVATIONS AND SEDIMENT DEPTHS OBTAINED ON NOVEMBER 17, 2020 ARE SHOWN ON PLANS WITH ASTERISKS.

PROJ. No.: 20170390U30
DATE: JUNE 2022

FIG. 1B

TOWN OF HAVERHILL

CROSS SECTION LOCATION MAP NO. 1 CLOSE-UP AT DAM AREA

HAVERHILL MASSACHUSETTS

FUSS & O'NEILL
317 IRON HORSE WAY, SUITE 204
PROVIDENCE, RI 02908
401.861.3070
www.fando.com

SCALE:
HORZ.: 1"= 40'
VERT.:
DATUM:
HORZ.: NAD83
VERT.: NAVD88
40 20 0 40
GRAPHIC SCALE

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER

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MS VIEW: LAYER STATE: Plotter: NONE CTB File: FO.STB

File Path: J:\DWG\P2017\0390\U30\Civil\Figures\Hydraulic_Report_Cross_Section_Locations\20170390U20_EXC01_U30.dwg Layout: FIG 1C Plotted: Thu, June 09, 2022 - 12:27 PM User: cnauman
MS VIEW: LAYER STATE: Plotter: NONE CTB File: FO.STB

PROJ. No.: 20170390U30
DATE: JUNE 2022

FIG. 1C

TOWN OF HAVERHILL

CROSS SECTION
LOCATION MAP NO. 2

HAVERHILL MASSACHUSETTS

FUSS & O'NEILL
317 IRON HORSE WAY, SUITE 204
PROVIDENCE, RI 02908
401.861.3070
www.fando.com

SCALE:
HORZ.: 1"= 200'
VERT.:
DATUM:
HORZ.: NAD83
VERT.: NAVD88

200 100 0 200
GRAPHIC SCALE

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER

I-495 BRIDGES

I-495 BRIDGES

VALLEY PIPE SUPPORT STRUCTURE/CROSSING

MBTA RAILROAD BRIDGE

TOWN OF HAVERHILL

CROSS SECTION
LOCATION MAP NO. 3

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390U30
DATE: JUNE 2022

FIG. 1D

FUSS & O'NEILL
317 IRON HORSE WAY, SUITE 204
PROVIDENCE, RI 02908
401.861.3070
www.fando.com

SCALE:
HORZ.: 1"= 200'
VERT.:
DATUM:
HORZ.: NAD83
VERT.: NAVD88

200 100 0 200
GRAPHIC SCALE

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER

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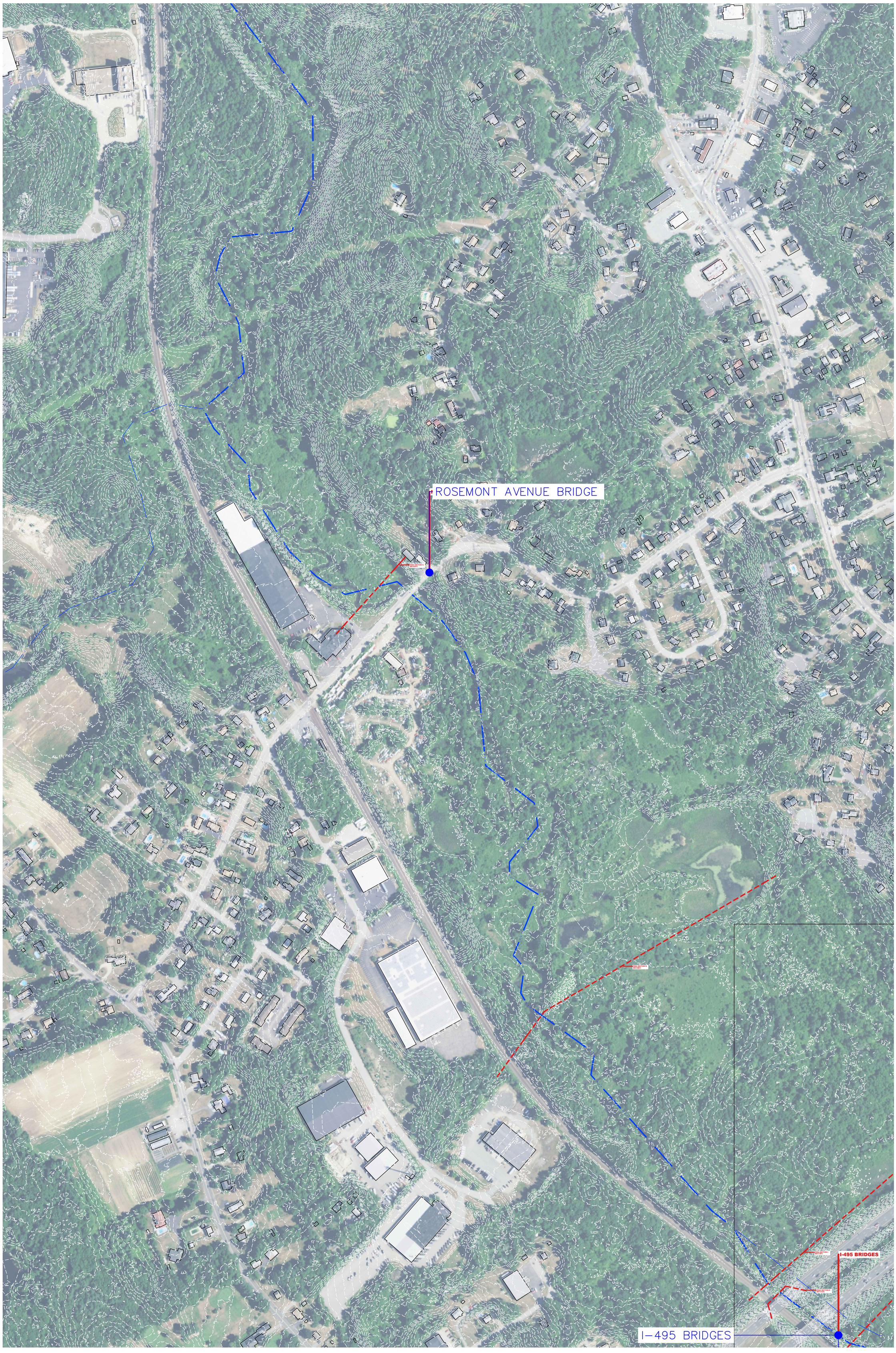
MS VIEW: LAYER STATE: Plotter: NONE CTB File: FO.STB



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MS VIEW: LAYER STATE: Plotter: NONE CTB File: FO.STB

PROJ. No.: 20170390U30

DATE: JUNE 2022

FIG. 1E

TOWN OF HAVERHILL

CROSS SECTION
LOCATION MAP NO. 4

HAVERHILL MASSACHUSETTS

FUSS & O'NEILL
317 IRON HORSE WAY, SUITE 204
PROVIDENCE, RI 02908
401.861.3070
www.fando.com

SCALE:
HORZ.: 1"= 200'
VERT.:
DATUM:
HORZ.: NAD83
VERT.: NAVD88

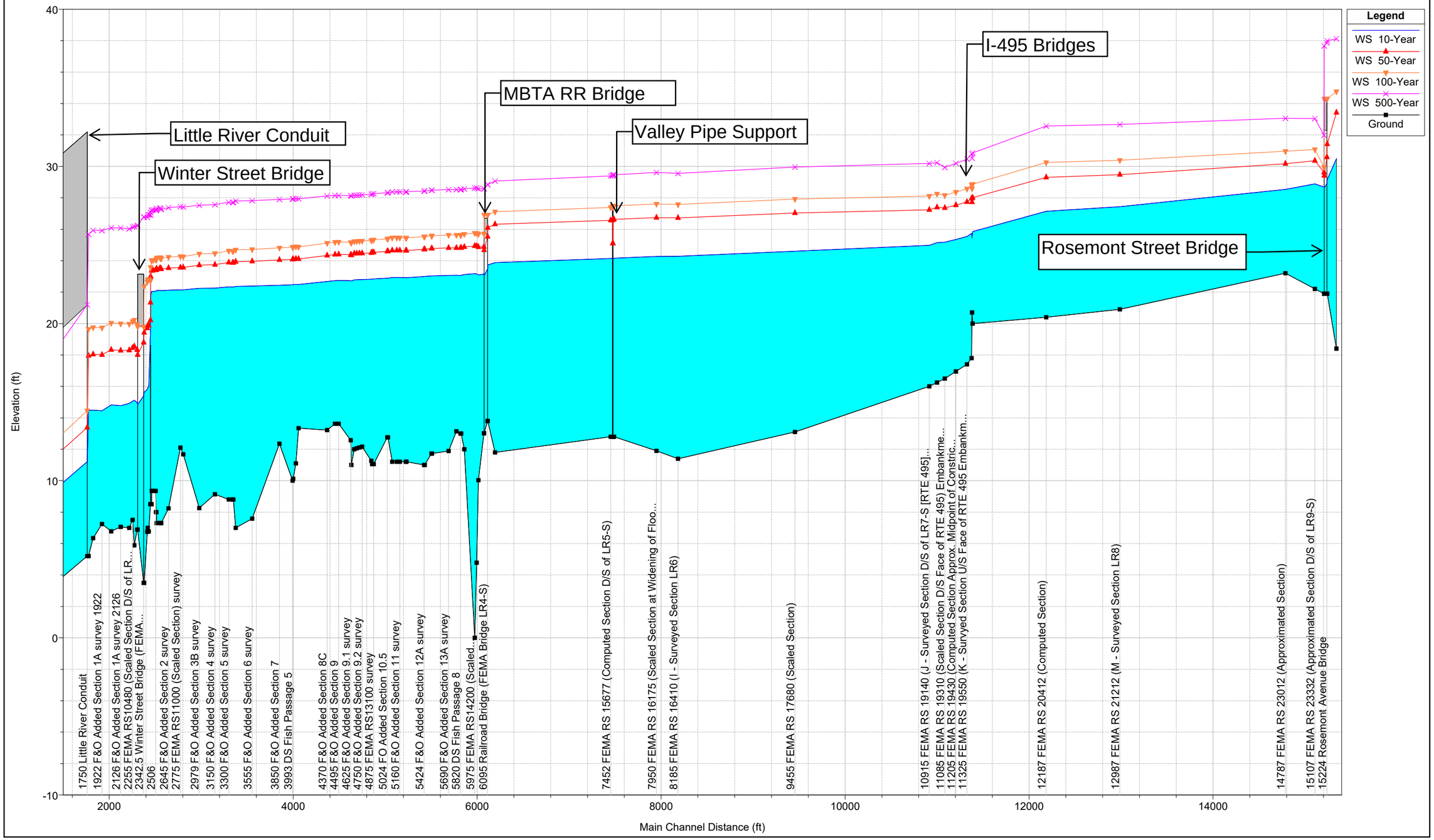
200 100 0 200
GRAPHIC SCALE

No.	DATE	DESCRIPTION	DESIGNER	REVIEWER

Attachment 8

Pre-Dam Removal Model HEC-RAS Profile and Output Summary (Flood Flows)

HEC-RAS Model Plan: FO PreConditions Model with survey 6/14/2022



HEC-RAS Plan: precon survey River: Little River Reach: Little River

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Vel Chnl	Top Width
			(cfs)	(ft)	(ft)	(ft/s)	(ft)
Little River	15341	10-Year	980.00	18.40	30.48	1.70	299.59
Little River	15341	50-Year	1640.00	18.40	33.42	1.80	321.67
Little River	15341	100-Year	1990.00	18.40	34.77	1.85	338.54
Little River	15341	500-Year	3030.00	18.40	38.13	2.01	404.08
Little River	15241	10-Year	980.00	21.90	29.17	8.15	36.13
Little River	15241	50-Year	1640.00	21.90	31.42	10.22	181.22
Little River	15241	100-Year	1990.00	21.90	34.30	6.10	369.04
Little River	15241	500-Year	3030.00	21.90	37.99	4.33	542.92
Little River	15224		Bridge				
Little River	15207	10-Year	980.00	21.90	28.69	8.77	25.02
Little River	15207	50-Year	1640.00	21.90	29.62	12.81	61.30
Little River	15207	100-Year	1990.00	21.90	29.94	14.87	81.92
Little River	15207	500-Year	3030.00	21.90	31.99	17.75	220.02
Little River	15107	10-Year	980.00	22.20	28.89	3.96	110.48
Little River	15107	50-Year	1640.00	22.20	30.36	4.76	144.15
Little River	15107	100-Year	1990.00	22.20	31.07	5.03	160.59
Little River	15107	500-Year	3030.00	22.20	33.04	5.50	205.87
Little River	14787	10-Year	980.00	23.20	28.54	3.41	273.84
Little River	14787	50-Year	1640.00	23.20	30.17	3.40	472.67
Little River	14787	100-Year	1990.00	23.20	30.96	3.29	507.50
Little River	14787	500-Year	3030.00	23.20	33.06	3.09	599.80
Little River	12987	10-Year	980.00	20.90	27.44	2.37	447.56
Little River	12987	50-Year	1640.00	20.90	29.48	2.26	616.11
Little River	12987	100-Year	1990.00	20.90	30.40	2.21	676.41
Little River	12987	500-Year	3030.00	20.90	32.67	2.17	825.93
Little River	12187	10-Year	980.00	20.40	27.15	2.22	465.43
Little River	12187	50-Year	1640.00	20.40	29.30	2.09	637.42
Little River	12187	100-Year	1990.00	20.40	30.25	2.05	699.65
Little River	12187	500-Year	3030.00	20.40	32.57	2.03	851.83
Little River	11387	10-Year	1160.00	20.00	25.85	6.42	49.20
Little River	11387	50-Year	1920.00	20.00	28.01	7.49	57.39
Little River	11387	100-Year	2330.00	20.00	28.87	8.10	60.67
Little River	11387	500-Year	3520.00	20.00	30.85	9.72	68.20
Little River	11381	10-Year	1160.00	20.70	25.49	7.67	47.44
Little River	11381	50-Year	1920.00	20.70	27.73	8.36	56.09
Little River	11381	100-Year	2330.00	20.70	28.59	8.94	59.40
Little River	11381	500-Year	3520.00	20.70	30.52	10.57	66.86
Little River	11375	10-Year	1160.00	17.80	25.74	4.82	51.02
Little River	11375	50-Year	1920.00	17.80	27.96	6.02	58.69
Little River	11375	100-Year	2330.00	17.80	28.83	6.65	61.68
Little River	11375	500-Year	3520.00	17.80	30.80	8.31	68.49
Little River	11325	10-Year	1160.00	17.40	25.54	5.34	46.34

HEC-RAS Plan: precon survey River: Little River Reach: Little River (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Vel Chnl	Top Width
			(cfs)	(ft)	(ft)	(ft/s)	(ft)
Little River	11325	50-Year	1920.00	17.40	27.74	6.50	54.18
Little River	11325	100-Year	2330.00	17.40	28.58	7.15	57.18
Little River	11325	500-Year	3520.00	17.40	30.46	8.87	63.90
Little River	11205	10-Year	1160.00	16.95	25.35	5.13	47.25
Little River	11205	50-Year	1920.00	16.95	27.54	6.31	55.08
Little River	11205	100-Year	2330.00	16.95	28.36	6.96	58.02
Little River	11205	500-Year	3520.00	16.95	30.19	8.71	64.55
Little River	11085	10-Year	1160.00	16.50	25.18	4.92	48.25
Little River	11085	50-Year	1920.00	16.50	27.36	6.11	56.05
Little River	11085	100-Year	2330.00	16.50	28.17	6.77	58.93
Little River	11085	500-Year	3520.00	16.50	29.94	8.55	65.26
Little River	11000	10-Year	1160.00	16.25	25.15	3.62	58.11
Little River	11000	50-Year	1920.00	16.25	27.39	4.11	217.12
Little River	11000	100-Year	2330.00	16.25	28.25	4.26	343.83
Little River	11000	500-Year	3520.00	16.25	30.24	4.21	543.28
Little River	10915	10-Year	1160.00	16.00	24.98	3.57	58.46
Little River	10915	50-Year	1920.00	16.00	27.23	3.99	230.20
Little River	10915	100-Year	2330.00	16.00	28.12	3.93	360.40
Little River	10915	500-Year	3520.00	16.00	30.19	3.23	559.85
Little River	9455	10-Year	1160.00	13.10	24.61	1.23	540.79
Little River	9455	50-Year	1920.00	13.10	27.03	1.21	783.37
Little River	9455	100-Year	2330.00	13.10	27.92	1.25	871.63
Little River	9455	500-Year	3520.00	13.10	29.96	1.35	1027.29
Little River	8185	10-Year	1160.00	11.40	24.29	2.12	84.19
Little River	8185	50-Year	1920.00	11.40	26.72	2.68	122.52
Little River	8185	100-Year	2330.00	11.40	27.58	2.97	143.81
Little River	8185	500-Year	3520.00	11.40	29.56	3.65	221.88
Little River	7950	10-Year	1160.00	11.90	24.27	1.06	422.62
Little River	7950	50-Year	1920.00	11.90	26.74	1.13	434.82
Little River	7950	100-Year	2330.00	11.90	27.61	1.21	439.12
Little River	7950	500-Year	3520.00	11.90	29.62	1.43	447.00
Little River	7488	10-Year	1160.00	12.80	24.16	1.62	178.22
Little River	7488	50-Year	1920.00	12.80	26.63	1.87	194.40
Little River	7488	100-Year	2330.00	12.80	27.49	2.05	199.28
Little River	7488	500-Year	3520.00	12.80	29.46	2.47	328.77
Little River	7478	10-Year	1160.00	12.80	24.15	1.63	178.19
Little River	7478	50-Year	1920.00	12.80	26.62	1.89	194.37
Little River	7478	100-Year	2330.00	12.80	27.48	2.07	199.27
Little River	7478	500-Year	3520.00	12.80	29.46	2.48	328.62
Little River	7475		Bridge				
Little River	7472	10-Year	1160.00	12.80	24.15	1.63	178.14
Little River	7472	50-Year	1920.00	12.80	26.57	1.89	194.05

HEC-RAS Plan: precon survey River: Little River Reach: Little River (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Vel Chnl	Top Width
			(cfs)	(ft)	(ft)	(ft/s)	(ft)
Little River	7472	100-Year	2330.00	12.80	27.40	2.07	199.02
Little River	7472	500-Year	3520.00	12.80	29.40	2.49	326.80
Little River	7452	10-Year	1160.00	12.80	24.14	1.62	178.09
Little River	7452	50-Year	1920.00	12.80	26.57	1.89	194.00
Little River	7452	100-Year	2330.00	12.80	27.39	2.07	199.00
Little River	7452	500-Year	3520.00	12.80	29.40	2.49	326.49
Little River	6195	10-Year	1160.00	11.80	23.88	1.10	247.01
Little River	6195	50-Year	1920.00	11.80	26.32	1.30	289.28
Little River	6195	100-Year	2330.00	11.80	27.12	1.44	309.20
Little River	6195	500-Year	3520.00	11.80	29.07	1.75	401.46
Little River	6115	10-Year	1160.00	13.80	23.73	2.85	110.57
Little River	6115	50-Year	1920.00	13.80	26.09	3.51	141.54
Little River	6115	100-Year	2330.00	13.80	26.92	3.54	173.94
Little River	6115	500-Year	3520.00	13.80	28.85	4.02	342.03
Little River	6095		Bridge				
Little River	6075	10-Year	1160.00	13.02	23.15	3.47	106.98
Little River	6075	50-Year	1920.00	13.02	24.88	4.48	129.62
Little River	6075	100-Year	2330.00	13.02	25.71	4.51	140.42
Little River	6075	500-Year	3520.00	13.02	28.58	4.40	343.28
Little River	6015	10-Year	1160.00	10.03	23.09	2.80	230.37
Little River	6015	50-Year	1920.00	10.03	24.86	3.12	326.67
Little River	6015	100-Year	2330.00	10.03	25.69	3.15	339.35
Little River	6015	500-Year	3520.00	10.03	28.59	2.69	433.29
Little River	5995	10-Year	1160.00	4.78	23.17	0.54	353.19
Little River	5995	50-Year	1920.00	4.78	24.94	0.73	376.55
Little River	5995	100-Year	2330.00	4.78	25.76	0.81	385.82
Little River	5995	500-Year	3520.00	4.78	28.62	0.94	482.29
Little River	5975	10-Year	1160.00	0.00	23.17	0.38	252.39
Little River	5975	50-Year	1920.00	0.00	24.94	0.56	307.67
Little River	5975	100-Year	2330.00	0.00	25.76	0.65	348.65
Little River	5975	500-Year	3520.00	0.00	28.62	0.83	491.95
Little River	5861	10-Year	1160.00	12.00	23.13	1.79	220.81
Little River	5861	50-Year	1920.00	12.00	24.88	2.20	260.86
Little River	5861	100-Year	2330.00	12.00	25.70	2.37	293.24
Little River	5861	500-Year	3520.00	12.00	28.57	2.43	407.49
Little River	5826	10-Year	1160.00	13.00	23.07	2.55	201.58
Little River	5826	50-Year	1920.00	13.00	24.82	3.00	241.50
Little River	5826	100-Year	2330.00	13.00	25.64	3.16	274.60
Little River	5826	500-Year	3520.00	13.00	28.53	3.05	392.14
Little River	5820	10-Year	1160.00	13.00	23.06	2.60	192.21
Little River	5820	50-Year	1920.00	13.00	24.81	3.07	229.10
Little River	5820	100-Year	2330.00	13.00	25.63	3.24	260.92

HEC-RAS Plan: precon survey River: Little River Reach: Little River (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Vel Chnl	Top Width
			(cfs)	(ft)	(ft)	(ft/s)	(ft)
Little River	5820	500-Year	3520.00	13.00	28.52	3.15	374.12
Little River	5775	10-Year	1160.00	13.14	23.07	1.62	228.33
Little River	5775	50-Year	1920.00	13.14	24.82	1.96	263.57
Little River	5775	100-Year	2330.00	13.14	25.63	2.09	294.50
Little River	5775	500-Year	3520.00	13.14	28.53	2.14	404.40
Little River	5690	10-Year	1160.00	11.89	23.06	0.93	228.01
Little River	5690	50-Year	1920.00	11.89	24.82	1.18	243.52
Little River	5690	100-Year	2330.00	11.89	25.63	1.28	253.97
Little River	5690	500-Year	3520.00	11.89	28.52	1.39	346.51
Little River	5510	10-Year	1160.00	11.73	23.03	1.01	202.33
Little River	5510	50-Year	1920.00	11.73	24.77	1.29	221.44
Little River	5510	100-Year	2330.00	11.73	25.59	1.42	236.48
Little River	5510	500-Year	3520.00	11.73	28.49	1.53	354.81
Little River	5504	10-Year	1160.00	11.73	23.03	1.01	202.32
Little River	5504	50-Year	1920.00	11.73	24.77	1.29	221.42
Little River	5504	100-Year	2330.00	11.73	25.58	1.42	236.46
Little River	5504	500-Year	3520.00	11.73	28.48	1.53	354.80
Little River	5430	10-Year	1160.00	11.00	23.00	1.39	154.13
Little River	5430	50-Year	1920.00	11.00	24.73	1.79	170.52
Little River	5430	100-Year	2330.00	11.00	25.53	1.96	178.31
Little River	5430	500-Year	3520.00	11.00	28.44	2.11	358.43
Little River	5424	10-Year	1160.00	11.00	22.99	1.39	154.11
Little River	5424	50-Year	1920.00	11.00	24.73	1.79	170.50
Little River	5424	100-Year	2330.00	11.00	25.53	1.96	178.29
Little River	5424	500-Year	3520.00	11.00	28.43	2.11	358.37
Little River	5232	10-Year	1160.00	11.20	22.92	1.99	235.90
Little River	5232	50-Year	1920.00	11.20	24.64	2.44	273.29
Little River	5232	100-Year	2330.00	11.20	25.45	2.61	290.78
Little River	5232	500-Year	3520.00	11.20	28.38	2.61	474.84
Little River	5226	10-Year	1160.00	11.20	22.92	1.99	235.85
Little River	5226	50-Year	1920.00	11.20	24.64	2.44	273.23
Little River	5226	100-Year	2330.00	11.20	25.45	2.61	290.72
Little River	5226	500-Year	3520.00	11.20	28.38	2.62	474.80
Little River	5160	10-Year	1160.00	11.20	22.93	0.67	280.69
Little River	5160	50-Year	1920.00	11.20	24.66	0.88	299.04
Little River	5160	100-Year	2330.00	11.20	25.46	0.98	312.23
Little River	5160	500-Year	3520.00	11.20	28.39	1.09	470.98
Little River	5128	10-Year	1160.00	11.20	22.93	0.67	280.67
Little River	5128	50-Year	1920.00	11.20	24.66	0.88	298.99
Little River	5128	100-Year	2330.00	11.20	25.46	0.98	312.18
Little River	5128	500-Year	3520.00	11.20	28.39	1.09	470.96
Little River	5077	10-Year	1160.00	11.20	22.93	0.67	280.65

HEC-RAS Plan: precon survey River: Little River Reach: Little River (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Vel Chnl	Top Width
			(cfs)	(ft)	(ft)	(ft/s)	(ft)
Little River	5077	50-Year	1920.00	11.20	24.65	0.88	298.92
Little River	5077	100-Year	2330.00	11.20	25.46	0.98	312.10
Little River	5077	500-Year	3520.00	11.20	28.38	1.09	470.92
Little River	5030	10-Year	1160.00	12.76	22.89	1.51	174.47
Little River	5030	50-Year	1920.00	12.76	24.60	1.87	185.18
Little River	5030	100-Year	2330.00	12.76	25.40	2.03	189.88
Little River	5030	500-Year	3520.00	12.76	28.32	2.14	379.59
Little River	5024	10-Year	1160.00	12.76	22.89	1.51	174.45
Little River	5024	50-Year	1920.00	12.76	24.60	1.88	185.16
Little River	5024	100-Year	2330.00	12.76	25.39	2.03	189.86
Little River	5024	500-Year	3520.00	12.76	28.32	2.14	379.46
Little River	4875	10-Year	1160.00	11.05	22.84	1.37	138.43
Little River	4875	50-Year	1920.00	11.05	24.54	1.80	144.08
Little River	4875	100-Year	2330.00	11.05	25.33	1.98	153.40
Little River	4875	500-Year	3520.00	11.05	28.26	2.21	364.89
Little River	4859	10-Year	1160.00	11.05	22.83	1.37	138.41
Little River	4859	50-Year	1920.00	11.05	24.53	1.80	144.06
Little River	4859	100-Year	2330.00	11.05	25.32	1.99	153.28
Little River	4859	500-Year	3520.00	11.05	28.25	2.21	364.10
Little River	4850	10-Year	1160.00	11.26	22.82	1.67	105.60
Little River	4850	50-Year	1920.00	11.26	24.50	2.25	118.98
Little River	4850	100-Year	2330.00	11.26	25.28	2.50	125.05
Little River	4850	500-Year	3520.00	11.26	28.21	2.78	367.24
Little River	4750	10-Year	1160.00	12.16	22.80	1.30	111.27
Little River	4750	50-Year	1920.00	12.16	24.48	1.79	118.23
Little River	4750	100-Year	2330.00	12.16	25.26	2.01	124.60
Little River	4750	500-Year	3520.00	12.16	28.19	2.32	364.87
Little River	4721	10-Year	1160.00	12.11	22.80	1.30	111.26
Little River	4721	50-Year	1920.00	12.11	24.47	1.79	118.16
Little River	4721	100-Year	2330.00	12.11	25.25	2.01	124.52
Little River	4721	500-Year	3520.00	12.11	28.18	2.32	363.63
Little River	4692	10-Year	1160.00	12.06	22.79	1.29	111.24
Little River	4692	50-Year	1920.00	12.06	24.46	1.78	118.09
Little River	4692	100-Year	2330.00	12.06	25.24	2.01	124.44
Little River	4692	500-Year	3520.00	12.06	28.17	2.31	362.39
Little River	4663	10-Year	1160.00	12.00	22.78	1.29	111.23
Little River	4663	50-Year	1920.00	12.00	24.45	1.78	118.02
Little River	4663	100-Year	2330.00	12.00	25.23	2.00	124.35
Little River	4663	500-Year	3520.00	12.00	28.16	2.31	361.16
Little River	4632	10-Year	1160.00	11.00	22.70	2.61	169.67
Little River	4632	50-Year	1920.00	11.00	24.35	3.29	217.57
Little River	4632	100-Year	2330.00	11.00	25.13	3.52	231.43
Little River	4632	500-Year	3520.00	11.00	28.12	3.39	484.10

HEC-RAS Plan: precon survey River: Little River Reach: Little River (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Vel Chnl	Top Width
			(cfs)	(ft)	(ft)	(ft/s)	(ft)
Little River	4625	10-Year	1160.00	12.58	22.73	1.77	167.76
Little River	4625	50-Year	1920.00	12.58	24.38	2.20	218.19
Little River	4625	100-Year	2330.00	12.58	25.17	2.36	232.07
Little River	4625	500-Year	3520.00	12.58	28.14	2.33	486.44
Little River	4495	10-Year	1160.00	13.62	22.73	0.66	311.74
Little River	4495	50-Year	1920.00	13.62	24.40	0.85	326.11
Little River	4495	100-Year	2330.00	13.62	25.18	0.93	336.75
Little River	4495	500-Year	3520.00	13.62	28.16	1.02	524.31
Little River	4455	10-Year	1160.00	13.62	22.73	0.66	311.71
Little River	4455	50-Year	1920.00	13.62	24.40	0.85	326.05
Little River	4455	100-Year	2330.00	13.62	25.18	0.93	336.70
Little River	4455	500-Year	3520.00	13.62	28.15	1.02	523.90
Little River	4370	10-Year	1160.00	13.22	22.68	1.75	246.74
Little River	4370	50-Year	1920.00	13.22	24.33	2.03	371.19
Little River	4370	100-Year	2330.00	13.22	25.12	2.10	406.25
Little River	4370	500-Year	3520.00	13.22	28.12	1.88	615.05
Little River	4060	10-Year	1160.00	13.34	22.49	1.82	131.85
Little River	4060	50-Year	1920.00	13.34	24.11	2.35	148.95
Little River	4060	100-Year	2330.00	13.34	24.88	2.57	169.27
Little River	4060	500-Year	3520.00	13.34	27.94	2.65	393.80
Little River	4030	10-Year	1160.00	11.10	22.50	1.28	140.62
Little River	4030	50-Year	1920.00	11.10	24.12	1.72	149.44
Little River	4030	100-Year	2330.00	11.10	24.89	1.91	164.09
Little River	4030	500-Year	3520.00	11.10	27.95	2.09	463.38
Little River	4000	10-Year	1160.00	10.13	22.48	1.38	137.86
Little River	4000	50-Year	1920.00	10.13	24.10	1.81	155.37
Little River	4000	100-Year	2330.00	10.13	24.88	1.99	171.61
Little River	4000	500-Year	3520.00	10.13	27.94	2.15	256.41
Little River	3993	10-Year	1160.00	10.00	22.47	1.98	179.37
Little River	3993	50-Year	1920.00	10.00	24.08	2.58	217.04
Little River	3993	100-Year	2330.00	10.00	24.85	2.81	228.58
Little River	3993	500-Year	3520.00	10.00	27.93	2.88	385.32
Little River	3850	10-Year	1160.00	12.35	22.44	1.25	178.70
Little River	3850	50-Year	1920.00	12.35	24.04	1.61	216.53
Little River	3850	100-Year	2330.00	12.35	24.82	1.76	228.03
Little River	3850	500-Year	3520.00	12.35	27.90	1.84	383.27
Little River	3555	10-Year	1160.00	7.58	22.38	1.21	135.95
Little River	3555	50-Year	1920.00	7.58	23.96	1.68	180.47
Little River	3555	100-Year	2330.00	7.58	24.72	1.89	203.64
Little River	3555	500-Year	3520.00	7.58	27.82	2.07	379.64
Little River	3375	10-Year	1160.00	7.00	22.37	0.92	143.35
Little River	3375	50-Year	1920.00	7.00	23.94	1.29	149.05

HEC-RAS Plan: precon survey River: Little River Reach: Little River (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Vel Chnl	Top Width
			(cfs)	(ft)	(ft)	(ft/s)	(ft)
Little River	3375	100-Year	2330.00	7.00	24.69	1.45	197.49
Little River	3375	500-Year	3520.00	7.00	27.80	1.63	495.32
Little River	3350	10-Year	1160.00	8.80	22.33	1.95	116.51
Little River	3350	50-Year	1920.00	8.80	23.87	2.71	123.71
Little River	3350	100-Year	2330.00	8.80	24.61	3.04	127.42
Little River	3350	500-Year	3520.00	8.80	27.71	3.39	367.84
Little River	3342	10-Year	1160.00	8.80	22.33	1.95	116.50
Little River	3342	50-Year	1920.00	8.80	23.87	2.71	123.70
Little River	3342	100-Year	2330.00	8.80	24.61	3.04	127.40
Little River	3342	500-Year	3520.00	8.80	27.70	3.39	367.41
Little River	3300	10-Year	1160.00	8.80	22.34	1.13	117.38
Little River	3300	50-Year	1920.00	8.80	23.88	1.59	123.84
Little River	3300	100-Year	2330.00	8.80	24.63	1.80	127.50
Little River	3300	500-Year	3520.00	8.80	27.72	2.09	369.44
Little River	3150	10-Year	1160.00	9.14	22.26	2.00	85.49
Little River	3150	50-Year	1920.00	9.14	23.74	2.77	112.49
Little River	3150	100-Year	2330.00	9.14	24.46	3.10	129.76
Little River	3150	500-Year	3520.00	9.14	27.57	3.33	230.37
Little River	2979	10-Year	1160.00	8.26	22.24	1.28	99.23
Little River	2979	50-Year	1920.00	8.26	23.72	1.87	126.15
Little River	2979	100-Year	2330.00	8.26	24.43	2.13	140.04
Little River	2979	500-Year	3520.00	8.26	27.53	2.50	229.14
Little River	2805	10-Year	1160.00	11.68	22.15	2.08	104.22
Little River	2805	50-Year	1920.00	11.68	23.57	2.77	152.38
Little River	2805	100-Year	2330.00	11.68	24.26	3.04	171.74
Little River	2805	500-Year	3520.00	11.68	27.42	3.01	310.29
Little River	2775	10-Year	1160.00	12.10	22.14	1.92	202.57
Little River	2775	50-Year	1920.00	12.10	23.57	2.49	254.71
Little River	2775	100-Year	2330.00	12.10	24.27	2.71	280.16
Little River	2775	500-Year	3520.00	12.10	27.43	2.61	395.60
Little River	2645	10-Year	1160.00	8.24	22.12	1.27	124.53
Little River	2645	50-Year	1920.00	8.24	23.54	1.77	126.71
Little River	2645	100-Year	2330.00	8.24	24.23	1.99	127.84
Little River	2645	500-Year	3520.00	8.24	27.38	2.24	264.44
Little River	2567	10-Year	1160.00	7.30	22.09	1.85	124.48
Little River	2567	50-Year	1920.00	7.30	23.47	2.67	126.60
Little River	2567	100-Year	2330.00	7.30	24.14	3.05	127.68
Little River	2567	500-Year	3520.00	7.30	27.27	3.58	253.40
Little River	2561	10-Year	1160.00	7.30	22.09	1.83	124.48
Little River	2561	50-Year	1920.00	7.30	23.47	2.64	126.61
Little River	2561	100-Year	2330.00	7.30	24.14	3.01	127.68
Little River	2561	500-Year	3520.00	7.30	27.27	3.52	253.64

HEC-RAS Plan: precon survey River: Little River Reach: Little River (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Vel Chnl	Top Width
			(cfs)	(ft)	(ft)	(ft/s)	(ft)
Little River	2558	10-Year	1160.00	7.30	22.11	1.08	124.51
Little River	2558	50-Year	1920.00	7.30	23.52	1.54	126.67
Little River	2558	100-Year	2330.00	7.30	24.20	1.75	127.78
Little River	2558	500-Year	3520.00	7.30	27.34	2.04	260.63
Little River	2550	10-Year	1160.00	7.30	22.11	1.08	124.51
Little River	2550	50-Year	1920.00	7.30	23.51	1.54	126.67
Little River	2550	100-Year	2330.00	7.30	24.20	1.76	127.78
Little River	2550	500-Year	3520.00	7.30	27.34	2.04	260.47
Little River	2516	10-Year	1160.00	7.30	22.11	1.08	124.50
Little River	2516	50-Year	1920.00	7.30	23.51	1.54	126.66
Little River	2516	100-Year	2330.00	7.30	24.19	1.76	127.77
Little River	2516	500-Year	3520.00	7.30	27.33	2.04	259.75
Little River	2513	10-Year	1160.00	8.00	22.06	2.01	83.90
Little River	2513	50-Year	1920.00	8.00	23.41	2.94	90.39
Little River	2513	100-Year	2330.00	8.00	24.06	3.37	184.06
Little River	2513	500-Year	3520.00	8.00	27.20	3.74	487.93
Little River	2509	10-Year	1160.00	8.00	22.06	2.01	83.90
Little River	2509	50-Year	1920.00	8.00	23.41	2.94	90.39
Little River	2509	100-Year	2330.00	8.00	24.06	3.37	184.06
Little River	2509	500-Year	3520.00	8.00	27.20	3.74	487.87
Little River	2506	10-Year	1160.00	9.35	22.06	1.99	82.26
Little River	2506	50-Year	1920.00	9.35	23.42	2.74	89.92
Little River	2506	100-Year	2330.00	9.35	24.07	3.06	184.16
Little River	2506	500-Year	3520.00	9.35	27.26	2.79	494.26
Little River	2480	10-Year	1160.00	9.35	22.04	1.99	82.17
Little River	2480	50-Year	1920.00	9.35	23.39	2.75	89.77
Little River	2480	100-Year	2330.00	9.35	24.04	3.08	183.90
Little River	2480	500-Year	3520.00	9.35	27.24	2.80	492.19
Little River	2464	10-Year	1160.00	9.35	22.03	2.00	82.11
Little River	2464	50-Year	1920.00	9.35	23.37	2.76	89.67
Little River	2464	100-Year	2330.00	9.35	24.02	3.08	183.73
Little River	2464	500-Year	3520.00	9.35	27.23	2.81	490.85
Little River	2461	10-Year	1160.00	8.50	22.04	1.81	55.46
Little River	2461	50-Year	1920.00	8.50	23.37	2.68	58.21
Little River	2461	100-Year	2330.00	8.50	24.02	3.09	70.59
Little River	2461	500-Year	3520.00	8.50	27.19	3.23	378.86
Little River	2451	10-Year	1160.00	8.50	21.79	3.60	75.11
Little River	2451	50-Year	1920.00	8.50	23.00	4.65	75.12
Little River	2451	100-Year	2330.00	8.50	23.59	5.10	75.12
Little River	2451	500-Year	3520.00	8.50	27.07	3.98	275.28
Little River	2450		Inl Struct				
Little River	2449	10-Year	1160.00	8.50	19.44	7.94	75.09

HEC-RAS Plan: precon survey River: Little River Reach: Little River (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Vel Chnl	Top Width
			(cfs)	(ft)	(ft)	(ft/s)	(ft)
Little River	2449	50-Year	1920.00	8.50	20.22	9.40	75.10
Little River	2449	100-Year	2330.00	8.50	22.73	5.93	75.12
Little River	2449	500-Year	3520.00	8.50	26.90	4.55	262.36
Little River	2430	10-Year	1160.00	6.77	15.96	1.90	76.74
Little River	2430	50-Year	1920.00	6.77	19.89	2.08	81.38
Little River	2430	100-Year	2330.00	6.77	22.83	2.00	84.85
Little River	2430	500-Year	3520.00	6.77	26.94	2.29	113.12
Little River	2420	10-Year	1160.00	7.00	15.93	2.22	68.99
Little River	2420	50-Year	1920.00	7.00	19.86	2.41	71.23
Little River	2420	100-Year	2330.00	7.00	22.80	2.31	72.90
Little River	2420	500-Year	3520.00	7.00	26.92	2.59	340.53
Little River	2415	10-Year	1160.00	6.75	15.82	3.27	43.97
Little River	2415	50-Year	1920.00	6.75	19.71	3.62	46.10
Little River	2415	100-Year	2330.00	6.75	22.66	3.49	47.72
Little River	2415	500-Year	3520.00	6.75	26.76	3.78	240.17
Little River	2380	10-Year	1160.00	3.50	15.63	4.49	45.90
Little River	2380	50-Year	1920.00	3.50	19.42	5.25	45.94
Little River	2380	100-Year	2330.00	3.50	22.36	5.19	45.98
Little River	2380	500-Year	3520.00	3.50	26.78	3.58	271.38
Little River	2342.5		Bridge				
Little River	2305	10-Year	1160.00	6.89	14.96	5.96	45.88
Little River	2305	50-Year	1920.00	6.89	18.32	6.65	45.92
Little River	2305	100-Year	2330.00	6.89	19.97	6.96	45.95
Little River	2305	500-Year	3520.00	6.89	26.24	3.44	564.61
Little River	2273	10-Year	1160.00	5.89	15.13	3.37	51.24
Little River	2273	50-Year	1920.00	5.89	18.54	3.64	57.39
Little River	2273	100-Year	2330.00	5.89	20.23	3.71	62.08
Little River	2273	500-Year	3520.00	5.89	26.19	3.16	311.80
Little River	2255	10-Year	1160.00	7.50	15.05	3.92	45.30
Little River	2255	50-Year	1920.00	7.50	18.46	4.24	52.24
Little River	2255	100-Year	2330.00	7.50	20.14	4.33	58.32
Little River	2255	500-Year	3520.00	7.50	26.15	3.58	223.03
Little River	2218	10-Year	1160.00	7.00	14.92	4.61	36.79
Little River	2218	50-Year	1920.00	7.00	18.30	5.07	39.51
Little River	2218	100-Year	2330.00	7.00	19.97	5.20	43.44
Little River	2218	500-Year	3520.00	7.00	26.02	4.44	287.47
Little River	2126	10-Year	1160.00	7.06	14.78	5.28	45.66
Little River	2126	50-Year	1920.00	7.06	18.28	5.13	62.17
Little River	2126	100-Year	2330.00	7.06	20.00	5.01	71.64
Little River	2126	500-Year	3520.00	7.06	26.09	3.87	297.44
Little River	2021	10-Year	1160.00	6.78	14.83	3.59	60.53
Little River	2021	50-Year	1920.00	6.78	18.34	3.64	71.85

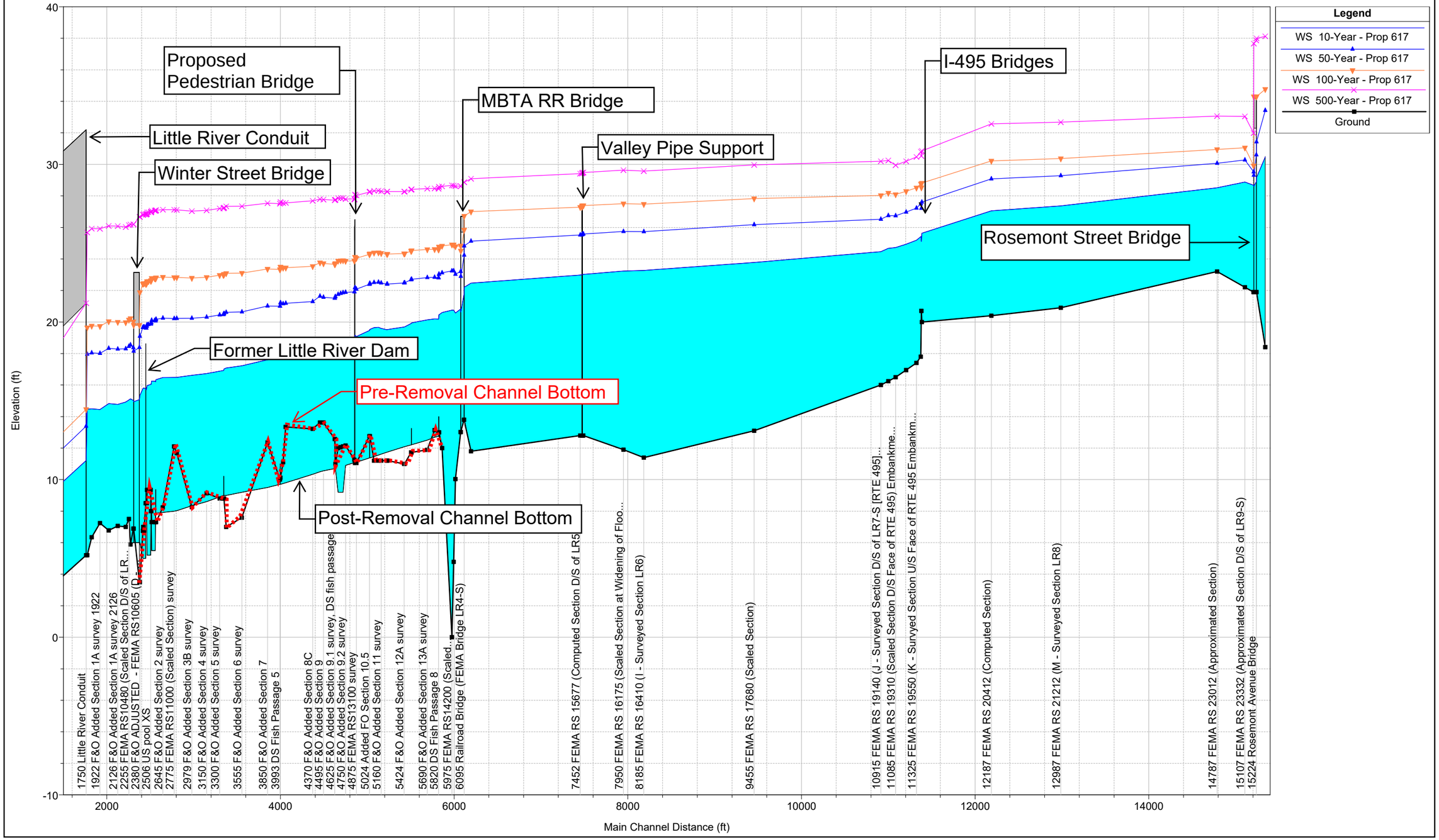
HEC-RAS Plan: precon survey River: Little River Reach: Little River (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Vel Chnl	Top Width
			(cfs)	(ft)	(ft)	(ft/s)	(ft)
Little River	2021	100-Year	2330.00	6.78	20.04	3.65	78.96
Little River	2021	500-Year	3520.00	6.78	26.10	3.12	116.86
Little River	1922	10-Year	1160.00	7.24	14.45	5.35	40.86
Little River	1922	50-Year	1920.00	7.24	18.01	5.33	52.18
Little River	1922	100-Year	2330.00	7.24	19.74	5.30	59.02
Little River	1922	500-Year	3520.00	7.24	25.92	4.43	86.59
Little River	1825	10-Year	1160.00	6.34	14.49	4.05	44.70
Little River	1825	50-Year	1920.00	6.34	18.04	4.42	53.99
Little River	1825	100-Year	2330.00	6.34	19.76	4.53	59.46
Little River	1825	500-Year	3520.00	6.34	25.92	4.08	77.85
Little River	1775 FEMA Section A	10-Year	1160.00	5.20	14.47	3.95	41.24
Little River	1775 FEMA Section A	50-Year	1920.00	5.20	17.96	4.60	43.80
Little River	1775 FEMA Section A	100-Year	2330.00	5.20	19.64	4.88	45.03
Little River	1775 FEMA Section A	500-Year	3520.00	5.20	25.68	5.08	49.45
Little River	1750		Bridge				
Little River	0010	10-Year	1160.00	-3.30	1.03	14.14	360.14
Little River	0010	50-Year	1920.00	-3.30	1.90	17.39	535.00
Little River	0010	100-Year	2330.00	-3.30	2.33	18.77	619.45
Little River	0010	500-Year	3520.00	-3.30	3.26	22.78	806.71
Little River	0	10-Year	1160.00	-3.30	1.60	1.49	664.57
Little River	0	50-Year	1920.00	-3.30	1.60	2.46	664.57
Little River	0	100-Year	2330.00	-3.30	1.60	2.99	664.57
Little River	0	500-Year	3520.00	-3.30	-0.89	33.20	226.32

Attachment 9

Post-Condition Model (With In-River Improvements) HEC-RAS Profile and Output Summary (Flood Flows)

HEC-RAS Model Plan: 1) Prop 617 6/20/2022 2) precon survey 6/20/2022



HEC-RAS Plan: Prop 617 River: Little River Reach: Little River

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Vel Chnl	Top Width
			(cfs)	(ft)	(ft)	(ft/s)	(ft)
Little River	15341	10-Year	980.00	18.40	30.47	1.71	299.55
Little River	15341	50-Year	1640.00	18.40	33.43	1.80	321.70
Little River	15341	100-Year	1990.00	18.40	34.76	1.85	338.51
Little River	15341	500-Year	3030.00	18.40	38.13	2.01	404.08
Little River	15241	10-Year	980.00	21.90	29.16	8.16	35.68
Little River	15241	50-Year	1640.00	21.90	31.43	10.21	181.67
Little River	15241	100-Year	1990.00	21.90	34.30	6.11	368.92
Little River	15241	500-Year	3030.00	21.90	37.99	4.33	542.92
Little River	15224		Bridge				
Little River	15207	10-Year	980.00	21.90	28.68	8.78	25.00
Little River	15207	50-Year	1640.00	21.90	29.52	12.97	55.99
Little River	15207	100-Year	1990.00	21.90	29.92	14.91	80.53
Little River	15207	500-Year	3030.00	21.90	31.99	17.75	220.02
Little River	15107	10-Year	980.00	22.20	28.88	3.97	110.19
Little River	15107	50-Year	1640.00	22.20	30.28	4.84	142.25
Little River	15107	100-Year	1990.00	22.20	31.06	5.04	160.22
Little River	15107	500-Year	3030.00	22.20	33.05	5.49	205.95
Little River	14787	10-Year	980.00	23.20	28.52	3.43	272.78
Little River	14787	50-Year	1640.00	23.20	30.06	3.52	468.02
Little River	14787	100-Year	1990.00	23.20	30.94	3.30	506.70
Little River	14787	500-Year	3030.00	23.20	33.06	3.09	599.95
Little River	12987	10-Year	980.00	20.90	27.36	2.43	441.14
Little River	12987	50-Year	1640.00	20.90	29.28	2.37	603.48
Little River	12987	100-Year	1990.00	20.90	30.37	2.22	674.63
Little River	12987	500-Year	3030.00	20.90	32.68	2.16	826.22
Little River	12187	10-Year	980.00	20.40	27.05	2.29	457.07
Little River	12187	50-Year	1640.00	20.40	29.08	2.20	623.09
Little River	12187	100-Year	1990.00	20.40	30.22	2.06	697.72
Little River	12187	500-Year	3030.00	20.40	32.57	2.03	852.12
Little River	11387	10-Year	1160.00	20.00	25.63	6.71	48.34
Little River	11387	50-Year	1920.00	20.00	27.61	7.93	55.88
Little River	11387	100-Year	2330.00	20.00	28.82	8.15	60.49
Little River	11387	500-Year	3520.00	20.00	30.86	9.71	68.23
Little River	11381	10-Year	1160.00	20.70	25.11	8.38	45.97
Little River	11381	50-Year	1920.00	20.70	27.21	9.09	54.09
Little River	11381	100-Year	2330.00	20.70	28.53	9.01	59.17
Little River	11381	500-Year	3520.00	20.70	30.53	10.56	66.90
Little River	11375	10-Year	1160.00	17.80	25.42	5.05	49.93
Little River	11375	50-Year	1920.00	17.80	27.50	6.35	57.11
Little River	11375	100-Year	2330.00	17.80	28.77	6.69	61.50
Little River	11375	500-Year	3520.00	17.80	30.81	8.30	68.52
Little River	11325	10-Year	1160.00	17.40	25.18	5.67	45.06

HEC-RAS Plan: Prop 617 River: Little River Reach: Little River (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Vel Chnl	Top Width
			(cfs)	(ft)	(ft)	(ft/s)	(ft)
Little River	11325	50-Year	1920.00	17.40	27.22	6.94	52.34
Little River	11325	100-Year	2330.00	17.40	28.52	7.19	56.96
Little River	11325	500-Year	3520.00	17.40	30.47	8.86	63.93
Little River	11205	10-Year	1160.00	16.95	24.94	5.47	45.80
Little River	11205	50-Year	1920.00	16.95	26.97	6.77	53.04
Little River	11205	100-Year	2330.00	16.95	28.30	7.01	57.79
Little River	11205	500-Year	3520.00	16.95	30.20	8.71	64.58
Little River	11085	10-Year	1160.00	16.50	24.73	5.27	46.64
Little River	11085	50-Year	1920.00	16.50	26.74	6.58	53.83
Little River	11085	100-Year	2330.00	16.50	28.10	6.82	58.68
Little River	11085	500-Year	3520.00	16.50	29.95	8.54	65.30
Little River	11000	10-Year	1160.00	16.25	24.68	3.95	56.10
Little River	11000	50-Year	1920.00	16.25	26.75	4.58	122.28
Little River	11000	100-Year	2330.00	16.25	28.18	4.32	333.00
Little River	11000	500-Year	3520.00	16.25	30.25	4.20	544.25
Little River	10915	10-Year	1160.00	16.00	24.46	3.93	56.25
Little River	10915	50-Year	1920.00	16.00	26.52	4.56	125.46
Little River	10915	100-Year	2330.00	16.00	28.03	4.01	348.41
Little River	10915	500-Year	3520.00	16.00	30.20	3.22	560.87
Little River	9455	10-Year	1160.00	13.10	23.78	1.51	462.33
Little River	9455	50-Year	1920.00	13.10	26.18	1.43	698.15
Little River	9455	100-Year	2330.00	13.10	27.83	1.27	862.78
Little River	9455	500-Year	3520.00	13.10	29.97	1.35	1027.76
Little River	8185	10-Year	1160.00	11.40	23.27	2.41	79.26
Little River	8185	50-Year	1920.00	11.40	25.74	2.97	106.97
Little River	8185	100-Year	2330.00	11.40	27.48	3.00	141.25
Little River	8185	500-Year	3520.00	11.40	29.57	3.64	222.62
Little River	7950	10-Year	1160.00	11.90	23.23	1.35	412.90
Little River	7950	50-Year	1920.00	11.90	25.75	1.32	429.91
Little River	7950	100-Year	2330.00	11.90	27.51	1.23	438.63
Little River	7950	500-Year	3520.00	11.90	29.63	1.43	447.00
Little River	7488	10-Year	1160.00	12.80	23.02	1.99	170.75
Little River	7488	50-Year	1920.00	12.80	25.58	2.15	187.55
Little River	7488	100-Year	2330.00	12.80	27.38	2.07	198.97
Little River	7488	500-Year	3520.00	12.80	29.48	2.47	329.28
Little River	7478	10-Year	1160.00	12.80	23.01	2.00	170.70
Little River	7478	50-Year	1920.00	12.80	25.58	2.17	187.51
Little River	7478	100-Year	2330.00	12.80	27.38	2.10	198.96
Little River	7478	500-Year	3520.00	12.80	29.47	2.47	329.13
Little River	7475		Bridge				
Little River	7472	10-Year	1160.00	12.80	23.00	2.00	170.61
Little River	7472	50-Year	1920.00	12.80	25.54	2.18	187.25

HEC-RAS Plan: Prop 617 River: Little River Reach: Little River (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Vel Chnl	Top Width
			(cfs)	(ft)	(ft)	(ft/s)	(ft)
Little River	7472	100-Year	2330.00	12.80	27.29	2.10	198.69
Little River	7472	500-Year	3520.00	12.80	29.42	2.49	327.37
Little River	7452	10-Year	1160.00	12.80	22.98	2.01	170.52
Little River	7452	50-Year	1920.00	12.80	25.53	2.17	187.18
Little River	7452	100-Year	2330.00	12.80	27.29	2.10	198.64
Little River	7452	500-Year	3520.00	12.80	29.41	2.49	327.07
Little River	6195	10-Year	1160.00	11.80	22.47	1.40	219.45
Little River	6195	50-Year	1920.00	11.80	25.13	1.52	268.65
Little River	6195	100-Year	2330.00	11.80	27.00	1.46	304.15
Little River	6195	500-Year	3520.00	11.80	29.09	1.74	402.46
Little River	6115	10-Year	1160.00	13.80	22.20	3.64	90.61
Little River	6115	50-Year	1920.00	13.80	24.83	4.07	124.95
Little River	6115	100-Year	2330.00	13.80	26.72	3.99	149.90
Little River	6115	500-Year	3520.00	13.80	28.87	4.01	343.11
Little River	6095		Bridge				
Little River	6075	10-Year	1160.00	13.02	20.82	5.48	76.46
Little River	6075	50-Year	1920.00	13.02	23.21	5.69	107.71
Little River	6075	100-Year	2330.00	13.02	24.83	5.47	128.94
Little River	6075	500-Year	3520.00	13.02	28.62	4.37	345.35
Little River	6015	10-Year	1160.00	10.03	20.57	4.26	54.80
Little River	6015	50-Year	1920.00	10.03	23.03	4.69	225.43
Little River	6015	100-Year	2330.00	10.03	24.80	3.85	325.65
Little River	6015	500-Year	3520.00	10.03	28.63	2.67	433.58
Little River	5995	10-Year	1160.00	4.78	20.75	0.75	295.49
Little River	5995	50-Year	1920.00	4.78	23.24	0.89	354.33
Little River	5995	100-Year	2330.00	4.78	24.91	0.89	376.24
Little River	5995	500-Year	3520.00	4.78	28.66	0.94	482.61
Little River	5975	10-Year	1160.00	0.00	20.76	0.44	207.18
Little River	5975	50-Year	1920.00	0.00	23.24	0.62	253.82
Little River	5975	100-Year	2330.00	0.00	24.91	0.68	306.33
Little River	5975	500-Year	3520.00	0.00	28.66	0.82	493.92
Little River	5861	10-Year	1160.00	12.00	20.60	3.28	190.27
Little River	5861	50-Year	1920.00	12.00	23.13	3.13	220.81
Little River	5861	100-Year	2330.00	12.00	24.82	2.84	258.61
Little River	5861	500-Year	3520.00	12.00	28.61	2.51	409.10
Little River	5826	10-Year	1160.00	12.75	20.45	3.77	167.71
Little River	5826	50-Year	1920.00	12.75	23.03	3.57	201.07
Little River	5826	100-Year	2330.00	12.75	24.76	3.19	239.05
Little River	5826	500-Year	3520.00	12.75	28.58	2.76	393.97
Little River	5823		Inl Struct				
Little River	5820	10-Year	1160.00	12.75	20.18	5.22	159.35

HEC-RAS Plan: Prop 617 River: Little River Reach: Little River (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Vel Chnl	Top Width
			(cfs)	(ft)	(ft)	(ft/s)	(ft)
Little River	5820	50-Year	1920.00	12.75	22.81	5.18	189.33
Little River	5820	100-Year	2330.00	12.75	24.59	4.71	220.58
Little River	5820	500-Year	3520.00	12.75	28.46	4.25	371.55
Little River	5775	10-Year	1160.00	12.69	20.19	4.47	198.60
Little River	5775	50-Year	1920.00	12.69	22.84	4.33	225.93
Little River	5775	100-Year	2330.00	12.69	24.62	3.94	255.87
Little River	5775	500-Year	3520.00	12.69	28.47	3.60	402.39
Little River	5690	10-Year	1160.00	12.50	20.13	4.40	202.27
Little River	5690	50-Year	1920.00	12.50	22.82	4.15	224.46
Little River	5690	100-Year	2330.00	12.50	24.61	3.80	240.84
Little River	5690	500-Year	3520.00	12.50	28.47	3.54	346.45
Little River	5510	10-Year	1160.00	12.21	19.95	4.38	178.24
Little River	5510	50-Year	1920.00	12.21	22.71	4.12	200.76
Little River	5510	100-Year	2330.00	12.21	24.53	3.78	216.91
Little River	5510	500-Year	3520.00	12.21	28.42	3.55	353.98
Little River	5507		Inl Struct				
Little River	5504	10-Year	1160.00	12.20	19.90	4.42	177.58
Little River	5504	50-Year	1920.00	12.20	22.69	4.13	200.64
Little River	5504	100-Year	2330.00	12.20	24.51	3.79	216.49
Little River	5504	500-Year	3520.00	12.20	28.40	3.56	353.75
Little River	5430	10-Year	1160.00	12.09	19.70	5.10	119.14
Little River	5430	50-Year	1920.00	12.09	22.49	5.10	149.37
Little River	5430	100-Year	2330.00	12.09	24.35	4.75	166.83
Little River	5430	500-Year	3520.00	12.09	28.27	4.53	353.35
Little River	5424	10-Year	1160.00	12.08	19.69	5.11	118.94
Little River	5424	50-Year	1920.00	12.08	22.48	5.10	149.32
Little River	5424	100-Year	2330.00	12.08	24.34	4.75	166.79
Little River	5424	500-Year	3520.00	12.08	28.27	4.53	353.28
Little River	5232	10-Year	1160.00	11.75	19.52	4.69	150.22
Little River	5232	50-Year	1920.00	11.75	22.41	4.49	224.81
Little River	5232	100-Year	2330.00	11.75	24.31	4.06	266.12
Little River	5232	500-Year	3520.00	11.75	28.27	3.72	472.46
Little River	5226	10-Year	1160.00	11.74	19.51	4.69	149.89
Little River	5226	50-Year	1920.00	11.74	22.41	4.49	224.73
Little River	5226	100-Year	2330.00	11.74	24.31	4.06	266.07
Little River	5226	500-Year	3520.00	11.74	28.27	3.72	472.43
Little River	5160	10-Year	1160.00	11.62	19.59	3.43	237.76
Little River	5160	50-Year	1920.00	11.62	22.48	3.23	277.47
Little River	5160	100-Year	2330.00	11.62	24.36	2.98	294.22
Little River	5160	500-Year	3520.00	11.62	28.30	2.87	470.22
Little River	5128	10-Year	1160.00	11.56	19.67	0.90	265.08
Little River	5128	50-Year	1920.00	11.56	22.53	1.05	296.24

HEC-RAS Plan: Prop 617 River: Little River Reach: Little River (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Vel Chnl	Top Width
			(cfs)	(ft)	(ft)	(ft/s)	(ft)
Little River	5128	100-Year	2330.00	11.56	24.40	1.06	309.57
Little River	5128	500-Year	3520.00	11.56	28.33	1.17	470.45
Little River	5077	10-Year	1160.00	11.47	19.64	1.51	239.12
Little River	5077	50-Year	1920.00	11.47	22.51	1.43	277.70
Little River	5077	100-Year	2330.00	11.47	24.39	1.34	294.61
Little River	5077	500-Year	3520.00	11.47	28.32	1.35	470.37
Little River	5030	10-Year	1160.00	11.38	19.53	2.78	129.45
Little River	5030	50-Year	1920.00	11.38	22.44	2.39	171.41
Little River	5030	100-Year	2330.00	11.38	24.33	2.18	183.44
Little River	5030	500-Year	3520.00	11.38	28.27	2.13	376.82
Little River	5027		Inl Struct				
Little River	5024	10-Year	1160.00	11.38	19.46	2.84	129.32
Little River	5024	50-Year	1920.00	11.38	22.39	2.41	171.09
Little River	5024	100-Year	2330.00	11.38	24.30	2.19	183.20
Little River	5024	500-Year	3520.00	11.38	28.25	2.14	375.20
Little River	4875	10-Year	1160.00	11.10	19.08	4.68	104.98
Little River	4875	50-Year	1920.00	11.10	22.08	4.75	135.91
Little River	4875	100-Year	2330.00	11.10	24.05	4.48	142.45
Little River	4875	500-Year	3520.00	11.10	28.03	4.52	332.32
Little River	4859	10-Year	1160.00	11.09	19.16	3.25	82.92
Little River	4859	50-Year	1920.00	11.09	22.17	3.06	121.34
Little River	4859	100-Year	2330.00	11.09	24.12	2.86	137.25
Little River	4859	500-Year	3520.00	11.09	28.09	2.86	341.20
Little River	4854.5		Bridge				
Little River	4850	10-Year	1160.00	11.08	18.94	4.80	81.91
Little River	4850	50-Year	1920.00	11.08	21.91	5.08	98.59
Little River	4850	100-Year	2330.00	11.08	23.89	4.89	114.23
Little River	4850	500-Year	3520.00	11.08	27.81	5.03	290.12
Little River	4750	10-Year	1160.00	10.90	18.88	4.31	95.62
Little River	4750	50-Year	1920.00	10.90	21.89	4.54	108.96
Little River	4750	100-Year	2330.00	10.90	23.87	4.39	114.03
Little River	4750	500-Year	3520.00	10.90	27.80	4.60	289.36
Little River	4721	10-Year	1160.00	9.20	18.80	4.46	128.81
Little River	4721	50-Year	1920.00	9.20	21.86	4.27	184.37
Little River	4721	100-Year	2330.00	9.20	23.91	3.37	193.34
Little River	4721	500-Year	3520.00	9.20	27.87	2.96	299.96
Little River	4692	10-Year	1160.00	9.20	18.78	4.47	128.31
Little River	4692	50-Year	1920.00	9.20	21.81	4.33	183.54
Little River	4692	100-Year	2330.00	9.20	23.90	3.38	193.28
Little River	4692	500-Year	3520.00	9.20	27.87	2.96	299.65
Little River	4663	10-Year	1160.00	9.20	18.76	4.48	127.80

HEC-RAS Plan: Prop 617 River: Little River Reach: Little River (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Vel Chnl	Top Width
			(cfs)	(ft)	(ft)	(ft/s)	(ft)
Little River	4663	50-Year	1920.00	9.20	21.75	4.39	182.68
Little River	4663	100-Year	2330.00	9.20	23.88	3.39	193.22
Little River	4663	500-Year	3520.00	9.20	27.86	2.96	299.34
Little River	4632	10-Year	1160.00	10.70	18.70	4.63	42.47
Little River	4632	50-Year	1920.00	10.70	21.61	4.89	140.72
Little River	4632	100-Year	2330.00	10.70	23.71	4.40	202.20
Little River	4632	500-Year	3520.00	10.70	27.76	4.01	414.24
Little River	4629		Inl Struct				
Little River	4625	10-Year	1160.00	10.70	18.49	4.79	42.02
Little River	4625	50-Year	1920.00	10.70	21.51	4.97	139.11
Little River	4625	100-Year	2330.00	10.70	23.66	4.44	200.40
Little River	4625	500-Year	3520.00	10.70	27.73	4.03	411.64
Little River	4495	10-Year	1160.00	10.56	18.40	4.10	235.37
Little River	4495	50-Year	1920.00	10.56	21.57	3.23	288.54
Little River	4495	100-Year	2330.00	10.56	23.72	2.76	311.36
Little River	4495	500-Year	3520.00	10.56	27.77	2.59	398.86
Little River	4455	10-Year	1160.00	10.50	18.56	0.69	250.73
Little River	4455	50-Year	1920.00	10.50	21.64	0.80	288.93
Little River	4455	100-Year	2330.00	10.50	23.76	0.80	311.88
Little River	4455	500-Year	3520.00	10.50	27.80	0.90	399.73
Little River	4370	10-Year	1160.00	10.34	18.19	4.73	70.92
Little River	4370	50-Year	1920.00	10.34	21.30	4.76	181.26
Little River	4370	100-Year	2330.00	10.34	23.54	4.15	312.14
Little River	4370	500-Year	3520.00	10.34	27.69	3.45	585.82
Little River	4060	10-Year	1160.00	9.80	18.01	3.75	79.64
Little River	4060	50-Year	1920.00	9.80	21.19	3.95	117.92
Little River	4060	100-Year	2330.00	9.80	23.45	3.71	140.93
Little River	4060	500-Year	3520.00	9.80	27.56	3.78	355.22
Little River	4030	10-Year	1160.00	9.75	17.93	4.24	100.92
Little River	4030	50-Year	1920.00	9.75	21.16	4.25	136.17
Little River	4030	100-Year	2330.00	9.75	23.44	3.91	143.75
Little River	4030	500-Year	3520.00	9.75	27.55	3.96	406.42
Little River	4000	10-Year	1160.00	9.70	17.95	3.58	75.10
Little River	4000	50-Year	1920.00	9.70	21.22	2.97	121.65
Little River	4000	100-Year	2330.00	9.70	23.50	2.46	148.12
Little River	4000	500-Year	3520.00	9.70	27.61	2.31	244.72
Little River	3996		Inl Struct				
Little River	3993	10-Year	1160.00	9.70	17.74	4.56	71.45
Little River	3993	50-Year	1920.00	9.70	21.01	4.56	160.66
Little River	3993	100-Year	2330.00	9.70	23.34	4.06	200.07
Little River	3993	500-Year	3520.00	9.70	27.50	3.87	354.58

HEC-RAS Plan: Prop 617 River: Little River Reach: Little River (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Vel Chnl	Top Width
			(cfs)	(ft)	(ft)	(ft/s)	(ft)
Little River	3850	10-Year	1160.00	9.50	17.61	3.96	68.50
Little River	3850	50-Year	1920.00	9.50	21.01	2.72	160.68
Little River	3850	100-Year	2330.00	9.50	23.36	2.17	200.74
Little River	3850	500-Year	3520.00	9.50	27.54	1.98	356.79
Little River	3555	10-Year	1160.00	9.20	17.22	4.42	66.68
Little River	3555	50-Year	1920.00	9.20	20.65	4.55	106.90
Little River	3555	100-Year	2330.00	9.20	23.11	4.19	156.38
Little River	3555	500-Year	3520.00	9.20	27.35	4.08	367.59
Little River	3375	10-Year	1160.00	9.00	17.08	4.38	107.06
Little River	3375	50-Year	1920.00	9.00	20.61	4.22	136.97
Little River	3375	100-Year	2330.00	9.00	23.09	3.84	145.99
Little River	3375	500-Year	3520.00	9.00	27.34	3.85	451.10
Little River	3350	10-Year	1160.00	9.00	17.02	4.58	83.99
Little River	3350	50-Year	1920.00	9.00	20.53	4.59	111.21
Little River	3350	100-Year	2330.00	9.00	23.03	4.21	119.78
Little River	3350	500-Year	3520.00	9.00	27.26	4.37	320.61
Little River	3346		Inl Struct				
Little River	3342	10-Year	1160.00	9.00	16.92	4.66	82.60
Little River	3342	50-Year	1920.00	9.00	20.48	4.62	111.08
Little River	3342	100-Year	2330.00	9.00	22.98	4.23	119.58
Little River	3342	500-Year	3520.00	9.00	27.21	4.39	316.13
Little River	3300	10-Year	1160.00	8.90	16.88	4.64	82.43
Little River	3300	50-Year	1920.00	8.90	20.45	4.60	111.85
Little River	3300	100-Year	2330.00	8.90	22.97	4.21	120.03
Little River	3300	500-Year	3520.00	8.90	27.20	4.37	315.10
Little River	3150	10-Year	1160.00	8.60	16.73	4.60	57.24
Little River	3150	50-Year	1920.00	8.60	20.31	4.79	69.72
Little River	3150	100-Year	2330.00	8.60	22.84	4.54	96.11
Little River	3150	500-Year	3520.00	8.60	27.08	4.75	212.26
Little River	2979	10-Year	1160.00	8.34	16.62	4.21	47.57
Little River	2979	50-Year	1920.00	8.34	20.23	4.52	58.96
Little River	2979	100-Year	2330.00	8.34	22.78	4.33	97.90
Little River	2979	500-Year	3520.00	8.34	27.04	4.57	210.61
Little River	2805	10-Year	1160.00	8.03	16.49	3.91	54.42
Little River	2805	50-Year	1920.00	8.03	20.23	3.44	87.27
Little River	2805	100-Year	2330.00	8.03	22.83	2.99	127.33
Little River	2805	500-Year	3520.00	8.03	27.11	2.93	290.93
Little River	2775	10-Year	1160.00	8.00	16.49	3.61	56.98
Little River	2775	50-Year	1920.00	8.00	20.22	3.45	132.55
Little River	2775	100-Year	2330.00	8.00	22.83	3.04	227.69
Little River	2775	500-Year	3520.00	8.00	27.13	2.90	384.43
Little River	2645	10-Year	1160.00	7.92	16.48	2.92	83.96

HEC-RAS Plan: Prop 617 River: Little River Reach: Little River (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Vel Chnl	Top Width
			(cfs)	(ft)	(ft)	(ft/s)	(ft)
Little River	2645	50-Year	1920.00	7.92	20.24	2.59	113.71
Little River	2645	100-Year	2330.00	7.92	22.84	2.32	125.64
Little River	2645	500-Year	3520.00	7.92	27.12	2.43	239.67
Little River	2567	10-Year	1160.00	7.87	16.34	3.80	56.58
Little River	2567	50-Year	1920.00	7.87	20.17	3.22	113.25
Little River	2567	100-Year	2330.00	7.87	22.81	2.70	125.58
Little River	2567	500-Year	3520.00	7.87	27.10	2.69	237.15
Little River	2564		Inl Struct				
Little River	2561	10-Year	1160.00	7.50	16.21	3.74	55.94
Little River	2561	50-Year	1920.00	7.50	20.08	3.20	112.70
Little River	2561	100-Year	2330.00	7.50	22.76	2.68	125.51
Little River	2561	500-Year	3520.00	7.50	27.06	2.67	233.26
Little River	2558	10-Year	1160.00	5.50	16.25	3.02	59.34
Little River	2558	50-Year	1920.00	5.50	20.09	3.07	112.76
Little River	2558	100-Year	2330.00	5.50	22.76	2.73	125.52
Little River	2558	500-Year	3520.00	5.50	27.06	2.79	233.72
Little River	2550	10-Year	1160.00	5.50	16.25	2.97	59.34
Little River	2550	50-Year	1920.00	5.50	20.10	2.80	112.83
Little River	2550	100-Year	2330.00	5.50	22.77	2.44	125.53
Little River	2550	500-Year	3520.00	5.50	27.06	2.51	233.84
Little River	2516	10-Year	1160.00	5.50	16.26	2.74	76.66
Little River	2516	50-Year	1920.00	5.50	20.11	2.53	112.89
Little River	2516	100-Year	2330.00	5.50	22.78	2.27	125.56
Little River	2516	500-Year	3520.00	5.50	27.07	2.39	234.26
Little River	2513	10-Year	1160.00	7.50	16.12	3.89	45.84
Little River	2513	50-Year	1920.00	7.50	19.95	3.93	67.91
Little River	2513	100-Year	2330.00	7.50	22.65	3.59	84.78
Little River	2513	500-Year	3520.00	7.50	27.00	3.39	464.22
Little River	2511		Inl Struct				
Little River	2509	10-Year	1160.00	7.25	16.03	3.34	51.24
Little River	2509	50-Year	1920.00	7.25	19.88	3.48	70.30
Little River	2509	100-Year	2330.00	7.25	22.61	3.27	85.50
Little River	2509	500-Year	3520.00	7.25	26.95	3.34	459.06
Little River	2506	10-Year	1160.00	5.20	16.04	3.19	50.54
Little River	2506	50-Year	1920.00	5.20	19.88	3.31	71.03
Little River	2506	100-Year	2330.00	5.20	22.62	3.02	88.09
Little River	2506	500-Year	3520.00	5.20	26.98	2.76	462.25
Little River	2480	10-Year	1160.00	5.20	15.99	3.25	49.18
Little River	2480	50-Year	1920.00	5.20	19.85	3.38	68.69
Little River	2480	100-Year	2330.00	5.20	22.59	3.12	78.64
Little River	2480	500-Year	3520.00	5.20	26.96	2.87	459.86

HEC-RAS Plan: Prop 617 River: Little River Reach: Little River (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Vel Chnl	Top Width
			(cfs)	(ft)	(ft)	(ft/s)	(ft)
Little River	2464	10-Year	1160.00	5.20	15.96	3.26	49.12
Little River	2464	50-Year	1920.00	5.20	19.83	3.37	72.04
Little River	2464	100-Year	2330.00	5.20	22.58	3.07	87.48
Little River	2464	500-Year	3520.00	5.20	26.96	2.80	459.43
Little River	2461	10-Year	1160.00	7.25	15.86	4.04	46.91
Little River	2461	50-Year	1920.00	7.25	19.73	4.04	52.19
Little River	2461	100-Year	2330.00	7.25	22.49	3.76	59.50
Little River	2461	500-Year	3520.00	7.25	26.86	3.67	347.98
Little River	2456		Inl Struct				
Little River	2451	10-Year	1160.00	7.25	15.70	4.30	48.50
Little River	2451	50-Year	1920.00	7.25	19.62	3.95	61.36
Little River	2451	100-Year	2330.00	7.25	22.41	3.50	75.20
Little River	2451	500-Year	3520.00	7.25	26.84	3.32	252.06
Little River	2449	10-Year	1160.00	5.00	15.76	3.31	47.96
Little River	2449	50-Year	1920.00	5.00	19.64	3.43	61.42
Little River	2449	100-Year	2330.00	5.00	22.42	3.16	75.20
Little River	2449	500-Year	3520.00	5.00	26.82	3.13	256.82
Little River	2430	10-Year	1160.00	5.00	15.81	2.06	68.00
Little River	2430	50-Year	1920.00	5.00	19.69	2.29	79.88
Little River	2430	100-Year	2330.00	5.00	22.45	2.23	79.88
Little River	2430	500-Year	3520.00	5.00	26.84	2.53	112.98
Little River	2420	10-Year	1160.00	5.00	15.80	2.17	65.00
Little River	2420	50-Year	1920.00	5.00	19.67	2.49	73.90
Little River	2420	100-Year	2330.00	5.00	22.43	2.45	73.90
Little River	2420	500-Year	3520.00	5.00	26.82	2.78	331.30
Little River	2415	10-Year	1160.00	5.00	15.77	2.43	58.00
Little River	2415	50-Year	1920.00	5.00	19.65	2.68	65.01
Little River	2415	100-Year	2330.00	5.00	22.42	2.60	65.02
Little River	2415	500-Year	3520.00	5.00	26.79	2.94	242.40
Little River	2380	10-Year	1160.00	6.00	15.34	5.17	41.94
Little River	2380	50-Year	1920.00	6.00	19.10	5.83	46.00
Little River	2380	100-Year	2330.00	6.00	21.88	5.72	46.00
Little River	2380	500-Year	3520.00	6.00	26.67	3.99	265.73
Little River	2342.5		Bridge				
Little River	2305	10-Year	1160.00	6.00	15.02	5.22	45.88
Little River	2305	50-Year	1920.00	6.00	18.37	6.08	45.93
Little River	2305	100-Year	2330.00	6.00	20.02	6.43	45.95
Little River	2305	500-Year	3520.00	6.00	26.19	3.33	559.70
Little River	2273	10-Year	1160.00	5.89	15.13	3.37	51.24
Little River	2273	50-Year	1920.00	5.89	18.54	3.64	57.39
Little River	2273	100-Year	2330.00	5.89	20.23	3.71	62.08
Little River	2273	500-Year	3520.00	5.89	26.19	3.16	311.80

HEC-RAS Plan: Prop 617 River: Little River Reach: Little River (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Vel Chnl	Top Width
			(cfs)	(ft)	(ft)	(ft/s)	(ft)
Little River	2255	10-Year	1160.00	7.50	15.05	3.92	45.30
Little River	2255	50-Year	1920.00	7.50	18.46	4.24	52.24
Little River	2255	100-Year	2330.00	7.50	20.14	4.33	58.32
Little River	2255	500-Year	3520.00	7.50	26.15	3.58	223.03
Little River	2218	10-Year	1160.00	7.00	14.92	4.61	36.79
Little River	2218	50-Year	1920.00	7.00	18.30	5.07	39.51
Little River	2218	100-Year	2330.00	7.00	19.97	5.20	43.44
Little River	2218	500-Year	3520.00	7.00	26.02	4.44	287.47
Little River	2126	10-Year	1160.00	7.06	14.78	5.28	45.66
Little River	2126	50-Year	1920.00	7.06	18.28	5.13	62.17
Little River	2126	100-Year	2330.00	7.06	20.00	5.01	71.64
Little River	2126	500-Year	3520.00	7.06	26.09	3.87	297.44
Little River	2021	10-Year	1160.00	6.78	14.83	3.59	60.53
Little River	2021	50-Year	1920.00	6.78	18.34	3.64	71.85
Little River	2021	100-Year	2330.00	6.78	20.04	3.65	78.96
Little River	2021	500-Year	3520.00	6.78	26.10	3.12	116.86
Little River	1922	10-Year	1160.00	7.24	14.45	5.35	40.86
Little River	1922	50-Year	1920.00	7.24	18.01	5.33	52.18
Little River	1922	100-Year	2330.00	7.24	19.74	5.30	59.02
Little River	1922	500-Year	3520.00	7.24	25.92	4.43	86.59
Little River	1825	10-Year	1160.00	6.34	14.49	4.05	44.70
Little River	1825	50-Year	1920.00	6.34	18.04	4.42	53.99
Little River	1825	100-Year	2330.00	6.34	19.76	4.53	59.46
Little River	1825	500-Year	3520.00	6.34	25.92	4.08	77.85
Little River	1775 FEMA Section A	10-Year	1160.00	5.20	14.47	3.95	41.24
Little River	1775 FEMA Section A	50-Year	1920.00	5.20	17.96	4.60	43.80
Little River	1775 FEMA Section A	100-Year	2330.00	5.20	19.64	4.88	45.03
Little River	1775 FEMA Section A	500-Year	3520.00	5.20	25.68	5.08	49.45
Little River	1750		Bridge				
Little River	0010	10-Year	1160.00	-3.30	1.03	14.14	360.14
Little River	0010	50-Year	1920.00	-3.30	1.90	17.39	535.00
Little River	0010	100-Year	2330.00	-3.30	2.33	18.77	619.45
Little River	0010	500-Year	3520.00	-3.30	3.26	22.78	806.71
Little River	0	10-Year	1160.00	-3.30	1.60	1.49	664.57
Little River	0	50-Year	1920.00	-3.30	1.60	2.46	664.57
Little River	0	100-Year	2330.00	-3.30	1.60	2.99	664.57
Little River	0	500-Year	3520.00	-3.30	-0.89	33.20	226.32

Attachment 10

Sediment Sieve and Mobility Analysis Results

Little River Dam Removal
Sediment Mobility Calculations
April 6, 2021
Updated June 2022

Location	Description	Average Hydr Depth (feet)	Average n-value	Average d50 Sed. (mm)	Average D50 sed ft
Transect 1: RS 2450 - RS 2480	Sample 02	1.72	0.05061111	0.2647	0.00086848
Transect 2: RS 3850 - RS 4000	Sample 03	1.72	0.065	1.2535	0.00411273
Transect 3: RS 5510	Sample 04	1.78	0.03	0.0901	0.00029562

Table 7: Post Dam Removal Flow Depths and Critical Flow Velocities (for report)

section Loca	Post Dam Removal Channel Depths (feet)				Post Dam Removal Critical Flow Velocities (fps)			
	Base Condition (Low) Flow Condition	10-Year Flood	50-Year Flood	100-Year Flood	Base Condition (Low) Flow Condition	10-Year Flood	50-Year Flood	100-Year Flood
1	1.72	6.32	8.52	9.98	1.17	1.45	1.52	1.56
2	1.72	4.29	4.87	6.04	1.96	2.28	2.33	2.41
3	1.78	2.54	4.88	6.25	0.82	0.87	0.97	1.01

Table 8: Post Dam Removal Flow Depths and Critical Flow Velocities (for report)

section Loca	Post Dam Removal Computed Average Flow Velocities (fps)				Potential for Sediment Mobility			
	Base Condition (Low) Flow Condition	10-Year Flood	50-Year Flood	100-Year Flood	Base Condition (Low) Flow Condition	10-Year Flood	50-Year Flood	100-Year Flood
1	0.34	3.86	3.79	3.46	Low	High	High	High
2	0.23	3.77	2.85	2.32	Low	High	High	High
3	0.22	4.38	4.12	3.78	Low	High	High	High

River	Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Vel Chnl (ft/s)	Hydr Depth (ft)	Max Chl Dpth (ft)
Little River	Little River	5510	10-Year	1160	12.21	19.95	4.38	2.54	7.74
Little River	Little River	5510	50-Year	1920	12.21	22.71	4.12	4.88	10.5
Little River	Little River	5510	100-Year	2330	12.21	24.53	3.78	6.25	12.32
Little River	Little River	5510	Base Conditic	9.8	12.21	14.29	0.22	1.78	2.08
Little River	Little River	4000	10-Year	1160	9.7	17.95	3.58	4.31	8.25
Little River	Little River	4000	50-Year	1920	9.7	21.22	2.97	5.32	11.52
Little River	Little River	4000	100-Year	2330	9.7	23.5	2.46	6.46	13.8
Little River	Little River	4000	Base Conditic	9.8	9.7	12.03	0.19	1.9	2.33
Little River	Little River	3850	10-Year	1160	9.5	17.61	3.96	4.27	8.11
Little River	Little River	3850	50-Year	1920	9.5	21.01	2.72	4.42	11.51
Little River	Little River	3850	100-Year	2330	9.5	23.36	2.17	5.61	13.86
Little River	Little River	3850	Base Conditic	9.8	9.5	11.26	0.26	1.53	1.76
Little River	Little River	2480	10-Year	1160	5.2	15.99	3.25	7.26	10.79
Little River	Little River	2480	50-Year	1920	5.2	19.85	3.38	8.47	14.65
Little River	Little River	2480	100-Year	2330	5.2	22.59	3.12	9.97	17.39
Little River	Little River	2480	Base Conditic	9.8	5.2	9.04	0.12	2.82	3.84
Little River	Little River	2461	10-Year	1160	7.25	15.86	4.04	6.12	8.61
Little River	Little River	2461	50-Year	1920	7.25	19.73	4.04	9.14	12.48
Little River	Little River	2461	100-Year	2330	7.25	22.49	3.76	10.74	15.24
Little River	Little River	2461	Base Conditic	9.8	7.25	9.04	0.31	1.42	1.79
Little River	Little River	2451	10-Year	1160	7.25	15.7	4.3	5.57	8.45
Little River	Little River	2451	50-Year	1920	7.25	19.62	3.95	7.96	12.37
Little River	Little River	2451	100-Year	2330	7.25	22.41	3.5	9.22	15.16
Little River	Little River	2451	Base Conditic	9.8	7.25	8.33	0.58	0.93	1.08

River	Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Vel Chnl (ft/s)	Hydr Depth (ft)	Max Chl Dpth (ft)
Little River	Little River	2449	10-Year	1160	5	15.76	3.31	7.31	10.76
Little River	Little River	2449	50-Year	1920	5	19.64	3.43	9.2	14.64
Little River	Little River	2449	100-Year	2330	5	22.42	3.16	10.22	17.42
Little River	Little River	2449	Base Condi	9.8	5	8.34	0.15	2.57	3.34

THIELSCH ENGINEERING

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Let's Build a Solid Foundation

Client Information:
Fuss & O'Neil
North Quincy, MA
PM: Matt Kissane
Assigned By: Matt Kissane
Collected By: Client

Project Information:
MVP Action Grant RY21
Haverhill, MA
F&ON Project Number: 201703901.V20
Summary Page: 1 of 1
Report Date: 11.23.2020

LABORATORY TESTING DATA SHEET, Report No.: 7420-L-155

Source	Sample No.	Depth (Ft)	Laboratory No.	Identification Tests								Proctor / CBR / Permeability Tests								Laboratory Log and Soil Description
				As Received Water Content %	LL %	PL %	Gravel %	Sand %	Fines %	Org. %	G_s	Dry unit wt. pcf	Test Water Content %	γ_d MAX (pcf) W_{opt} (%)	γ_d MAX (pcf) W_{opt} (%) (Corr.)	Target Test Setup as % of Proctor	CBR @ 0.1"	CBR @ 0.2"	Permeability cm/sec	
				D2216	D4318		D6913			D2974	D854			D1557						
Boring	1543201117-02	-	20-S-3562	106.9			9.4	67.3	23.3											Brown silty sand
Boring	1543201117-03	-	20-S-3563	50.1			22.0	71.3	6.7											Brown poorly graded sand with silt and gravel
Boring	1543201117-04	-	20-S-3564	91.0			2.3	53.0	44.7											Brown silty sand

Date Received: *11.19.2020*

Reviewed By: SH

Date Reviewed: *11.23.2020*

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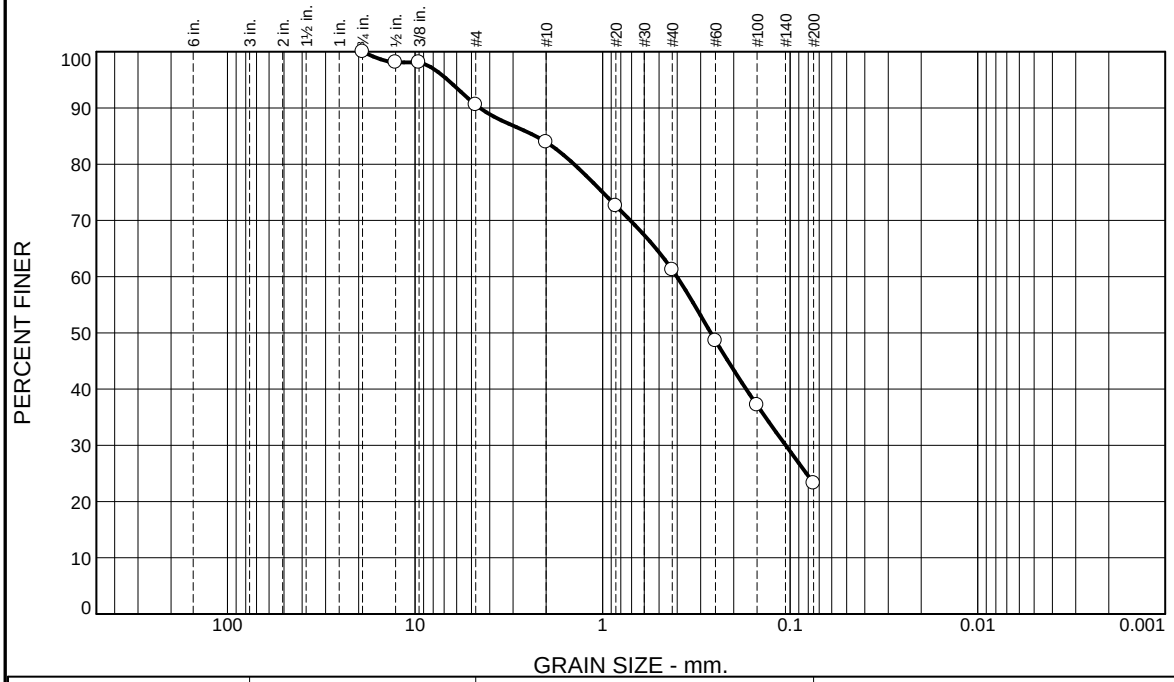
Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	9.4	6.7	22.7	37.9	23.3	

Test Results (C136 & ASTM C 117)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
0.75"	100.0		
0.5"	98.1		
0.375"	98.1		
#4	90.6		
#10	83.9		
#20	72.6		
#40	61.2		
#60	48.6		
#100	37.1		
#200	23.3		

* (no specification provided)

Material Description

Brown silty sand

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-2-4(0)

Coefficients

D_{90}= 4.5071 D_{85}= 2.2730 D_{60}= 0.4016
D_{50}= 0.2647 D_{30}= 0.1056 D_{15}=
D_{10}= C_u= C_c=

Remarks

Date Received: 11.19.2020 **Date Tested:** 11.23.2020

Tested By: AV

Checked By: Steven Accetta

Title: Laboratory Coordinator

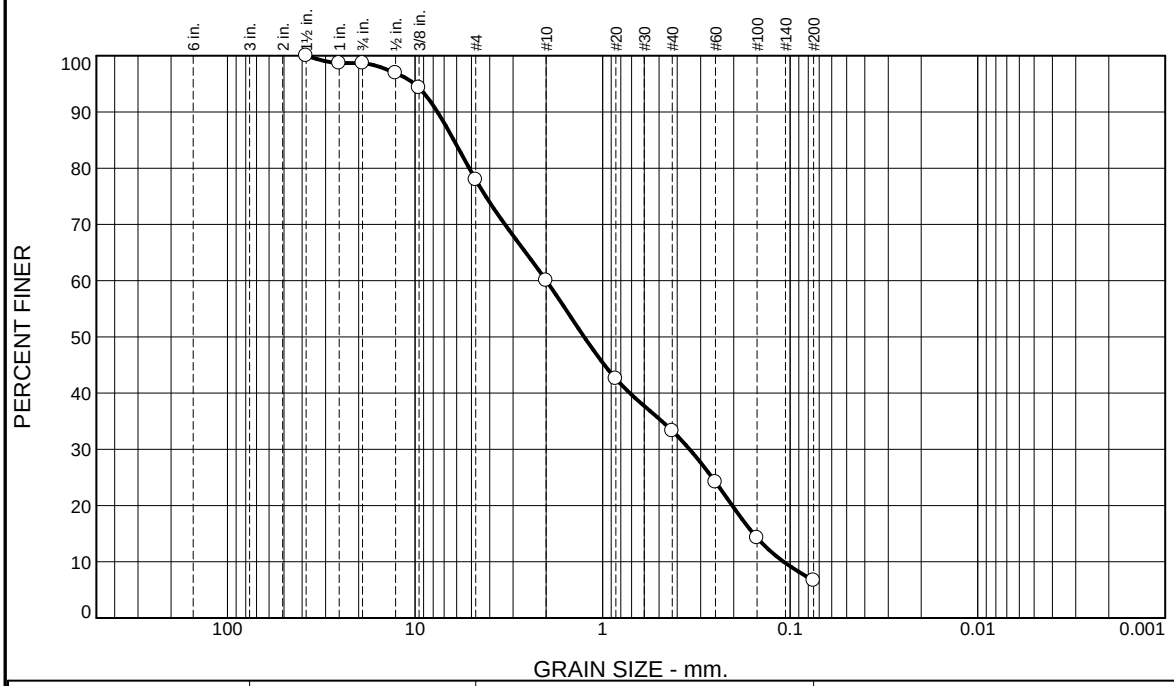
Source of Sample: Borings **Date Sampled:**
Sample Number: 1543201117-02

Thielsch Engineering Inc.

Cranston, RI

Client: Fuss & O'Neil
Project: MVP Action Grant RY21
Haverhill, MA
Project No: 20170390.V20 **Figure** 20-S-3562

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	1.3	20.7	18.0	26.7	26.6	6.7	

Test Results (C136 & ASTM C 117)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1.5"	100.0		
1"	98.7		
0.75"	98.7		
0.5"	96.9		
0.375"	94.3		
#4	78.0		
#10	60.0		
#20	42.6		
#40	33.3		
#60	24.2		
#100	14.3		
#200	6.7		

* (no specification provided)

Material Description

Brown poorly graded sand with silt and gravel

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SP-SM **AASHTO (M 145)=** A-1-b

Coefficients

D_{90}= 7.5833 D_{85}= 6.2094 D_{60}= 1.9954
D_{50}= 1.2535 D_{30}= 0.3433 D_{15}= 0.1567
D_{10}= 0.1083 C_u= 18.42 C_c= 0.55

Remarks

Date Received: 11.19.2020 **Date Tested:** 11.23.2020

Tested By: AV

Checked By: Rebecca Roth

Title: Laboratory Coordinator

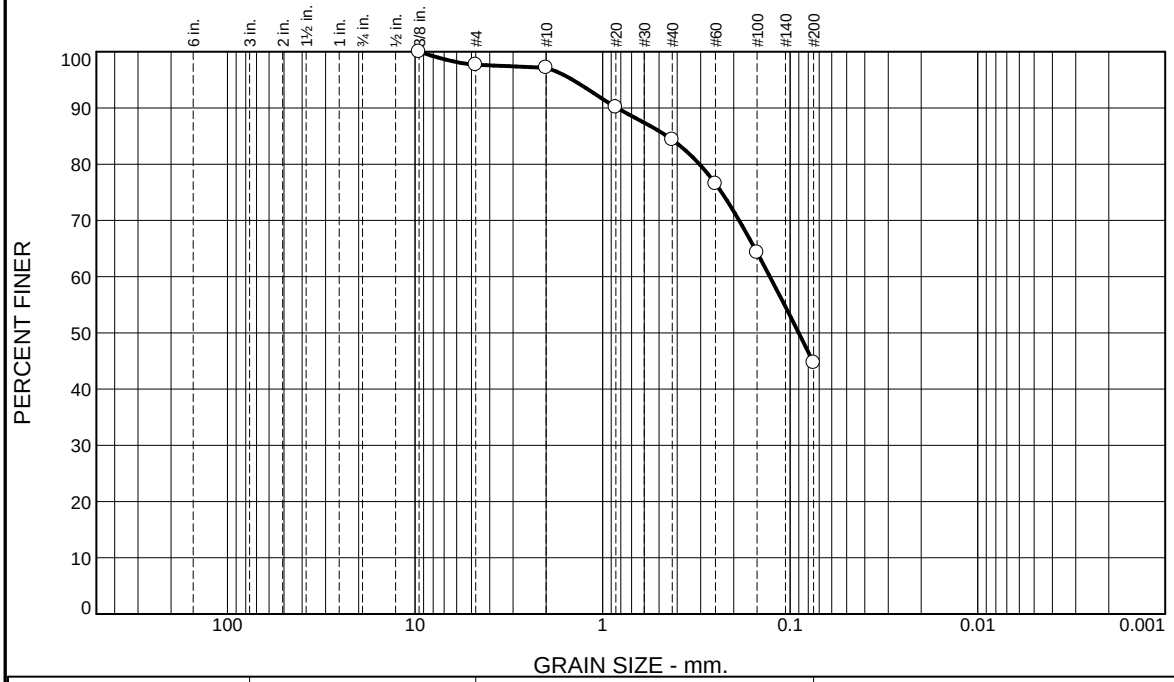
Source of Sample: Borings **Date Sampled:**
Sample Number: 1543201117-03

Thielsch Engineering Inc.

Cranston, RI

Client: Fuss & O'Neil
Project: MVP Action Grant RY21
Haverhill, MA
Project No: 20170390.V20 **Figure** 20-S-3563

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	2.3	0.5	12.9	39.6	44.7	

Test Results (C136 & ASTM C 117)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
0.375"	100.0		
#4	97.7		
#10	97.2		
#20	90.1		
#40	84.3		
#60	76.5		
#100	64.3		
#200	44.7		

* (no specification provided)

Material Description

Brown silty sand

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-4(0)

Coefficients

D_{90}= 0.8363 D_{85}= 0.4536 D_{60}= 0.1282
D_{50}= 0.0901 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Date Received: 11.19.2020 **Date Tested:** 11.23.2020

Tested By: AV

Checked By: Rebecca Roth

Title: Laboratory Coordinator

Source of Sample: Borings **Date Sampled:**
Sample Number: 1543201117-04

Thielsch Engineering Inc.

Cranston, RI

Client: Fuss & O'Neil
Project: MVP Action Grant RY21
Haverhill, MA
Project No: 20170390.V20 **Figure** 20-S-3564

Attachment 11

Scour Countermeasure, Lower Riverbank Slope Protection, Channel Bottom Protection, Grade Control Boulder/Scour Pool, and Nature-like Fishway Weir/Pool Bottom Stone Sizing Computations

Little River Dam Removal Project
Riverbank Stabilization, Channel Bottom, Grade Control Boulder/Scour Pool,
Nature-like Fishway Weir and Resting Pool, and Scour Countermeasure Sizing Calculations
December 2023

I. NLF Boulder Sizing

Maximum Shear Stress at Low Flow Weir Opening

τ0	1.11 lbs/sf	obtained from HEC-RAS at RS2461 (10-Year Yielded Largest Shear Stress)

Stone Size Based On Rosgen Equation

Stone Parameter	Rosgen[1]
Grain Size, D, ft.	3.05
Equivalent Stone Weight (assume 160 lbs/cf)	2372.39
Safety Factor	1.00
Minimum Stone Weight	2372.39
Minimum Stone Dia. (ft.)	**3.05**

Recommended Min. Stone Weight (lbs): **2372.39 lbs.**
Recommended Min. Stone Volume (cf): **14.83 cf**

1. Rosgen Equation

The Rosgen 2001 equation is an empirical relationship between the calculated shear stress and the required stone size. Safety factors are built into the equation. This equation tends to oversize stone for all shear stress values and is typically used only as a maximum for stone size.

Rosgen (2001) equation (metric units)

$D=0.1724Ln(\tau_i)+0.6349$

Conversions:
1m=3.28 ft.
4.882 kg/m²= 1 lb/ft²

II.Grade Control Boulder Sizing

Maximum Shear Stress at Low Flow Weir Opening

τ0	0.93 lbs/sf	obtained from HEC-RAS at RS5826 (10-Year Yielded Largest Shear Stress)

Stone Size Based On Rosgen Equation

Stone Parameter	Rosgen[1]
Grain Size, D, ft.	2.95
Equivalent Stone Weight (assume 160 lbs/cf)	2144.08
Safety Factor	1.00
Minimum Stone Weight	2144.08
Minimum Stone Dia. (ft.)	**2.95**

Recommended Min. Stone Weight (lbs): **2144.08 lbs.**
Recommended Min. Stone Volume (cf): **13.40 cf**

III. River Channel Bottom Protection Outside of Scour Pools and NLF

Isbash Equation: $D_{50}= V^2 / (2*g*C^2*(S-1))$

where

V=	5.11	water velocity (greatest velocity occurs for 10-year flood at RS5424)	
g=	32.2	gravitational constant	
C=	1.2	Isbash constant factor (usually 0.86 for highly turbulent; 1.2 for low turbulence)	
S=	2.65	specific gravity of stone (typical value of 2.65)	
D50=	0.170651 ft.	or	2.047815 inches (say 2 inches)

IV. Channel Sideslope Protection

CALTRANS Chanel Riprap Sideslope

$W=0.00002/(Gs-1)^{3} * ((VM*V^{3}*G_s)/(\sin^{3}(r-a))$

where

W=		minimum rock weight (lbs)
V=	5.83	flow velocity (fps) occurs for 50-year flood at RS2380
VM=	**0.67**	**0.67 if parallel to flow**
VM=	1.33	1.33 if impinging flow
Gs=	2.65	specific gravity of rock
r=	40	angle of repose
a=	26.5	outside slope face angle to the horizontal (26.5 degrees for 2H:1V)

W=	**24.39801 lbs**	**(Equivalent to 6.5" stone)**	**Thus, use riprap ranging in size from 4" to 14" (with a d50=7)**

V. Stone Size, Length, and Depth of Scour Pool at Grade Control Boulders

$D_{30}= 1.95*S^{0.555}*q^{2/3}*1.25 / g^{1/3}$

where

S=	0.001572		Active Channel Width (ACW)-ft.
g=	32.2		
q=	0.723219	95% Exc.	18.39 ft. (conservative at RS2451)
q=	16.52635	Bankfull	32.07 ft. (conservative at RS2451)
q=	27.6059	10-year	42.02 ft. (conservative at RS4625)
q=	36.78866	50-year	52.19 ft. (conservative at RS2461)
q=	39.15966	100-year	59.5 ft. (conservative at RS2461)
q=	0.544444	Base	18 ft. (conservative at RS2451)
q=	5.88	5% Exc.	27.38 ft. (conservative at RS2451)
q=	2.04	50% Exc.	21.7 ft. (conservative at RS2451)

			D30 (Inches)	D50 (Inches)	
$D_{30}=$	0.13819	ft. (for Bankfull)	1.66	1.989935	
$D_{30}=$	0.194548	ft. (for 10-year)	2.33	2.801493	
$D_{30}=$	0.235596	ft. (for 50-year)	2.83	3.392589	
$D_{30}=$	**0.245614**	**ft. (for 100-year)**	**2.95**	**3.536834**	**Use stone ranging in size from 2" to 8" with a D50 of 4"**

Isbash Equation: $D_{50}= V^2 / (2*g*C^2*(S-1))$

per Part 654 National Engineering Handbook Technical Supplement 14C

where

V=	5.22	water velocity (greatest velocity occurs for 10-year flood at RS5820)	
g=	32.2	gravitational constant	
C=	0.86	Isbash constant factor (usually 0.86 for high turbulence)	
S=	2.65	specific gravity of stone (typical value of 2.65)	
D50=	0.346716 ft.	or	4.160596 inches (say 4 inches)

Pool Length = ACW * (0.409+4.211*H/ACW)+87.341(S_0*q25/(g^0.5*ACW^1.5)

			H (Drop Across Weir)		
L for 100-year=	**25.17418 ft.**	**(25' Pool Length Required)**	0.17	ft	(max at RS5823)
L for 10-year=	18.42617 ft.		0.27	ft	(max at RS5823)
L for Bankfull=	14.66108 ft.		0.35	ft	(max at RS5507)
L for 5%=	13.24688 ft.		0.48	ft	(max at RS4629)
L for 50%=	11.8757 ft.		0.71	ft	(max at RS4629)
L for 95%=	10.55751 ft.		0.8	ft	(max at RS4629)
L for Base Conditions=	10.52335 ft.		0.79	ft	(max at RS4629)

Pool Depth (per Part 654 National Engineering Handbook Technical Supplement 14C)

Scour Depth = ACW * (-0.0118+1.394*H/ACW)+5.514(S_0*q25/(g^0.5*ACW^1.5)

Scour Depth=	95% Exc.	0.828756	feet	
	Bankfull	0.671531	feet	
	Base	**0.8333**	**feet**	**(Say 1 foot)**

VI. NLF Channel Bottom Protection

Abt and Johnson Equation (1991): $D_{50}= \Phi e * \Phi c * a * 5.23 * S_o^{0.43} * q^{0.56}$

per USBR's Rock Ramp Design Guidelines (2007)

where

Φe=	1.2		coefficient for the empirical envelope on the regression relationship = 1.2;
Φc=	1.2		coefficient for flow concentration due to channelization within the revetment=1.2
a=	1.0		shape factor for rounded versus angular material
S_o=	0.013	ft./ft.	profile slope of the rock ramp
q=	50.65		100-year unit discharge (cfs)/ft weir channel width); use Q= and channel width=46 feet
D50=	**9.626489**	**inches (say 10 inches)**	

Isbash Equation: $D_{50}= V^2 / (2*g*C^2*(S-1))$

per Part 654 National Engineering Handbook Technical Supplement 14C

where

V=	5.72	water velocity (greatest 100-year velocity occurs at RS2380)					
g=	32.2	gravitational constant					
C=	0.86	Isbash constant factor (usually 0.86 for high turbulence)					
S=	2.65	specific gravity of stone (typical value of 2.65)					
D50=	0.416318	ft.	or	4.995817783	inches	**(say 7 inches)**	

VII. Winter Street Scour Countermeasures

Isbash Equation: $D_{50}= V^2 / (2*g*C^2*(S-1))$

where

V=	9.88	water velocity (100-year flood)				
g=	32.2	gravitational constant				
C=	0.86	Isbash constant factor (usually 0.86 for highly turbulent; 1.2 for low turbulence)				
S=	2.65	specific gravity of stone (typical value of 2.65)				
D50=	0.637943	ft.	or	7.655311	inches	(low turbulence)
D50=	**1.242073**	**ft.**	**or**	**14.90488**	**inches**	**(high turbulence)**

USBR Equation (Appropriate for Sizing Riprap Below Stilling Basin):

D50= $0.0122*V^{2.06}$

where

V=	9.88	fps	(100-year flood)			
D50=	**1.366341**	**ft.**	**or**	**16.39609**	**inches**	

HEC-23, Design Guideline 14 for Rock Riprap at Bridge Abutments

						Notes
D_{50}= ((K*y)/ (S-1)) * (V^ /g*y)						DG 14 - Fro
where	V=	5.38	characteristic average velocity in the contracted section, ft/s		(500-year)	DG 14 calls
	K=	1.02	velocity multiplier equal to 0.89 for spill through or 1.02 for vertical wall			This is verti
	y=	20.67	depth of flow in the contracted bridge opening, ft		(500-year)	DG 14 calls
	g=	32.2	gravitational constant			
	S=	2.65	specific gravity of stone (typical value of 2.65)			
						DG 14 says
500-year	**D50=**	**0.56**	**ft.**	**or**	**6.7 inches**	DG 14 says
D_{50}= ((K*y)/ (S-1)) * (V^ /g*y)						
where	V=	9.88	characteristic average velocity in the contracted section, ft/s		(100-year)	BR Open Ve
	K=	1.02	velocity multiplier equal to 0.89 for spill through or 1.02 for vertical wall			
	y=	13.8	average flow depth at culvert entrance before scour, ft		(100-year)	Bridge Max
	g=	32.2	gravitational constant			
	S=	2.65	specific gravity of stone (typical value of 2.65)			
Largest Size for 100-year	**D50=**	**1.87**	**ft.**	**or**	**22.5 inches**	
D_{50}= ((K*y)/ (S-1)) * (V^ /g*y)						
where	V=	8.33	characteristic average velocity in the contracted section, ft/s		(50-year)	BR Open Ve
	K=	1.02	velocity multiplier equal to 0.89 for spill through or 1.02 for vertical wall			
	y=	12.38	average flow depth at culvert entrance before scour, ft		(50-year)	Bridge Max
	g=	32.2	gravitational constant			
	S=	2.65	specific gravity of stone (typical value of 2.65)			
50-year	**D50=**	**1.33**	**ft.**	**or**	**16.0 inches**	
D_{50}= ((K*y)/ (S-1)) * (V^ /g*y)						
where	V=	6.3	characteristic average velocity in the contracted section, ft/s		(10-year)	BR Open Ve
	K=	1.02	velocity multiplier equal to 0.89 for spill through or 1.02 for vertical wall			
	y=	9.07	average flow depth at culvert entrance before scour, ft		(10-year)	Bridge Max
	g=	32.2	gravitational constant			
	S=	2.65	specific gravity of stone (typical value of 2.65)			
10-year	**D50=**	**0.76**	**ft.**	**or**	**9.1 inches**	
D_{50}= ((K*y)/ (S-1)) * (V^ /g*y)						
where	V=	3.6	characteristic average velocity in the contracted section, ft/s		(bankfull)	BR Open Ve
	K=	1.02	velocity multiplier equal to 0.89 for spill through or 1.02 for vertical wall			
	y=	5.25	average flow depth at culvert entrance before scour, ft		(bankfull)	Bridge Max
	g=	32.2	gravitational constant			
	S=	2.65	specific gravity of stone (typical value of 2.65)			
Bankfull	**D50=**	**0.25**	**ft.**	**or**	**3.0 inches**	
Largest Size for 100-year	**D50=**	**1.87**	**ft.**	**or**	**22.5 inches**	
Riprap Gradation						DG 14- use

Class VII: 15in- 48in, D50=24in, D100=48in

Table 4.1. Minimum and Maximum Allowable Particle Size in Inches.								
Nominal Riprap Class by Median Particle Diameter		d_{15}		d_{50}		d_{85}		d_{100}
Class	Size	Min	Max	Min	Max	Min	Max	Max
I	6 in	3.7	5.2	5.7	6.9	7.8	9.2	12.0
II	9 in	5.5	7.8	8.5	10.5	11.5	14.0	18.0
III	12 in	7.3	10.5	11.5	14.0	15.5	18.5	24.0
IV	15 in	9.2	13.0	14.5	17.5	19.5	23.0	30.0
V	18 in	11.0	15.5	17.0	20.5	23.5	27.5	36.0
VI	21 in	13.0	18.5	20.0	24.0	27.5	32.5	42.0
VII	24 in	14.5	21.0	23.0	27.5	31.0	37.0	48.0
VIII	30 in	18.5	26.0	28.5	34.5	39.0	46.0	60.0
IX	36 in	22.0	31.5	34.0	41.5	47.0	55.5	72.0
X	42 in	25.5	36.5	40.0	48.5	54.5	64.5	84.0
Note: Particle size d corresponds to the intermediate ("B") axis of the particle.								

Riprap Thickness (larger of either 1.5 times D50 or D100)

1.5 x D50= 33.7 inches < D100= 48 inches

DG 14- thic

VIII. MBTA Scour Countermeasures

Isbash Equation: $D_{50}= V^2 / (2*g*C^2*(S-1))$

where

V=	7.97		water velocity within bridge (50-year flood)	
g=	32.2		gravitational constant	
C=	0.86		Isbash constant factor (usually 0.86 for highly turbulent; 1.2 for low turbulence)	
S=	2.65		specific gravity of stone (typical value of 2.65)	
D50=	0.41513	ft.	or 4.981563 inches	(low turbulence)
D50=	**0.808258**	**ft.**	**or 9.699094 inches**	**(high turbulence)**

USBR Equation (Appropriate for Sizing Riprap Below Stilling Basin):

D50= $0.0122*V^{2.06}$ where

V=	7.97	fps	(50-year)
D50=	**0.877736**	**ft.**	**or 10.53283 inches**

HEC-23, Design Guideline 14 for Rock Riprap at Bridge Abutments

DG 14 - Fro

$D_{50}= ((K*y)/ (S-1)) * (V^2 /g*y)$

where

V=	4.27		characteristic average velocity in the contracted section, ft/s	(500-year)
K=	1.02		velocity multiplier equal to 0.89 for spill through or 1.02 for vertical wall	
y=	15.6		depth of flow in the contracted bridge opening, ft	(500-year)
g=	32.2		gravitational constant	
S=	2.65		specific gravity of stone (typical value of 2.65)	

BR Open Ve

Bridge Max

500-year	**D50=**	**0.35**	**ft.**	**or 4.2 inches**	

D_{50}= ((K*y)/ (S-1)) * (V^2 /g*y)

where	V=	7.92	characteristic average velocity in the contracted section, ft/s	(100-year)	BR Open Ve
	K=	1.02	velocity multiplier equal to 0.89 for spill through or 1.02 for vertical wall		
	y=	12.03	average flow depth at culvert entrance before scour, ft	(100-year)	Bridge Max
	g=	32.2	gravitational constant		
	S=	2.65	specific gravity of stone (typical value of 2.65)		

100-year	**D50=**	**1.20**	**ft.**	**or**	**14.5 inches**

D_{50}= ((K*y)/ (S-1)) * (V^2 /g*y)

where	V=	7.97	characteristic average velocity in the contracted section, ft/s	(50-year)	BR Open Ve
	K=	1.02	velocity multiplier equal to 0.89 for spill through or 1.02 for vertical wall		
	y=	10.42	average flow depth at culvert entrance before scour, ft	(50-year)	Bridge Max
	g=	32.2	gravitational constant		
	S=	2.65	specific gravity of stone (typical value of 2.65)		

Largest Size for 50-year	**D50=**	**1.22**	**ft.**	**or**	**14.6 inches**

D_{50}= ((K*y)/ (S-1)) * (V^2 /g*y)

where	V=	7.01	characteristic average velocity in the contracted section, ft/s	(10-year)	BR Open Ve
	K=	1.02	velocity multiplier equal to 0.89 for spill through or 1.02 for vertical wall		
	y=	8.02	average flow depth at culvert entrance before scour, ft	(10-year)	Bridge Max
	g=	32.2	gravitational constant		
	S=	2.65	specific gravity of stone (typical value of 2.65)		

10-year	**D50=**	**0.94**	**ft.**	**or**	**11.3 inches**

D_{50}= ((K*y)/ (S-1)) * (V^2 /g*y)

where	V=	5.38	characteristic average velocity in the contracted section, ft/s	(bankfull)	BR Open Ve
	K=	1.02	velocity multiplier equal to 0.89 for spill through or 1.02 for vertical wall		
	y=	4.92	average flow depth at culvert entrance before scour, ft	(bankfull)	Bridge Max
	g=	32.2	gravitational constant		
	S=	2.65	specific gravity of stone (typical value of 2.65)		

Bankfull	**D50=**	**0.56**	**ft.**	**or**	**6.7 inches**

Largest Size for 50-year	**D50=**	**1.22**	**ft.**	**or**	**14.6 inches**

Riprap Gradation

DG 14- use

Class IV: 9in - 30in, D50=15in, D100=30in

Table 4.1. Minimum and Maximum Allowable Particle Size in Inches.								
Nominal Riprap Class by Median Particle Diameter		d_{15}		d_{50}		d_{85}		d_{100}
Class	Size	Min	Max	Min	Max	Min	Max	Max
I	6 in	3.7	5.2	5.7	6.9	7.8	9.2	12.0
II	9 in	5.5	7.8	8.5	10.5	11.5	14.0	18.0
III	12 in	7.3	10.5	11.5	14.0	15.5	18.5	24.0
IV	15 in	9.2	13.0	14.5	17.5	19.5	23.0	30.0
V	18 in	11.0	15.5	17.0	20.5	23.5	27.5	36.0
VI	21 in	13.0	18.5	20.0	24.0	27.5	32.5	42.0
VII	24 in	14.5	21.0	23.0	27.5	31.0	37.0	48.0
VIII	30 in	18.5	26.0	28.5	34.5	39.0	46.0	60.0
IX	36 in	22.0	31.5	34.0	41.5	47.0	55.5	72.0
X	42 in	25.5	36.5	40.0	48.5	54.5	64.5	84.0
Note: Particle size d corresponds to the intermediate ("B") axis of the particle.								

Riprap Thickness (larger of either 1.5 times D50 or D100)

DG 14- thic

1.5 x D50= 22.0 inches < D100= 36 inches

Weight Range for Stones in Class IV:

IX. Energy Dissipation Factors for Aquatic Passage (Sizing Resting Pools for Nature-Like Fishway)

EDF Equation: EDF= 62.4*Q*D / V

where Q= 201.7 Flow Over Weir Crests, cfs (5% Flow Exceedance During Fish Passage Migration Season)
D= 0.63 hydraulic drop between pools, ft. (represents maximum hydraulic drop at 5% Exceedance Flow)
V= 3888 Volume of pools, cf (45' avg length by 16' average width by 5.4' deep)

EDF= 2.039411 (during 5% Exceedance Flow Conditions) **(Since 2.09 or less, OK)**

where Q= 56.3 Flow Over Weir Crests, cfs (50% Flow Exceedance During Fish Passage Migration Season)
D= 0.68 hydraulic drop between pools, ft. (represents maximum hydraulic drop at 50% Exceedance Flow)
V= 2952 Volume of pools, cf (45' avg length by 16' average width by 4.1' deep)

EDF= 0.809255 (during 50% Exceedance Flow Conditions) **(Since 2.09 or less, OK)**

where Q= 13.3 Flow Over Weir Crests, cfs (95% Flow Exceedance During Fish Passage Migration Season)
D= 0.75 hydraulic drop between pools, ft. (represents maximum hydraulic drop at 95% Exceedance Flow)
V= 2448 Volume of pools, cf (45' avg length by 16' average width by 3.4' deep)

EDF= **0.254265** (during 95% Exceedance Flow Conditions) **(Since 2.09 or less, OK)**

Attachment 12

Post-Dam Removal (With No In-River Improvements) HEC-RAS Results for Fish Passage Assessment (Base Condition and Fish Passage Flows)

HEC-RAS Model Plan: Proposed No Grade Control 6/27/2022

Little River Little River

Little River Conduit

MBTA RR Bridge

Rosemont Street Bridge

Proposed Pedes-trian Bridge

Valley Pipe Support

Winter Street Bridge

I-495 Bridges

Legend

- WS 5% Exceedance
- WS 50% Exceedance
- WS 95% Exceedance
- WS Base Condition
- Ground

Elevation (ft)

30
25
20
15
10
5
0

1750 Little River Con...
1922 F&O Added Section 1A su...
2126 F&O Added Section 1A su...
2255 FEMA RS10480 (Scaled Sec...
2342.5 Winter Street Bri...
2506 US pool XS
2645 F&O Added Section 2 survey...
2775 FEMA RS11000 (Scaled Secti...
2979 F&O Added Section 3B survey
3150 F&O Added Section 4 survey
3300 F&O Added Section 5 survey
3555 F&O Added Section 6 survey
3850 F&O Added Section 7
3993 DS Fish Passage 5
4370 F&O Added Section 8C
4495 F&O Added Section 9
4625 F&O Added Section 9.1 survey, DS fi...
4750 F&O Added Section 9.2 survey
4875 FEMA RS13100 survey
5024 Added FO Section 10.5
5160 F&O Added Section 11 survey
5424 F&O Added Section 12A survey
5690 F&O Added Section 13A survey
5820 DS Fish Passage 8
597...
6095 Railroad Bridge (FEMA Bridge LR4-S)
7452 FEMA RS 15677 (Computed Section D/S of LR5-...
7950 FEMA RS 16175 (Scaled Section at Wideni...
8185 FEMA RS 16410 (I - Surveyed Section LR...
9455 FEMA RS 17680 (Scaled Section)
10915 FEMA RS 19140 (J - Surveyed Section D/S of LR7-S [RTE...
11085 FEMA RS 19310 (Scaled Section D/S Face of RTE 495) Emb...
11205 FEMA RS 19430 (Computed Section Approx. Midpoint of Cons...
11325 FEMA RS 19550 (K - Surveyed Section U/S Face of RTE 495 Emb...
12187 FEMA RS 20412 (Computed Section)
12987 FEMA RS 21212 (M - Surveyed Section LR8)
14787 FEMA RS 23012 (Approximated Section)
15107 FEMA RS 23332 (Approximated Section D/S of LR9-S)
15224 Rosemont Avenue Bridge

2000
4000
6000
8000
10000
12000
14000

Main Channel Distance (ft)

HEC-RAS Plan: proposed no grade control River: Little River Reach: Little River

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Vel Chnl	Flow Area	Top Width
			(cfs)	(ft)	(ft)	(ft)	(ft/s)	(sq ft)	(ft)
Little River	15341	5% Exceedance	201.70	18.40	26.54	8.14	1.04	545.34	253.37
Little River	15341	50% Exceedance	56.30	18.40	25.09	6.69	0.58	208.53	176.94
Little River	15341	95% Exceedance	13.30	18.40	24.23	5.83	0.21	101.46	82.04
Little River	15341	Base Condition	9.80	18.40	24.10	5.70	0.17	91.04	75.83
Little River	15241	5% Exceedance	201.70	21.90	26.37	4.47	2.79	83.34	21.91
Little River	15241	50% Exceedance	56.30	21.90	25.06	3.16	1.12	55.89	20.16
Little River	15241	95% Exceedance	13.30	21.90	24.23	2.33	0.36	39.50	19.04
Little River	15241	Base Condition	9.80	21.90	24.10	2.20	0.28	37.02	18.87
Little River	15224		Bridge						
Little River	15207	5% Exceedance	201.70	21.90	26.33	4.43	2.82	82.52	21.86
Little River	15207	50% Exceedance	56.30	21.90	25.06	3.16	1.12	55.73	20.15
Little River	15207	95% Exceedance	13.30	21.90	24.23	2.33	0.36	39.48	19.04
Little River	15207	Base Condition	9.80	21.90	24.10	2.20	0.29	37.01	18.87
Little River	15107	5% Exceedance	201.70	22.20	26.26	4.06	1.96	102.98	51.32
Little River	15107	50% Exceedance	56.30	22.20	25.02	2.82	1.13	49.66	35.23
Little River	15107	95% Exceedance	13.30	22.20	24.22	2.02	0.52	25.40	25.20
Little River	15107	Base Condition	9.80	22.20	24.09	1.89	0.44	22.29	23.61
Little River	14787	5% Exceedance	201.70	23.20	25.84	2.64	2.20	150.93	125.96
Little River	14787	50% Exceedance	56.30	23.20	24.63	1.43	1.64	38.80	59.80
Little River	14787	95% Exceedance	13.30	23.20	24.02	0.82	1.09	12.17	29.60
Little River	14787	Base Condition	9.80	23.20	23.93	0.73	1.03	9.51	26.16
Little River	12987	5% Exceedance	201.70	20.90	24.12	3.22	1.84	115.85	45.60
Little River	12987	50% Exceedance	56.30	20.90	22.69	1.79	1.08	53.36	41.54
Little River	12987	95% Exceedance	13.30	20.90	21.91	1.01	0.61	21.81	37.78
Little River	12987	Base Condition	9.80	20.90	21.80	0.90	0.55	17.81	35.63
Little River	12187	5% Exceedance	201.70	20.40	23.53	3.13	1.91	111.53	45.34
Little River	12187	50% Exceedance	56.30	20.40	22.19	1.79	1.08	53.19	41.53
Little River	12187	95% Exceedance	13.30	20.40	21.38	0.98	0.65	20.64	37.16
Little River	12187	Base Condition	9.80	20.40	21.26	0.86	0.60	16.35	34.82
Little River	11387	5% Exceedance	201.70	20.00	22.43	2.43	2.95	73.92	36.87
Little River	11387	50% Exceedance	56.30	20.00	21.52	1.52	1.41	41.51	33.73
Little River	11387	95% Exceedance	13.30	20.00	21.05	1.05	0.52	26.22	32.14
Little River	11387	Base Condition	9.80	20.00	20.99	0.99	0.41	24.40	31.95
Little River	11381	5% Exceedance	201.70	20.70	21.86	1.16	5.97	35.43	33.89
Little River	11381	50% Exceedance	56.30	20.70	21.22	0.52	3.94	14.56	31.55
Little River	11381	95% Exceedance	13.30	20.70	20.93	0.23	2.42	5.53	30.49
Little River	11381	Base Condition	9.80	20.70	20.91	0.21	2.00	4.92	30.41
Little River	11375	5% Exceedance	201.70	17.80	21.18	3.38	2.23	98.62	37.35
Little River	11375	50% Exceedance	56.30	17.80	19.74	1.94	1.23	47.67	33.37
Little River	11375	95% Exceedance	13.30	17.80	18.79	0.99	0.76	17.81	27.48
Little River	11375	Base Condition	9.80	17.80	18.65	0.85	0.70	14.09	25.61
Little River	11325	5% Exceedance	201.70	17.40	21.01	3.61	3.06	66.31	33.42
Little River	11325	50% Exceedance	56.30	17.40	19.60	2.20	2.26	24.89	22.67
Little River	11325	95% Exceedance	13.30	17.40	18.67	1.27	1.59	8.39	13.16
Little River	11325	Base Condition	9.80	17.40	18.54	1.14	1.47	6.69	11.75
Little River	11205	5% Exceedance	201.70	16.95	20.71	3.76	2.85	71.32	33.83
Little River	11205	50% Exceedance	56.30	16.95	19.16	2.21	2.23	25.23	22.82
Little River	11205	95% Exceedance	13.30	16.95	18.23	1.28	1.58	8.39	13.16
Little River	11205	Base Condition	9.80	16.95	18.09	1.14	1.47	6.66	11.72
Little River	11085	5% Exceedance	201.70	16.50	20.49	3.99	2.58	79.08	34.46
Little River	11085	50% Exceedance	56.30	16.50	18.76	2.26	2.13	26.45	23.37
Little River	11085	95% Exceedance	13.30	16.50	17.80	1.30	1.52	8.75	13.44
Little River	11085	Base Condition	9.80	16.50	17.66	1.16	1.40	6.98	12.00
Little River	11000	5% Exceedance	201.70	16.25	20.38	4.13	2.20	91.54	37.83
Little River	11000	50% Exceedance	56.30	16.25	18.55	2.30	1.85	30.46	26.54
Little River	11000	95% Exceedance	13.30	16.25	17.55	1.30	1.35	9.83	15.07
Little River	11000	Base Condition	9.80	16.25	17.42	1.17	1.24	7.91	13.52

HEC-RAS Plan: proposed no grade control River: Little River Reach: Little River (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Vel Chnl	Flow Area	Top Width
			(cfs)	(ft)	(ft)	(ft)	(ft/s)	(sq ft)	(ft)
Little River	10915	5% Exceedance	201.70	16.00	20.24	4.24	2.11	95.71	38.30
Little River	10915	50% Exceedance	56.30	16.00	18.32	2.32	1.81	31.15	26.84
Little River	10915	95% Exceedance	13.30	16.00	16.89	0.89	2.92	4.55	10.26
Little River	10915	Base Condition	9.80	16.00	16.82	0.82	2.50	3.92	9.51
Little River	9455	5% Exceedance	201.70	13.10	19.19	6.09	1.15	193.85	80.99
Little River	9455	50% Exceedance	56.30	13.10	16.95	3.85	0.96	60.48	38.28
Little River	9455	95% Exceedance	13.30	13.10	15.55	2.45	0.57	23.20	18.94
Little River	9455	Base Condition	9.80	13.10	15.20	2.10	0.57	17.06	16.24
Little River	8185	5% Exceedance	201.70	11.40	18.76	7.36	0.96	209.39	56.91
Little River	8185	50% Exceedance	56.30	11.40	16.64	5.24	0.53	106.20	40.53
Little River	8185	95% Exceedance	13.30	11.40	15.46	4.06	0.21	63.62	31.37
Little River	8185	Base Condition	9.80	11.40	15.11	3.71	0.18	53.30	28.71
Little River	7950	5% Exceedance	201.70	11.90	18.66	6.76	1.14	176.57	52.26
Little River	7950	50% Exceedance	56.30	11.90	16.59	4.69	0.66	85.06	36.27
Little River	7950	95% Exceedance	13.30	11.90	15.44	3.54	0.27	48.59	27.41
Little River	7950	Base Condition	9.80	11.90	15.10	3.20	0.25	39.65	24.76
Little River	7488	5% Exceedance	201.70	12.80	18.40	5.60	1.18	170.81	52.73
Little River	7488	50% Exceedance	56.30	12.80	16.43	3.63	0.72	77.80	41.38
Little River	7488	95% Exceedance	13.30	12.80	15.39	2.59	0.35	38.03	35.44
Little River	7488	Base Condition	9.80	12.80	15.04	2.24	0.37	26.51	29.95
Little River	7478	5% Exceedance	201.70	12.80	18.40	5.60	1.18	170.49	52.69
Little River	7478	50% Exceedance	56.30	12.80	16.42	3.62	0.73	77.61	41.36
Little River	7478	95% Exceedance	13.30	12.80	15.39	2.59	0.35	37.95	35.43
Little River	7478	Base Condition	9.80	12.80	15.04	2.24	0.37	26.42	29.89
Little River	7475		Bridge						
Little River	7472	5% Exceedance	201.70	12.80	18.39	5.59	1.19	169.91	52.63
Little River	7472	50% Exceedance	56.30	12.80	16.42	3.62	0.73	77.35	41.32
Little River	7472	95% Exceedance	13.30	12.80	15.39	2.59	0.35	37.85	35.41
Little River	7472	Base Condition	9.80	12.80	15.04	2.24	0.37	26.30	29.81
Little River	7452	5% Exceedance	201.70	12.80	18.37	5.57	1.19	169.27	52.56
Little River	7452	50% Exceedance	56.30	12.80	16.41	3.61	0.73	76.96	41.27
Little River	7452	95% Exceedance	13.30	12.80	15.38	2.58	0.35	37.69	35.39
Little River	7452	Base Condition	9.80	12.80	15.03	2.23	0.38	26.11	29.68
Little River	6195	5% Exceedance	201.70	11.80	17.92	6.12	0.75	267.18	87.31
Little River	6195	50% Exceedance	56.30	11.80	16.14	4.34	0.42	134.58	61.97
Little River	6195	95% Exceedance	13.30	11.80	15.32	3.52	0.15	88.46	50.24
Little River	6195	Base Condition	9.80	11.80	14.97	3.17	0.14	71.57	45.19
Little River	6115	5% Exceedance	201.70	13.80	17.79	3.99	2.16	93.44	44.02
Little River	6115	50% Exceedance	56.30	13.80	16.05	2.25	1.77	31.82	27.92
Little River	6115	95% Exceedance	13.30	13.80	15.30	1.50	0.95	14.06	18.76
Little River	6115	Base Condition	9.80	13.80	14.93	1.13	1.22	8.03	14.18
Little River	6095		Bridge						
Little River	6075	5% Exceedance	201.70	13.02	16.60	3.58	5.24	38.56	25.15
Little River	6075	50% Exceedance	56.30	13.02	14.89	1.87	5.50	10.24	10.94
Little River	6075	95% Exceedance	13.30	13.02	14.07	1.05	4.09	3.25	6.16
Little River	6075	Base Condition	9.80	13.02	13.95	0.93	3.90	2.51	5.42
Little River	6015	5% Exceedance	201.70	10.03	16.45	6.42	1.91	105.78	36.86
Little River	6015	50% Exceedance	56.30	10.03	14.70	4.67	1.14	49.47	25.34
Little River	6015	95% Exceedance	13.30	10.03	13.66	3.63	0.48	27.55	17.20
Little River	6015	Base Condition	9.80	10.03	13.52	3.49	0.39	25.21	16.09
Little River	5995	5% Exceedance	201.70	4.78	16.49	11.71	0.25	822.69	120.33
Little River	5995	50% Exceedance	56.30	4.78	14.71	9.93	0.09	620.34	106.66
Little River	5995	95% Exceedance	13.30	4.78	13.67	8.89	0.03	513.32	98.66
Little River	5995	Base Condition	9.80	4.78	13.53	8.75	0.02	499.46	97.58
Little River	5975	5% Exceedance	201.70	0.00	16.49	16.49	0.11	1863.53	168.16
Little River	5975	50% Exceedance	56.30	0.00	14.71	14.71	0.04	1569.67	161.39
Little River	5975	95% Exceedance	13.30	0.00	13.67	13.67	0.01	1403.48	157.44

HEC-RAS Plan: proposed no grade control River: Little River Reach: Little River (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Vel Chnl	Flow Area	Top Width
			(cfs)	(ft)	(ft)	(ft)	(ft/s)	(sq ft)	(ft)
Little River	5975	Base Condition	9.80	0.00	13.53	13.53	0.01	1381.28	156.90
Little River	5861	5% Exceedance	201.70	12.00	16.44	4.44	1.77	125.50	55.50
Little River	5861	50% Exceedance	56.30	12.00	14.68	2.68	1.24	46.60	34.26
Little River	5861	95% Exceedance	13.30	12.00	13.66	1.66	0.74	17.86	21.55
Little River	5861	Base Condition	9.80	12.00	13.52	1.52	0.65	14.99	19.74
Little River	5826	5% Exceedance	201.70	12.75	16.36	3.61	1.92	105.26	41.24
Little River	5826	50% Exceedance	56.30	12.75	14.62	1.87	1.30	43.41	29.52
Little River	5826	95% Exceedance	13.30	12.75	13.60	0.85	0.79	16.93	22.72
Little River	5826	Base Condition	9.80	12.75	13.47	0.72	0.70	13.92	21.81
Little River	5820	5% Exceedance	201.70	12.74	16.31	3.57	2.34	86.23	31.26
Little River	5820	50% Exceedance	56.30	12.74	14.59	1.85	1.47	38.38	24.40
Little River	5820	95% Exceedance	13.30	12.74	13.59	0.85	0.84	15.89	20.39
Little River	5820	Base Condition	9.80	12.74	13.46	0.72	0.74	13.18	19.86
Little River	5775	5% Exceedance	201.70	12.69	16.19	3.50	2.20	91.56	34.26
Little River	5775	50% Exceedance	56.30	12.69	14.49	1.80	1.41	39.97	26.36
Little River	5775	95% Exceedance	13.30	12.69	13.50	0.81	0.82	16.15	21.77
Little River	5775	Base Condition	9.80	12.69	13.37	0.68	0.74	13.27	21.15
Little River	5690	5% Exceedance	201.70	12.50	15.93	3.43	2.44	82.57	30.19
Little River	5690	50% Exceedance	56.30	12.50	14.29	1.79	1.49	37.84	24.35
Little River	5690	95% Exceedance	13.30	12.50	13.34	0.84	0.81	16.43	21.00
Little River	5690	Base Condition	9.80	12.50	13.22	0.72	0.71	13.82	20.55
Little River	5510	5% Exceedance	201.70	12.21	15.10	2.89	3.04	66.43	27.98
Little River	5510	50% Exceedance	56.30	12.21	13.61	1.40	1.96	28.65	22.85
Little River	5510	95% Exceedance	13.30	12.21	12.83	0.62	1.13	11.75	20.13
Little River	5510	Base Condition	9.80	12.21	12.73	0.52	1.01	9.74	19.78
Little River	5504	5% Exceedance	201.70	12.20	15.08	2.88	3.05	66.18	27.94
Little River	5504	50% Exceedance	56.30	12.20	13.60	1.40	1.98	28.48	22.81
Little River	5504	95% Exceedance	13.30	12.20	12.81	0.61	1.14	11.64	20.11
Little River	5504	Base Condition	9.80	12.20	12.71	0.51	1.02	9.63	19.76
Little River	5430	5% Exceedance	201.70	12.09	14.93	2.84	3.18	63.51	26.72
Little River	5430	50% Exceedance	56.30	12.09	13.46	1.37	2.04	27.56	22.21
Little River	5430	95% Exceedance	13.30	12.09	12.69	0.60	1.16	11.44	19.86
Little River	5430	Base Condition	9.80	12.09	12.59	0.50	1.03	9.48	19.55
Little River	5424	5% Exceedance	201.70	12.08	14.92	2.84	3.18	63.42	26.69
Little River	5424	50% Exceedance	56.30	12.08	13.45	1.37	2.05	27.52	22.19
Little River	5424	95% Exceedance	13.30	12.08	12.68	0.60	1.16	11.45	19.85
Little River	5424	Base Condition	9.80	12.08	12.59	0.51	1.03	9.49	19.55
Little River	5232	5% Exceedance	201.70	11.75	14.53	2.78	3.22	62.73	28.12
Little River	5232	50% Exceedance	56.30	11.75	13.03	1.28	2.25	25.03	22.12
Little River	5232	95% Exceedance	13.30	11.75	12.31	0.56	1.32	10.10	19.23
Little River	5232	Base Condition	9.80	11.75	12.22	0.47	1.16	8.48	18.89
Little River	5226	5% Exceedance	201.70	11.74	14.52	2.78	3.22	62.59	28.08
Little River	5226	50% Exceedance	56.30	11.74	13.01	1.27	2.26	24.89	22.08
Little River	5226	95% Exceedance	13.30	11.74	12.29	0.55	1.33	10.00	19.20
Little River	5226	Base Condition	9.80	11.74	12.21	0.47	1.17	8.40	18.87
Little River	5160	5% Exceedance	201.70	11.62	14.39	2.77	3.17	63.54	27.96
Little River	5160	50% Exceedance	56.30	11.62	12.84	1.22	2.28	24.71	22.41
Little River	5160	95% Exceedance	13.30	11.62	12.05	0.43	1.63	8.17	19.57
Little River	5160	Base Condition	9.80	11.62	11.96	0.34	1.56	6.27	19.21
Little River	5128	5% Exceedance	201.70	11.56	14.49	2.93	0.46	437.56	154.74
Little River	5128	50% Exceedance	56.30	11.56	12.90	1.34	0.29	195.58	148.89
Little River	5128	95% Exceedance	13.30	11.56	12.08	0.52	0.18	75.18	145.90
Little River	5128	Base Condition	9.80	11.56	11.98	0.42	0.16	60.49	145.53
Little River	5077	5% Exceedance	201.70	11.47	14.33	2.86	3.08	65.48	27.85
Little River	5077	50% Exceedance	56.30	11.47	12.82	1.35	2.05	27.44	22.66
Little River	5077	95% Exceedance	13.30	11.47	12.05	0.58	1.21	10.97	19.99
Little River	5077	Base Condition	9.80	11.47	11.95	0.48	1.08	9.06	19.66

HEC-RAS Plan: proposed no grade control River: Little River Reach: Little River (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Vel Chnl	Flow Area	Top Width
			(cfs)	(ft)	(ft)	(ft)	(ft/s)	(sq ft)	(ft)
Little River	5030	5% Exceedance	201.70	11.38	14.25	2.87	2.92	69.01	30.01
Little River	5030	50% Exceedance	56.30	11.38	12.74	1.36	1.99	28.25	23.66
Little River	5030	95% Exceedance	13.30	11.38	11.97	0.59	1.18	11.25	20.44
Little River	5030	Base Condition	9.80	11.38	11.87	0.49	1.05	9.31	20.04
Little River	5024	5% Exceedance	201.70	11.37	14.24	2.87	2.92	68.96	29.98
Little River	5024	50% Exceedance	56.30	11.37	12.72	1.35	2.00	28.21	23.65
Little River	5024	95% Exceedance	13.30	11.37	11.95	0.58	1.18	11.23	20.44
Little River	5024	Base Condition	9.80	11.37	11.86	0.49	1.05	9.30	20.04
Little River	4875	5% Exceedance	201.70	11.10	13.96	2.86	3.13	64.41	27.06
Little River	4875	50% Exceedance	56.30	11.10	12.44	1.34	2.10	26.87	22.24
Little River	4875	95% Exceedance	13.30	11.10	11.70	0.60	1.17	11.34	19.90
Little River	4875	Base Condition	9.80	11.10	11.61	0.51	1.03	9.52	19.61
Little River	4859	5% Exceedance	201.70	11.09	13.93	2.84	3.16	63.75	26.97
Little River	4859	50% Exceedance	56.30	11.09	12.40	1.31	2.14	26.29	22.14
Little River	4859	95% Exceedance	13.30	11.09	11.67	0.58	1.22	10.94	19.83
Little River	4859	Base Condition	9.80	11.09	11.58	0.49	1.07	9.17	19.55
Little River	4854.5		Bridge						
Little River	4850	5% Exceedance	201.70	11.08	13.91	2.83	3.18	63.49	26.92
Little River	4850	50% Exceedance	56.30	11.08	12.38	1.30	2.16	26.04	22.10
Little River	4850	95% Exceedance	13.30	11.08	11.65	0.57	1.23	10.78	19.80
Little River	4850	Base Condition	9.80	11.08	11.56	0.48	1.09	9.03	19.52
Little River	4750	5% Exceedance	201.70	10.90	13.73	2.83	3.03	66.46	29.02
Little River	4750	50% Exceedance	56.30	10.90	12.14	1.24	2.22	25.37	22.84
Little River	4750	95% Exceedance	13.30	10.90	11.36	0.46	1.52	8.73	19.80
Little River	4750	Base Condition	9.80	10.90	11.28	0.38	1.39	7.04	19.46
Little River	4721	5% Exceedance	201.70	9.20	13.77	4.57	1.96	103.01	82.26
Little River	4721	50% Exceedance	56.30	9.20	12.18	2.98	0.90	62.45	75.91
Little River	4721	95% Exceedance	13.30	9.20	11.38	2.18	0.30	44.09	72.74
Little River	4721	Base Condition	9.80	9.20	11.29	2.09	0.23	42.09	72.38
Little River	4692	5% Exceedance	201.70	9.20	13.75	4.55	1.96	102.70	82.22
Little River	4692	50% Exceedance	56.30	9.20	12.17	2.97	0.90	62.36	75.89
Little River	4692	95% Exceedance	13.30	9.20	11.38	2.18	0.30	44.07	72.73
Little River	4692	Base Condition	9.80	9.20	11.29	2.09	0.23	42.08	72.38
Little River	4663	5% Exceedance	201.70	9.20	13.74	4.54	1.97	102.39	82.17
Little River	4663	50% Exceedance	56.30	9.20	12.17	2.97	0.90	62.26	75.88
Little River	4663	95% Exceedance	13.30	9.20	11.38	2.18	0.30	44.06	72.73
Little River	4663	Base Condition	9.80	9.20	11.29	2.09	0.23	42.07	72.37
Little River	4632	5% Exceedance	201.70	10.70	13.61	2.91	3.05	66.10	28.63
Little River	4632	50% Exceedance	56.30	10.70	12.09	1.39	2.06	27.27	22.45
Little River	4632	95% Exceedance	13.30	10.70	11.36	0.66	1.12	11.93	19.47
Little River	4632	Base Condition	9.80	10.70	11.28	0.58	0.95	10.34	19.14
Little River	4625	5% Exceedance	201.70	10.69	13.60	2.91	3.06	65.97	28.59
Little River	4625	50% Exceedance	56.30	10.69	12.08	1.39	2.07	27.16	22.42
Little River	4625	95% Exceedance	13.30	10.69	11.35	0.66	1.11	11.93	19.47
Little River	4625	Base Condition	9.80	10.69	11.27	0.58	0.94	10.37	19.14
Little River	4495	5% Exceedance	201.70	10.56	13.35	2.79	3.11	64.85	28.52
Little River	4495	50% Exceedance	56.30	10.56	11.75	1.19	2.34	24.07	22.48
Little River	4495	95% Exceedance	13.30	10.56	10.91	0.35	2.05	6.49	19.31
Little River	4495	Base Condition	9.80	10.56	10.81	0.25	2.16	4.54	18.93
Little River	4455	5% Exceedance	201.70	10.50	13.45	2.95	0.34	586.77	204.80
Little River	4455	50% Exceedance	56.30	10.50	11.81	1.31	0.22	255.38	198.22
Little River	4455	95% Exceedance	13.30	10.50	10.95	0.45	0.15	86.71	194.79
Little River	4455	Base Condition	9.80	10.50	10.85	0.35	0.15	67.19	194.39
Little River	4370	5% Exceedance	201.70	10.34	13.30	2.96	2.93	68.77	28.46
Little River	4370	50% Exceedance	56.30	10.34	11.73	1.39	1.97	28.54	22.93
Little River	4370	95% Exceedance	13.30	10.34	10.91	0.57	1.22	10.87	20.02
Little River	4370	Base Condition	9.80	10.34	10.81	0.47	1.10	8.93	19.68

HEC-RAS Plan: proposed no grade control River: Little River Reach: Little River (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Vel Chnl	Flow Area	Top Width
			(cfs)	(ft)	(ft)	(ft)	(ft/s)	(sq ft)	(ft)
Little River	4060	5% Exceedance	201.70	9.80	12.92	3.12	2.47	81.71	34.39
Little River	4060	50% Exceedance	56.30	9.80	11.32	1.52	1.69	33.36	25.97
Little River	4060	95% Exceedance	13.30	9.80	10.44	0.64	1.06	12.55	21.35
Little River	4060	Base Condition	9.80	9.80	10.33	0.53	0.96	10.23	20.77
Little River	4030	5% Exceedance	201.70	9.75	12.87	3.12	2.67	75.47	30.44
Little River	4030	50% Exceedance	56.30	9.75	11.28	1.53	1.75	32.16	24.10
Little River	4030	95% Exceedance	13.30	9.75	10.40	0.65	1.06	12.54	20.60
Little River	4030	Base Condition	9.80	9.75	10.29	0.54	0.95	10.29	20.15
Little River	4000	5% Exceedance	201.70	9.70	12.82	3.12	2.78	72.43	29.70
Little River	4000	50% Exceedance	56.30	9.70	11.23	1.53	1.84	30.65	23.15
Little River	4000	95% Exceedance	13.30	9.70	10.36	0.66	1.11	11.98	19.53
Little River	4000	Base Condition	9.80	9.70	10.25	0.55	1.00	9.84	19.07
Little River	3993	5% Exceedance	201.70	9.69	12.81	3.12	2.79	72.39	29.67
Little River	3993	50% Exceedance	56.30	9.69	11.22	1.53	1.84	30.65	23.14
Little River	3993	95% Exceedance	13.30	9.69	10.35	0.66	1.11	12.00	19.53
Little River	3993	Base Condition	9.80	9.69	10.24	0.55	0.99	9.85	19.07
Little River	3850	5% Exceedance	201.70	9.50	12.61	3.11	2.74	73.71	29.33
Little River	3850	50% Exceedance	56.30	9.50	11.05	1.55	1.75	32.25	23.63
Little River	3850	95% Exceedance	13.30	9.50	10.18	0.68	1.01	13.18	20.49
Little River	3850	Base Condition	9.80	9.50	10.07	0.57	0.90	10.92	20.09
Little River	3555	5% Exceedance	201.70	9.20	12.22	3.02	2.75	73.27	30.57
Little River	3555	50% Exceedance	56.30	9.20	10.68	1.48	1.81	31.19	24.16
Little River	3555	95% Exceedance	13.30	9.20	9.86	0.66	1.05	12.71	20.74
Little River	3555	Base Condition	9.80	9.20	9.75	0.55	0.93	10.53	20.29
Little River	3375	5% Exceedance	201.70	9.00	11.94	2.94	2.87	70.28	29.77
Little River	3375	50% Exceedance	56.30	9.00	10.41	1.41	1.91	29.41	23.65
Little River	3375	95% Exceedance	13.30	9.00	9.60	0.60	1.15	11.56	20.41
Little River	3375	Base Condition	9.80	9.00	9.50	0.50	1.03	9.54	20.01
Little River	3350	5% Exceedance	201.70	8.96	11.90	2.94	2.88	70.13	29.66
Little River	3350	50% Exceedance	56.30	8.96	10.37	1.41	1.92	29.38	23.60
Little River	3350	95% Exceedance	13.30	8.96	9.56	0.60	1.15	11.55	20.38
Little River	3350	Base Condition	9.80	8.96	9.46	0.50	1.03	9.53	19.99
Little River	3342	5% Exceedance	201.70	8.95	11.89	2.94	2.88	70.00	29.62
Little River	3342	50% Exceedance	56.30	8.95	10.36	1.41	1.92	29.30	23.57
Little River	3342	95% Exceedance	13.30	8.95	9.55	0.60	1.16	11.48	20.36
Little River	3342	Base Condition	9.80	8.95	9.45	0.50	1.04	9.47	19.97
Little River	3300	5% Exceedance	201.70	8.90	11.82	2.92	2.91	69.21	29.40
Little River	3300	50% Exceedance	56.30	8.90	10.29	1.39	1.96	28.75	23.42
Little River	3300	95% Exceedance	13.30	8.90	9.47	0.57	1.22	10.91	20.23
Little River	3300	Base Condition	9.80	8.90	9.37	0.47	1.11	8.86	19.83
Little River	3150	5% Exceedance	201.70	8.60	11.59	2.99	2.87	70.23	28.97
Little River	3150	50% Exceedance	56.30	8.60	10.06	1.46	1.86	30.20	23.36
Little River	3150	95% Exceedance	13.30	8.60	9.21	0.61	1.13	11.72	20.25
Little River	3150	Base Condition	9.80	8.60	9.10	0.50	1.03	9.55	19.85
Little River	2979	5% Exceedance	201.70	8.34	11.36	3.02	2.69	74.86	31.60
Little River	2979	50% Exceedance	56.30	8.34	9.84	1.50	1.76	31.98	24.74
Little River	2979	95% Exceedance	13.30	8.34	8.94	0.60	1.14	11.70	20.72
Little River	2979	Base Condition	9.80	8.34	8.83	0.49	1.04	9.42	20.22
Little River	2805	5% Exceedance	201.70	8.03	11.13	3.10	2.68	75.14	30.46
Little River	2805	50% Exceedance	56.30	8.03	9.65	1.62	1.64	34.37	24.50
Little River	2805	95% Exceedance	13.30	8.03	8.75	0.72	0.95	13.98	20.89
Little River	2805	Base Condition	9.80	8.03	8.63	0.60	0.85	11.54	20.41
Little River	2775	5% Exceedance	201.70	8.00	11.10	3.10	2.58	78.31	32.52
Little River	2775	50% Exceedance	56.30	8.00	9.62	1.62	1.59	35.30	25.59
Little River	2775	95% Exceedance	13.30	8.00	8.72	0.72	0.93	14.25	21.39
Little River	2775	Base Condition	9.80	8.00	8.61	0.61	0.83	11.76	20.84
Little River	2645	5% Exceedance	201.70	7.92	10.97	3.05	2.76	73.11	29.99
Little River	2645	50% Exceedance	56.30	7.92	9.53	1.61	1.66	34.02	24.33

HEC-RAS Plan: proposed no grade control River: Little River Reach: Little River (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Vel Chnl	Flow Area	Top Width
			(cfs)	(ft)	(ft)	(ft)	(ft/s)	(sq ft)	(ft)
Little River	2645	95% Exceedance	13.30	7.92	8.65	0.73	0.94	14.14	20.87
Little River	2645	Base Condition	9.80	7.92	8.53	0.61	0.83	11.74	20.41
Little River	2567	5% Exceedance	201.70	7.86	10.91	3.05	2.79	72.30	30.45
Little River	2567	50% Exceedance	56.30	7.86	9.48	1.62	1.68	33.43	24.17
Little River	2567	95% Exceedance	13.30	7.86	8.61	0.75	0.94	14.08	20.33
Little River	2567	Base Condition	9.80	7.86	8.50	0.64	0.83	11.77	19.82
Little River	2561	5% Exceedance	201.70	7.85	10.90	3.06	2.78	72.51	30.47
Little River	2561	50% Exceedance	56.30	7.85	9.48	1.63	1.67	33.65	24.20
Little River	2561	95% Exceedance	13.30	7.85	8.61	0.76	0.93	14.28	20.37
Little River	2561	Base Condition	9.80	7.85	8.50	0.65	0.82	11.97	19.86
Little River	2558	5% Exceedance	201.70	7.84	10.92	3.08	2.24	90.07	35.48
Little River	2558	50% Exceedance	56.30	7.84	9.49	1.65	1.30	43.36	29.67
Little River	2558	95% Exceedance	13.30	7.84	8.61	0.77	0.70	18.98	26.13
Little River	2558	Base Condition	9.80	7.84	8.50	0.66	0.61	15.98	25.66
Little River	2550	5% Exceedance	201.70	7.83	10.92	3.09	2.23	90.49	35.50
Little River	2550	50% Exceedance	56.30	7.83	9.49	1.66	1.29	43.77	29.71
Little River	2550	95% Exceedance	13.30	7.83	8.61	0.79	0.69	19.35	26.18
Little River	2550	Base Condition	9.80	7.83	8.50	0.67	0.60	16.36	25.71
Little River	2516	5% Exceedance	201.70	7.76	10.91	3.15	2.18	92.50	35.78
Little River	2516	50% Exceedance	56.30	7.76	9.48	1.72	1.24	45.52	29.98
Little River	2516	95% Exceedance	13.30	7.76	8.61	0.85	0.63	20.95	26.44
Little River	2516	Base Condition	9.80	7.76	8.49	0.73	0.55	17.94	25.97
Little River	2513	5% Exceedance	201.70	7.75	10.88	3.13	2.50	80.59	31.50
Little River	2513	50% Exceedance	56.30	7.75	9.47	1.72	1.41	39.82	26.32
Little River	2513	95% Exceedance	13.30	7.75	8.60	0.85	0.72	18.44	23.14
Little River	2513	Base Condition	9.80	7.75	8.49	0.74	0.62	15.82	22.72
Little River	2509	5% Exceedance	201.70	7.74	10.89	3.15	2.28	88.44	38.84
Little River	2509	50% Exceedance	56.30	7.74	9.47	1.73	1.40	40.24	29.18
Little River	2509	95% Exceedance	13.30	7.74	8.60	0.86	0.76	17.55	23.28
Little River	2509	Base Condition	9.80	7.74	8.49	0.75	0.66	14.94	22.50
Little River	2506	5% Exceedance	201.70	7.74	10.82	3.08	2.91	69.39	32.09
Little River	2506	50% Exceedance	56.30	7.74	9.44	1.70	1.81	31.08	23.55
Little River	2506	95% Exceedance	13.30	7.74	8.59	0.85	0.99	13.38	18.30
Little River	2506	Base Condition	9.80	7.74	8.48	0.74	0.86	11.37	17.61
Little River	2480	5% Exceedance	201.70	7.69	10.62	2.93	3.12	64.57	31.05
Little River	2480	50% Exceedance	56.30	7.69	9.30	1.61	1.94	28.97	22.93
Little River	2480	95% Exceedance	13.30	7.69	8.51	0.82	1.04	12.74	18.05
Little River	2480	Base Condition	9.80	7.69	8.41	0.72	0.90	10.95	17.43
Little River	2464	5% Exceedance	201.70	7.65	10.47	2.82	3.31	60.93	30.21
Little River	2464	50% Exceedance	56.30	7.65	9.20	1.55	2.05	27.44	22.45
Little River	2464	95% Exceedance	13.30	7.65	8.45	0.80	1.07	12.37	17.89
Little River	2464	Base Condition	9.80	7.65	8.36	0.71	0.91	10.77	17.33
Little River	2461	5% Exceedance	201.70	7.65	10.42	2.77	3.56	56.60	27.87
Little River	2461	50% Exceedance	56.30	7.65	9.17	1.53	2.16	26.11	21.20
Little River	2461	95% Exceedance	13.30	7.65	8.44	0.79	1.11	11.99	17.26
Little River	2461	Base Condition	9.80	7.65	8.35	0.70	0.94	10.48	16.78
Little River	2451	5% Exceedance	201.70	7.63	10.35	2.72	3.76	53.61	26.43
Little River	2451	50% Exceedance	56.30	7.63	9.14	1.51	2.22	25.34	20.48
Little River	2451	95% Exceedance	13.30	7.63	8.43	0.80	1.11	11.94	16.94
Little River	2451	Base Condition	9.80	7.63	8.34	0.71	0.93	10.50	16.51
Little River	2449	5% Exceedance	201.70	7.62	10.36	2.73	3.47	58.07	28.47
Little River	2449	50% Exceedance	56.30	7.62	9.14	1.52	2.05	27.40	22.04
Little River	2449	95% Exceedance	13.30	7.62	8.43	0.80	1.03	12.92	18.24
Little River	2449	Base Condition	9.80	7.62	8.34	0.72	0.86	11.37	17.78
Little River	2430	5% Exceedance	201.70	7.59	10.41	2.82	1.90	106.24	47.30
Little River	2430	50% Exceedance	56.30	7.59	9.16	1.57	1.07	52.45	38.75
Little River	2430	95% Exceedance	13.30	7.59	8.43	0.84	0.51	25.94	33.75
Little River	2430	Base Condition	9.80	7.59	8.34	0.75	0.43	23.04	33.15

HEC-RAS Plan: proposed no grade control River: Little River Reach: Little River (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Vel Chnl	Flow Area	Top Width
			(cfs)	(ft)	(ft)	(ft)	(ft/s)	(sq ft)	(ft)
Little River	2420	5% Exceedance	201.70	7.57	10.40	2.84	1.83	110.07	48.55
Little River	2420	50% Exceedance	56.30	7.57	9.16	1.59	1.03	54.79	39.95
Little River	2420	95% Exceedance	13.30	7.57	8.43	0.86	0.48	27.46	34.92
Little River	2420	Base Condition	9.80	7.57	8.34	0.77	0.40	24.46	34.32
Little River	2415	5% Exceedance	201.70	7.56	10.36	2.81	2.32	87.07	41.08
Little River	2415	50% Exceedance	56.30	7.56	9.14	1.58	1.33	42.21	32.33
Little River	2415	95% Exceedance	13.30	7.56	8.42	0.86	0.64	20.84	27.19
Little River	2415	Base Condition	9.80	7.56	8.34	0.78	0.53	18.54	26.58
Little River	2380	5% Exceedance	201.70	6.00	10.33	4.33	2.40	84.02	34.59
Little River	2380	50% Exceedance	56.30	6.00	9.13	3.13	1.08	52.36	31.72
Little River	2380	95% Exceedance	13.30	6.00	8.42	2.42	0.38	34.84	30.01
Little River	2380	Base Condition	9.80	6.00	8.34	2.34	0.30	32.82	29.80
Little River	2342.5		Bridge						
Little River	2305	5% Exceedance	201.70	6.00	10.29	4.29	2.25	89.69	45.82
Little River	2305	50% Exceedance	56.30	6.00	9.12	3.12	0.99	57.02	45.49
Little River	2305	95% Exceedance	13.30	6.00	8.42	2.42	0.36	37.29	32.06
Little River	2305	Base Condition	9.80	6.00	8.33	2.33	0.28	34.98	30.42
Little River	2273	5% Exceedance	201.70	5.89	10.29	4.40	1.85	108.87	46.03
Little River	2273	50% Exceedance	56.30	5.89	9.11	3.22	1.01	55.65	44.72
Little River	2273	95% Exceedance	13.30	5.89	8.42	2.53	0.44	30.48	24.74
Little River	2273	Base Condition	9.80	5.89	8.33	2.44	0.34	28.45	23.85
Little River	2255	5% Exceedance	201.70	7.50	10.22	2.72	2.56	78.74	44.69
Little River	2255	50% Exceedance	56.30	7.50	9.04	1.54	2.17	25.96	44.54
Little River	2255	95% Exceedance	13.30	7.50	8.25	0.75	3.06	4.35	15.70
Little River	2255	Base Condition	9.80	7.50	8.19	0.69	2.84	3.45	13.65
Little River	2218	5% Exceedance	201.70	7.00	10.19	3.19	2.44	82.78	34.64
Little River	2218	50% Exceedance	56.30	7.00	9.03	2.03	1.31	42.85	34.11
Little River	2218	95% Exceedance	13.30	7.00	8.26	1.26	0.73	18.29	26.30
Little River	2218	Base Condition	9.80	7.00	8.14	1.14	0.64	15.24	23.78
Little River	2126	5% Exceedance	201.70	7.06	9.99	2.93	3.43	59.88	30.54
Little River	2126	50% Exceedance	56.30	7.06	8.93	1.87	1.94	29.13	26.68
Little River	2126	95% Exceedance	13.30	7.06	8.20	1.14	1.09	12.18	19.24
Little River	2126	Base Condition	9.80	7.06	8.09	1.03	0.97	10.07	17.73
Little River	2021	5% Exceedance	201.70	6.78	9.95	3.17	2.20	92.81	42.96
Little River	2021	50% Exceedance	56.30	6.78	8.88	2.10	1.14	49.33	37.93
Little River	2021	95% Exceedance	13.30	6.78	8.18	1.40	0.53	25.12	29.29
Little River	2021	Base Condition	9.80	6.78	8.07	1.29	0.45	22.00	27.40
Little River	1922	5% Exceedance	201.70	7.24	9.18	1.94	5.89	34.25	33.22
Little River	1922	50% Exceedance	56.30	7.24	8.50	1.26	3.93	14.34	22.95
Little River	1922	95% Exceedance	13.30	7.24	8.04	0.80	2.28	5.83	14.28
Little River	1922	Base Condition	9.80	7.24	7.95	0.71	2.11	4.65	12.63
Little River	1825	5% Exceedance	201.70	6.34	8.48	2.14	3.38	60.67	36.73
Little River	1825	50% Exceedance	56.30	6.34	7.21	0.87	3.75	15.03	35.04
Little River	1825	95% Exceedance	13.30	6.34	6.92	0.58	2.57	5.12	26.39
Little River	1825	Base Condition	9.80	6.34	6.86	0.52	2.58	3.79	18.37
Little River	1775 FEMA Section A	5% Exceedance	201.70	5.20	8.45	3.25	2.55	79.24	36.84
Little River	1775 FEMA Section A	50% Exceedance	56.30	5.20	6.91	1.71	2.08	27.06	28.23
Little River	1775 FEMA Section A	95% Exceedance	13.30	5.20	6.21	1.01	1.46	9.14	23.73
Little River	1775 FEMA Section A	Base Condition	9.80	5.20	6.13	0.93	1.34	7.33	21.63
Little River	1750		Bridge						
Little River	0010	5% Exceedance	201.70	-3.30	1.57	4.87	2.03	99.72	467.48
Little River	0010	50% Exceedance	56.30	-3.30	1.60	4.90	0.56	100.66	473.31
Little River	0010	95% Exceedance	13.30	-3.30	1.60	4.90	0.13	100.74	473.77
Little River	0010	Base Condition	9.80	-3.30	1.60	4.90	0.10	100.74	473.78
Little River	0	5% Exceedance	201.70	-3.30	1.60	4.90	0.26	1274.63	664.57
Little River	0	50% Exceedance	56.30	-3.30	1.60	4.90	0.07	1274.63	664.57

HEC-RAS Plan: proposed no grade control River: Little River Reach: Little River (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Vel Chnl	Flow Area	Top Width
			(cfs)	(ft)	(ft)	(ft)	(ft/s)	(sq ft)	(ft)
Little River	0	95% Exceedance	13.30	-3.30	1.60	4.90	0.02	1274.63	664.57
Little River	0	Base Condition	9.80	-3.30	1.60	4.90	0.01	1274.63	664.57

Attachment 13

Post-Condition Model (With In-River Improvements) HEC-RAS Profile and Output Summary (Base Condition and Fish Passage Flows)

OVERALL RIVER PROFILE

HEC-RAS Model Plan: FO Proposed Conditions 6/17/2022

Little River Little River

Legend

- WS 5% Exceedance
- WS 50% Exceedance
- WS 95% Exceedance
- WS Base Condition
- Ground

Little River Conduit

Winter Street Bridge

Proposed Pedestrian Bridge

MBTA RR Bridge

Valley Pipe Support

I-495 Bridges

Rosemont Street Bridge

Grade Control Boulder Weir (Typ.)

Nature-like Fishway

Elevation (ft)

40
30
20
10
0
-10

Main Channel Distance (ft)

0
2000
4000
6000
8000
10000
12000
14000
16000

1750 Little River Conduit
1855 FEMA RS 11085(B - Surveyed Section U/S of LR1-S),survey updated
1922 F&O Added Section 1A survey 1922
2021 F&O Added Section 1A survey 2021
2126 F&O Added Section 1A survey 2126
2218 F&O Added Section 1A survey update
2273 F&O Added Section 1B survey
2342.5 Winter Street Bridge (FEMA LR2-S)
2400 F&O Added Section 1D survey
2506 US pool XS
2561 DS Fish Passage 3
2645 F&O Added Section 2 survey
2775 FEMA RS11000 (Scaled Section) survey
2979 F&O Added Section 3B survey
3150 F&O Added Section 4 survey
3300 F&O Added Section 5 survey
3375 FEMA RS11600 (Scaled Section) survey
3555 F&O Added Section 6 survey
3850 F&O Added Section 7
3993 DS Fish Passage 5
4060 F&O Added Section 8B survey
4370 F&O Added Section 8C
4455 interpolated for inlet cross section
4625 F&O Added Section 9.1 survey, DS fish passage 6
4692 additional XS between FO 9.2 and FO 9.1
4750 F&O Added Section 9.2 survey
4850 F&O Added Section 10 survey interpolated
5024 Added FO Section 10.5
5128 additional pool XS
5226 DS Fish Passage 7
5424 F&O Added Section 12A survey
5504 F&O Added Section 12B survey
5690 F&O Added Section 13A survey
5775 FEMA RS14000 (Scaled Section D/S of Bend) survey
5861
5975 FEMA RS14200 (Scaled Section D/S of LR4-S U/S of Bend surve...
6075 FEMA RS14300 (Computed Section D/S Face of LR4-S) survey
6195 FEMA RS 14420 (G - Surveyed Section U/S of LR4-S)
7452 FEMA RS 15677 (Computed Section D/S of LR5-S)
7950 FEMA RS 16175 (Scaled Section at Widening of Floodplain)
8185 FEMA RS 16410 (I - Surveyed Section LR5)
9455 FEMA RS 17660 (Scaled Section)
10015 FEMA RS 19140 (J - Surveyed Section D/S of LR7-S (RTE 495) Fully Expanded)
11000 FEMA RS 19225 (Computed Section D/S of RTE 495 Fully Expanded)
11085 FEMA RS 19310 (Scaled Section D/S Face of RTE 495) Embankment
11205 FEMA RS 19430 (Computed Section Approx. Midpoint of Constriction Under RTE 495)
11335 FEMA RS 19550 (K - Surveyed Section U/S Toe of RTE 495 Embankment (PZ-S)
11381 FEMA RS 19600 (L - Computed Section ELMIN Surveyed High Pt. of Riprap Construction)
14787 FEMA RS 23012 (Approximated Section)
15107 FEMA RS 23332 (Approximated Section D/S of LR9-S)
15207 FEMA RS 23432 (Computed Section D/S Face LR9-S)
15341 FEMA RS 23566 (O - Surveyed Section U/S LR9-S)
12187 FEMA RS 20412 (Computed Section)
12987 FEMA RS 21212 (M - Surveyed Section LR8)

PROJECT AREA RIVER PROFILE

HEC-RAS Model Plan: FO Proposed 6/17 6/27/2022

Little River Little River

Little River Conduit

Proposed Pedes-
trian Bridge

MBTA RR Bridge

Winter Street Bridge

Valley Pipe Support

Nature-like Fishway

Grade Control
Boulder Weir (Typ.)

Legend

- WS 5% Exceedance
- WS 50% Exceedance
- WS 95% Exceedance
- WS Base Condition
- Ground

Elevation (ft)

30
25
20
15
10
5
0

1000
2000
3000
4000
5000
6000
7000

Main Channel Distance (ft)

1750 Little River Con...
1825 FEMA RS10050 (B - Sur...
1922 F&O Added Section 1A sur...
2021 F&O Added Section 1A s...
2126 F&O Added Section 1A su...
2218 F&O Added Section 1A su...
2305 FEMA RS10530 (C - S...
2342.5 Winter Street Bri...
2449 FEMA RS 10674 (S...
2506 US pool XS
2564 Fish Passage Weir #1
2645 F&O Added Section 2 survey
2775 FEMA RS11000 (Scaled Sectio...
2979 F&O Added Section 3B survey
3150 F&O Added Section 4 survey
3300 F&O Added Section 5 survey
3375 FEMA RS11600 (Scaled Section) ...
3555 F&O Added Section 6 survey
3850 F&O Added Section 7
3993 DS Fish Passage 5
4060 F&O Added Section 8B survey
4370 F&O Added Section 8C
4455 interpolated for inlet cross s...sh...
4625 F&O Added Section 9.1 su...
4692 additional XS between FO ...
4750 F&O Added Section 9.2 su...plat...
4850 F&O Added Section 10 sur...
5024 Added FO Section 10.5
5128 additional pool XS
5226 DS Fish Passage 7
5424 F&O Added Section 12A survey
5504 F&O Added Section 12B survey
5690 F&O Added Section 13A survey
5775 FEMA RS14000 (Scaled Section D/S of Bend) su...
5861
59...
6075 FEMA RS14300 (Computed Section D/S Face of LR...
6195 FEMA RS 14420 (G - Surveyed Section U/S o...
7452 FEMA RS 15677 (Computed Section D/S of LR5-S...

HEC-RAS Plan: Proposed 617 River: Little River Reach: Little River

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Vel Chnl	Max Chl Dpth	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft/s)	(ft)	(sq ft)	(ft)	
Little River	15341	5% Exceedance	201.70	18.40	26.54	1.04	8.14	545.34	253.37	0.08
Little River	15341	50% Exceedance	56.30	18.40	25.09	0.58	6.69	208.53	176.94	0.05
Little River	15341	95% Exceedance	13.30	18.40	24.23	0.21	5.83	101.46	82.04	0.02
Little River	15341	Base Condition	9.80	18.40	24.10	0.17	5.70	91.04	75.83	0.02
Little River	15241	5% Exceedance	201.70	21.90	26.37	2.79	4.47	83.34	21.91	0.24
Little River	15241	50% Exceedance	56.30	21.90	25.06	1.12	3.16	55.89	20.16	0.11
Little River	15241	95% Exceedance	13.30	21.90	24.23	0.36	2.33	39.50	19.04	0.04
Little River	15241	Base Condition	9.80	21.90	24.10	0.28	2.20	37.02	18.87	0.03
Little River	15224		Bridge							
Little River	15207	5% Exceedance	201.70	21.90	26.33	2.82	4.43	82.52	21.86	0.24
Little River	15207	50% Exceedance	56.30	21.90	25.06	1.12	3.16	55.73	20.15	0.11
Little River	15207	95% Exceedance	13.30	21.90	24.23	0.36	2.33	39.48	19.04	0.04
Little River	15207	Base Condition	9.80	21.90	24.10	0.29	2.20	37.01	18.87	0.03
Little River	15107	5% Exceedance	201.70	22.20	26.26	1.96	4.06	102.98	51.32	0.24
Little River	15107	50% Exceedance	56.30	22.20	25.02	1.13	2.82	49.66	35.23	0.17
Little River	15107	95% Exceedance	13.30	22.20	24.22	0.52	2.02	25.40	25.20	0.09
Little River	15107	Base Condition	9.80	22.20	24.09	0.44	1.89	22.29	23.61	0.08
Little River	14787	5% Exceedance	201.70	23.20	25.84	2.20	2.64	150.93	125.96	0.26
Little River	14787	50% Exceedance	56.30	23.20	24.63	1.64	1.43	38.80	59.80	0.30
Little River	14787	95% Exceedance	13.30	23.20	24.02	1.09	0.82	12.17	29.60	0.30
Little River	14787	Base Condition	9.80	23.20	23.93	1.03	0.73	9.51	26.16	0.30
Little River	12987	5% Exceedance	201.70	20.90	24.12	1.84	3.22	115.85	45.60	0.19
Little River	12987	50% Exceedance	56.30	20.90	22.69	1.08	1.79	53.36	41.54	0.16
Little River	12987	95% Exceedance	13.30	20.90	21.91	0.61	1.01	21.81	37.78	0.14
Little River	12987	Base Condition	9.80	20.90	21.80	0.55	0.90	17.81	35.63	0.14
Little River	12187	5% Exceedance	201.70	20.40	23.53	1.91	3.13	111.53	45.34	0.21
Little River	12187	50% Exceedance	56.30	20.40	22.19	1.08	1.79	53.19	41.53	0.16
Little River	12187	95% Exceedance	13.30	20.40	21.38	0.65	0.98	20.64	37.16	0.15
Little River	12187	Base Condition	9.80	20.40	21.26	0.60	0.86	16.35	34.82	0.15
Little River	11387	5% Exceedance	201.70	20.00	22.43	2.95	2.43	73.92	36.87	0.35
Little River	11387	50% Exceedance	56.30	20.00	21.52	1.41	1.52	41.51	33.73	0.22
Little River	11387	95% Exceedance	13.30	20.00	21.05	0.52	1.05	26.22	32.14	0.10
Little River	11387	Base Condition	9.80	20.00	20.99	0.41	0.99	24.40	31.95	0.08
Little River	11381	5% Exceedance	201.70	20.70	21.86	5.97	1.16	35.43	33.89	1.00
Little River	11381	50% Exceedance	56.30	20.70	21.22	3.94	0.52	14.56	31.55	1.01
Little River	11381	95% Exceedance	13.30	20.70	20.93	2.42	0.23	5.53	30.49	1.00
Little River	11381	Base Condition	9.80	20.70	20.91	2.00	0.21	4.92	30.41	0.87
Little River	11375	5% Exceedance	201.70	17.80	21.18	2.23	3.38	98.62	37.35	0.23
Little River	11375	50% Exceedance	56.30	17.80	19.74	1.23	1.94	47.66	33.37	0.18
Little River	11375	95% Exceedance	13.30	17.80	18.79	0.76	0.99	17.81	27.48	0.16
Little River	11375	Base Condition	9.80	17.80	18.65	0.70	0.85	14.10	25.61	0.17
Little River	11325	5% Exceedance	201.70	17.40	21.01	3.06	3.61	66.31	33.42	0.38
Little River	11325	50% Exceedance	56.30	17.40	19.60	2.26	2.20	24.88	22.67	0.38
Little River	11325	95% Exceedance	13.30	17.40	18.67	1.59	1.27	8.39	13.16	0.35
Little River	11325	Base Condition	9.80	17.40	18.54	1.46	1.14	6.69	11.75	0.34
Little River	11205	5% Exceedance	201.70	16.95	20.71	2.85	3.76	71.31	33.83	0.34
Little River	11205	50% Exceedance	56.30	16.95	19.16	2.23	2.21	25.22	22.82	0.37
Little River	11205	95% Exceedance	13.30	16.95	18.23	1.58	1.28	8.39	13.16	0.35
Little River	11205	Base Condition	9.80	16.95	18.09	1.47	1.14	6.66	11.72	0.34
Little River	11085	5% Exceedance	201.70	16.50	20.49	2.58	3.99	79.08	34.46	0.29
Little River	11085	50% Exceedance	56.30	16.50	18.76	2.13	2.26	26.41	23.35	0.35
Little River	11085	95% Exceedance	13.30	16.50	17.80	1.52	1.30	8.73	13.42	0.33
Little River	11085	Base Condition	9.80	16.50	17.67	1.39	1.17	7.06	12.07	0.32
Little River	11000	5% Exceedance	201.70	16.25	20.38	2.20	4.13	91.54	37.83	0.25
Little River	11000	50% Exceedance	56.30	16.25	18.54	1.85	2.29	30.37	26.50	0.31
Little River	11000	95% Exceedance	13.30	16.25	17.55	1.36	1.30	9.74	15.01	0.30
Little River	11000	Base Condition	9.80	16.25	17.44	1.19	1.19	8.25	13.81	0.27
Little River	10915	5% Exceedance	201.70	16.00	20.24	2.11	4.24	95.71	38.30	0.24
Little River	10915	50% Exceedance	56.30	16.00	18.32	1.82	2.32	30.98	26.77	0.30
Little River	10915	95% Exceedance	13.30	16.00	16.93	2.67	0.93	4.99	10.74	0.69
Little River	10915	Base Condition	9.80	16.00	16.71	3.39	0.71	2.89	8.18	1.00

HEC-RAS Plan: Proposed 617 River: Little River Reach: Little River (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Vel Chnl	Max Chl Dpth	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft/s)	(ft)	(sq ft)	(ft)	
Little River	9455	5% Exceedance	201.70	13.10	19.19	1.15	6.09	193.82	80.98	0.12
Little River	9455	50% Exceedance	56.30	13.10	16.97	0.95	3.87	61.36	38.72	0.12
Little River	9455	95% Exceedance	13.30	13.10	15.52	0.59	2.42	22.60	18.70	0.09
Little River	9455	Base Condition	9.80	13.10	15.32	0.51	2.22	19.08	17.18	0.09
Little River	8185	5% Exceedance	201.70	11.40	18.76	0.96	7.36	209.35	56.90	0.09
Little River	8185	50% Exceedance	56.30	11.40	16.67	0.52	5.27	107.55	40.78	0.06
Little River	8185	95% Exceedance	13.30	11.40	15.42	0.21	4.02	62.46	31.08	0.03
Little River	8185	Base Condition	9.80	11.40	15.25	0.17	3.85	57.34	29.78	0.02
Little River	7950	5% Exceedance	201.70	11.90	18.66	1.14	6.76	176.53	52.25	0.11
Little River	7950	50% Exceedance	56.30	11.90	16.63	0.65	4.73	86.33	36.54	0.07
Little River	7950	95% Exceedance	13.30	11.90	15.41	0.28	3.51	47.56	27.12	0.04
Little River	7950	Base Condition	9.80	11.90	15.24	0.23	3.34	43.20	25.85	0.03
Little River	7488	5% Exceedance	201.70	12.80	18.40	1.18	5.60	170.76	52.72	0.12
Little River	7488	50% Exceedance	56.30	12.80	16.47	0.71	3.67	79.60	41.63	0.09
Little River	7488	95% Exceedance	13.30	12.80	15.35	0.36	2.55	36.53	35.20	0.06
Little River	7488	Base Condition	9.80	12.80	15.20	0.31	2.40	31.39	32.96	0.06
Little River	7478	5% Exceedance	201.70	12.80	18.40	1.18	5.60	170.45	52.69	0.12
Little River	7478	50% Exceedance	56.30	12.80	16.47	0.71	3.67	79.42	41.61	0.09
Little River	7478	95% Exceedance	13.30	12.80	15.35	0.37	2.55	36.44	35.18	0.06
Little River	7478	Base Condition	9.80	12.80	15.20	0.31	2.40	31.32	32.92	0.06
Little River	7475		Bridge							
Little River	7472	5% Exceedance	201.70	12.80	18.39	1.19	5.59	169.86	52.62	0.12
Little River	7472	50% Exceedance	56.30	12.80	16.46	0.71	3.66	79.17	41.57	0.09
Little River	7472	95% Exceedance	13.30	12.80	15.34	0.37	2.54	36.33	35.17	0.06
Little River	7472	Base Condition	9.80	12.80	15.19	0.31	2.39	31.25	32.87	0.06
Little River	7452	5% Exceedance	201.70	12.80	18.37	1.19	5.57	169.22	52.55	0.12
Little River	7452	50% Exceedance	56.30	12.80	16.45	0.71	3.65	78.81	41.52	0.09
Little River	7452	95% Exceedance	13.30	12.80	15.34	0.37	2.54	36.15	35.14	0.06
Little River	7452	Base Condition	9.80	12.80	15.19	0.32	2.39	31.11	32.79	0.06
Little River	6195	5% Exceedance	201.70	11.80	17.92	0.76	6.12	267.06	87.29	0.08
Little River	6195	50% Exceedance	56.30	11.80	16.21	0.41	4.41	138.57	62.88	0.05
Little River	6195	95% Exceedance	13.30	11.80	15.27	0.15	3.47	86.00	49.54	0.02
Little River	6195	Base Condition	9.80	11.80	15.14	0.12	3.34	79.81	47.72	0.02
Little River	6115	5% Exceedance	201.70	13.80	17.79	2.16	3.99	93.37	44.01	0.26
Little River	6115	50% Exceedance	56.30	13.80	16.13	1.66	2.33	33.91	28.52	0.27
Little River	6115	95% Exceedance	13.30	13.80	15.25	1.02	1.45	13.09	18.11	0.21
Little River	6115	Base Condition	9.80	13.80	15.13	0.89	1.33	10.99	16.59	0.19
Little River	6095		Bridge							
Little River	6075	5% Exceedance	201.70	13.02	16.74	4.83	3.72	41.98	27.34	0.67
Little River	6075	50% Exceedance	56.30	13.02	15.64	2.80	2.62	20.11	15.33	0.43
Little River	6075	95% Exceedance	13.30	13.02	15.11	1.04	2.09	12.73	12.19	0.18
Little River	6075	Base Condition	9.80	13.02	15.02	0.84	2.00	11.73	11.71	0.15
Little River	6015	5% Exceedance	201.70	10.03	16.61	1.81	6.58	111.42	37.13	0.18
Little River	6015	50% Exceedance	56.30	10.03	15.63	0.74	5.60	76.47	32.68	0.08
Little River	6015	95% Exceedance	13.30	10.03	15.11	0.22	5.08	60.57	28.59	0.03
Little River	6015	Base Condition	9.80	10.03	15.02	0.17	4.99	58.22	27.93	0.02
Little River	5995	5% Exceedance	201.70	4.78	16.64	0.24	11.86	840.66	121.47	0.02
Little River	5995	50% Exceedance	56.30	4.78	15.63	0.08	10.85	722.01	113.73	0.01
Little River	5995	95% Exceedance	13.30	4.78	15.11	0.02	10.33	663.43	109.71	0.00
Little River	5995	Base Condition	9.80	4.78	15.02	0.01	10.24	654.30	109.07	0.00
Little River	5975	5% Exceedance	201.70	0.00	16.64	0.11	16.64	1888.56	168.72	0.01
Little River	5975	50% Exceedance	56.30	0.00	15.63	0.03	15.63	1720.19	164.89	0.00
Little River	5975	95% Exceedance	13.30	0.00	15.11	0.01	15.11	1634.24	162.90	0.00
Little River	5975	Base Condition	9.80	0.00	15.02	0.01	15.02	1620.66	162.59	0.00
Little River	5861	5% Exceedance	201.70	12.00	16.60	1.67	4.60	134.24	57.37	0.18
Little River	5861	50% Exceedance	56.30	12.00	15.62	0.72	3.62	84.15	45.62	0.09
Little River	5861	95% Exceedance	13.30	12.00	15.11	0.22	3.11	62.19	39.38	0.03
Little River	5861	Base Condition	9.80	12.00	15.02	0.17	3.02	58.96	38.37	0.02
Little River	5826	5% Exceedance	201.70	12.75	16.53	1.80	3.78	112.22	42.36	0.19

HEC-RAS Plan: Proposed 617 River: Little River Reach: Little River (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Vel Chnl	Max Chl Dpth	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft/s)	(ft)	(sq ft)	(ft)	
Little River	5826	50% Exceedance	56.30	12.75	15.61	0.74	2.86	76.03	36.18	0.09
Little River	5826	95% Exceedance	13.30	12.75	15.11	0.23	2.36	58.65	32.80	0.03
Little River	5826	Base Condition	9.80	12.75	15.02	0.18	2.27	55.96	32.24	0.02
Little River	5823		Inl Struct							
Little River	5820	5% Exceedance	201.70	12.75	16.26	2.39	3.51	84.37	31.05	0.26
Little River	5820	50% Exceedance	56.30	12.75	15.02	1.15	2.27	48.97	26.09	0.15
Little River	5820	95% Exceedance	13.30	12.75	14.38	0.40	1.63	33.03	23.52	0.06
Little River	5820	Base Condition	9.80	12.75	14.29	0.32	1.54	30.95	23.17	0.05
Little River	5775	5% Exceedance	201.70	12.69	16.23	2.17	3.54	92.90	34.44	0.23
Little River	5775	50% Exceedance	56.30	12.69	15.01	1.04	2.32	54.29	28.77	0.13
Little River	5775	95% Exceedance	13.30	12.69	14.38	0.36	1.69	37.00	25.83	0.05
Little River	5775	Base Condition	9.80	12.69	14.29	0.28	1.60	34.74	25.42	0.04
Little River	5690	5% Exceedance	201.70	12.50	16.16	2.24	3.66	89.85	31.03	0.23
Little River	5690	50% Exceedance	56.30	12.50	14.99	1.01	2.49	55.88	26.86	0.12
Little River	5690	95% Exceedance	13.30	12.50	14.38	0.33	1.88	40.00	24.67	0.05
Little River	5690	Base Condition	9.80	12.50	14.29	0.26	1.79	37.87	24.36	0.04
Little River	5510	5% Exceedance	201.70	12.21	16.05	2.13	3.84	94.53	31.26	0.22
Little River	5510	50% Exceedance	56.30	12.21	14.96	0.90	2.75	62.54	27.50	0.11
Little River	5510	95% Exceedance	13.30	12.21	14.37	0.28	2.16	46.95	25.46	0.04
Little River	5510	Base Condition	9.80	12.21	14.29	0.22	2.08	44.79	25.17	0.03
Little River	5507		Inl Struct							
Little River	5504	5% Exceedance	201.70	12.20	15.62	2.47	3.42	81.75	29.80	0.26
Little River	5504	50% Exceedance	56.30	12.20	14.36	1.20	2.16	47.01	25.46	0.16
Little River	5504	95% Exceedance	13.30	12.20	13.72	0.43	1.52	31.27	23.23	0.06
Little River	5504	Base Condition	9.80	12.20	13.63	0.34	1.43	29.19	22.92	0.05
Little River	5430	5% Exceedance	201.70	12.09	15.55	2.50	3.46	80.55	28.61	0.26
Little River	5430	50% Exceedance	56.30	12.09	14.34	1.17	2.25	48.21	24.90	0.15
Little River	5430	95% Exceedance	13.30	12.09	13.71	0.40	1.62	33.24	22.98	0.06
Little River	5430	Base Condition	9.80	12.09	13.62	0.31	1.53	31.22	22.71	0.05
Little River	5424	5% Exceedance	201.70	12.08	15.54	2.50	3.46	80.62	28.59	0.26
Little River	5424	50% Exceedance	56.30	12.08	14.34	1.16	2.26	48.39	24.91	0.15
Little River	5424	95% Exceedance	13.30	12.08	13.71	0.40	1.63	33.45	23.00	0.06
Little River	5424	Base Condition	9.80	12.08	13.62	0.31	1.54	31.43	22.73	0.05
Little River	5232	5% Exceedance	201.70	11.75	15.39	2.29	3.64	88.65	33.22	0.24
Little River	5232	50% Exceedance	56.30	11.75	14.29	1.01	2.54	56.01	27.15	0.12
Little River	5232	95% Exceedance	13.30	11.75	13.70	0.33	1.95	40.86	24.82	0.04
Little River	5232	Base Condition	9.80	11.75	13.62	0.25	1.87	38.75	24.48	0.04
Little River	5226	5% Exceedance	201.70	11.74	15.38	2.28	3.64	88.74	33.18	0.24
Little River	5226	50% Exceedance	56.30	11.74	14.29	1.00	2.55	56.21	27.16	0.12
Little River	5226	95% Exceedance	13.30	11.74	13.70	0.32	1.96	41.09	24.84	0.04
Little River	5226	Base Condition	9.80	11.74	13.62	0.25	1.88	38.98	24.49	0.04
Little River	5160	5% Exceedance	201.70	11.62	15.34	2.19	3.72	94.77	48.17	0.22
Little River	5160	50% Exceedance	56.30	11.62	14.27	0.93	2.65	60.46	27.56	0.11
Little River	5160	95% Exceedance	13.30	11.62	13.70	0.29	2.08	45.30	25.50	0.04
Little River	5160	Base Condition	9.80	11.62	13.62	0.23	2.00	43.14	25.19	0.03
Little River	5128	5% Exceedance	201.70	11.56	15.39	0.35	3.83	578.53	158.04	0.03
Little River	5128	50% Exceedance	56.30	11.56	14.28	0.14	2.72	405.73	153.98	0.02
Little River	5128	95% Exceedance	13.30	11.56	13.70	0.04	2.14	317.09	151.86	0.01
Little River	5128	Base Condition	9.80	11.56	13.62	0.03	2.06	304.14	151.54	0.00
Little River	5077	5% Exceedance	201.70	11.47	15.32	2.07	3.85	97.24	46.79	0.25
Little River	5077	50% Exceedance	56.30	11.47	14.27	0.88	2.80	63.92	27.66	0.10
Little River	5077	95% Exceedance	13.30	11.47	13.70	0.27	2.23	48.77	25.70	0.03
Little River	5077	Base Condition	9.80	11.47	13.62	0.21	2.15	46.61	25.41	0.03
Little River	5030	5% Exceedance	201.70	11.38	15.29	1.97	3.91	102.63	37.17	0.21
Little River	5030	50% Exceedance	56.30	11.38	14.26	0.81	2.88	69.30	30.05	0.09
Little River	5030	95% Exceedance	13.30	11.38	13.70	0.25	2.32	53.05	27.70	0.03
Little River	5030	Base Condition	9.80	11.38	13.62	0.19	2.24	50.72	27.35	0.03
Little River	5027		Inl Struct							
Little River	5024	5% Exceedance	201.70	11.38	14.83	2.32	3.45	87.05	32.42	0.25

HEC-RAS Plan: Proposed 617 River: Little River Reach: Little River (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Vel Chnl	Max Chl Dpth	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft/s)	(ft)	(sq ft)	(ft)	
Little River	5024	50% Exceedance	56.30	11.38	13.58	1.13	2.20	49.64	27.18	0.15
Little River	5024	95% Exceedance	13.30	11.38	12.94	0.40	1.56	33.09	24.50	0.06
Little River	5024	Base Condition	9.80	11.38	12.84	0.32	1.46	30.74	24.10	0.05
Little River	4875	5% Exceedance	201.70	11.10	14.70	2.36	3.60	85.48	29.43	0.24
Little River	4875	50% Exceedance	56.30	11.10	13.54	1.06	2.44	53.25	25.72	0.13
Little River	4875	95% Exceedance	13.30	11.10	12.93	0.35	1.83	38.25	23.80	0.05
Little River	4875	Base Condition	9.80	11.10	12.84	0.27	1.74	36.02	23.50	0.04
Little River	4859	5% Exceedance	201.70	11.09	14.69	2.36	3.60	85.34	29.39	0.24
Little River	4859	50% Exceedance	56.30	11.09	13.53	1.05	2.44	53.38	25.73	0.13
Little River	4859	95% Exceedance	13.30	11.09	12.93	0.35	1.84	38.47	23.82	0.05
Little River	4859	Base Condition	9.80	11.09	12.84	0.27	1.75	36.23	23.52	0.04
Little River	4854.5		Bridge							
Little River	4850	5% Exceedance	201.70	11.08	14.68	2.36	3.60	85.36	29.38	0.24
Little River	4850	50% Exceedance	56.30	11.08	13.53	1.05	2.45	53.56	25.73	0.13
Little River	4850	95% Exceedance	13.30	11.08	12.93	0.34	1.85	38.69	23.84	0.05
Little River	4850	Base Condition	9.80	11.08	12.84	0.27	1.76	36.45	23.54	0.04
Little River	4750	5% Exceedance	201.70	10.90	14.62	2.15	3.72	96.71	41.61	0.22
Little River	4750	50% Exceedance	56.30	10.90	13.51	0.93	2.61	60.25	28.17	0.11
Little River	4750	95% Exceedance	13.30	10.90	12.93	0.30	2.03	44.48	25.90	0.04
Little River	4750	Base Condition	9.80	10.90	12.83	0.23	1.93	42.08	25.53	0.03
Little River	4721	5% Exceedance	201.70	9.20	14.63	1.58	5.43	127.29	85.73	0.13
Little River	4721	50% Exceedance	56.30	9.20	13.51	0.58	4.31	96.26	81.25	0.05
Little River	4721	95% Exceedance	13.30	9.20	12.93	0.16	3.73	80.98	78.91	0.02
Little River	4721	Base Condition	9.80	9.20	12.83	0.12	3.63	78.61	78.53	0.01
Little River	4692	5% Exceedance	201.70	9.20	14.63	1.59	5.43	127.12	85.70	0.13
Little River	4692	50% Exceedance	56.30	9.20	13.51	0.59	4.31	96.23	81.25	0.05
Little River	4692	95% Exceedance	13.30	9.20	12.93	0.16	3.73	80.97	78.91	0.02
Little River	4692	Base Condition	9.80	9.20	12.83	0.12	3.63	78.61	78.53	0.01
Little River	4663	5% Exceedance	201.70	9.20	14.62	1.59	5.42	126.94	85.68	0.13
Little River	4663	50% Exceedance	56.30	9.20	13.51	0.59	4.31	96.20	81.25	0.05
Little River	4663	95% Exceedance	13.30	9.20	12.93	0.16	3.73	80.97	78.91	0.02
Little River	4663	Base Condition	9.80	9.20	12.83	0.12	3.63	78.61	78.53	0.01
Little River	4632	5% Exceedance	201.70	10.70	14.57	2.11	3.87	95.48	32.53	0.22
Little River	4632	50% Exceedance	56.30	10.70	13.50	0.89	2.80	62.98	28.18	0.11
Little River	4632	95% Exceedance	13.30	10.70	12.93	0.28	2.23	47.45	25.85	0.04
Little River	4632	Base Condition	9.80	10.70	12.83	0.22	2.13	45.07	25.47	0.03
Little River	4629		Inl Struct							
Little River	4625	5% Exceedance	201.70	10.70	14.09	2.51	3.39	80.29	30.58	0.27
Little River	4625	50% Exceedance	56.30	10.70	12.79	1.28	2.09	44.10	25.31	0.17
Little River	4625	95% Exceedance	13.30	10.70	12.13	0.47	1.43	28.24	22.62	0.07
Little River	4625	Base Condition	9.80	10.70	12.04	0.38	1.34	26.13	22.24	0.06
Little River	4495	5% Exceedance	201.70	10.56	13.97	2.43	3.41	83.16	30.84	0.26
Little River	4495	50% Exceedance	56.30	10.56	12.74	1.16	2.18	48.33	26.24	0.15
Little River	4495	95% Exceedance	13.30	10.56	12.12	0.41	1.56	32.75	23.90	0.06
Little River	4495	Base Condition	9.80	10.56	12.03	0.32	1.47	30.59	23.55	0.05
Little River	4455	5% Exceedance	201.70	10.50	14.03	0.29	3.53	705.63	207.11	0.03
Little River	4455	50% Exceedance	56.30	10.50	12.76	0.13	2.26	446.22	202.04	0.01
Little River	4455	95% Exceedance	13.30	10.50	12.13	0.04	1.63	318.91	199.50	0.01
Little River	4455	Base Condition	9.80	10.50	12.03	0.03	1.53	300.62	199.13	0.00
Little River	4370	5% Exceedance	201.70	10.34	13.94	2.30	3.60	87.56	30.70	0.24
Little River	4370	50% Exceedance	56.30	10.34	12.74	1.06	2.40	53.36	26.48	0.13
Little River	4370	95% Exceedance	13.30	10.34	12.12	0.35	1.78	37.70	24.30	0.05
Little River	4370	Base Condition	9.80	10.34	12.03	0.28	1.69	35.51	23.98	0.04
Little River	4060	5% Exceedance	201.70	9.80	13.78	1.78	3.98	113.20	38.91	0.18
Little River	4060	50% Exceedance	56.30	9.80	12.69	0.76	2.89	74.11	33.21	0.09
Little River	4060	95% Exceedance	13.30	9.80	12.12	0.24	2.32	55.80	30.18	0.03
Little River	4060	Base Condition	9.80	9.80	12.03	0.18	2.23	53.15	29.71	0.02
Little River	4030	5% Exceedance	201.70	9.75	13.75	1.94	4.00	103.97	33.66	0.19
Little River	4030	50% Exceedance	56.30	9.75	12.69	0.80	2.94	70.16	29.74	0.09
Little River	4030	95% Exceedance	13.30	9.75	12.12	0.25	2.37	53.77	27.45	0.03

HEC-RAS Plan: Proposed 617 River: Little River Reach: Little River (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Vel Chnl	Max Chl Dpth	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft/s)	(ft)	(sq ft)	(ft)	
Little River	4030	Base Condition	9.80	9.75	12.03	0.19	2.28	51.36	27.10	0.02
Little River	4000	5% Exceedance	201.70	9.70	13.73	1.99	4.03	101.47	33.50	0.20
Little River	4000	50% Exceedance	56.30	9.70	12.69	0.82	2.99	68.60	29.16	0.09
Little River	4000	95% Exceedance	13.30	9.70	12.12	0.25	2.42	52.66	26.80	0.03
Little River	4000	Base Condition	9.80	9.70	12.03	0.19	2.33	50.31	26.43	0.02
Little River	3996		Inl Struct							
Little River	3993	5% Exceedance	201.70	9.70	13.33	2.29	3.63	88.17	31.81	0.24
Little River	3993	50% Exceedance	56.30	9.70	12.01	1.13	2.31	49.94	26.38	0.14
Little River	3993	95% Exceedance	13.30	9.70	11.35	0.40	1.65	33.41	23.64	0.06
Little River	3993	Base Condition	9.80	9.70	11.26	0.31	1.56	31.34	23.27	0.05
Little River	3850	5% Exceedance	201.70	9.50	13.23	2.19	3.73	92.28	31.55	0.23
Little River	3850	50% Exceedance	56.30	9.50	11.98	1.01	2.48	55.74	27.01	0.12
Little River	3850	95% Exceedance	13.30	9.50	11.35	0.34	1.85	39.43	24.71	0.05
Little River	3850	Base Condition	9.80	9.50	11.26	0.26	1.76	37.31	24.40	0.04
Little River	3555	5% Exceedance	201.70	9.20	13.05	2.01	3.85	100.14	34.04	0.21
Little River	3555	50% Exceedance	56.30	9.20	11.92	0.87	2.72	64.51	29.35	0.10
Little River	3555	95% Exceedance	13.30	9.20	11.34	0.28	2.14	48.03	26.91	0.04
Little River	3555	Base Condition	9.80	9.20	11.26	0.21	2.06	45.80	26.56	0.03
Little River	3375	5% Exceedance	201.70	9.00	12.95	1.97	3.95	102.37	33.81	0.20
Little River	3375	50% Exceedance	56.30	9.00	11.90	0.82	2.90	69.03	29.60	0.09
Little River	3375	95% Exceedance	13.30	9.00	11.34	0.25	2.34	52.96	27.34	0.03
Little River	3375	Base Condition	9.80	9.00	11.25	0.19	2.25	50.72	27.01	0.02
Little River	3350	5% Exceedance	201.70	9.00	12.94	1.98	3.94	101.89	33.75	0.20
Little River	3350	50% Exceedance	56.30	9.00	11.90	0.82	2.90	68.93	29.59	0.09
Little River	3350	95% Exceedance	13.30	9.00	11.34	0.25	2.34	52.95	27.34	0.03
Little River	3350	Base Condition	9.80	9.00	11.25	0.19	2.25	50.71	27.01	0.02
Little River	3346		Inl Struct							
Little River	3342	5% Exceedance	201.70	9.00	12.46	2.34	3.46	86.32	31.85	0.25
Little River	3342	50% Exceedance	56.30	9.00	11.18	1.16	2.18	48.74	26.72	0.15
Little River	3342	95% Exceedance	13.30	9.00	10.56	0.40	1.56	32.98	24.25	0.06
Little River	3342	Base Condition	9.80	9.00	10.48	0.32	1.48	31.10	23.93	0.05
Little River	3300	5% Exceedance	201.70	8.90	12.43	2.30	3.53	87.84	31.77	0.24
Little River	3300	50% Exceedance	56.30	8.90	11.17	1.11	2.27	50.83	26.85	0.14
Little River	3300	95% Exceedance	13.30	8.90	10.56	0.38	1.66	35.24	24.48	0.06
Little River	3300	Base Condition	9.80	8.90	10.48	0.29	1.58	33.36	24.17	0.04
Little River	3150	5% Exceedance	201.70	8.60	12.32	2.18	3.72	92.47	31.67	0.23
Little River	3150	50% Exceedance	56.30	8.60	11.13	0.98	2.53	57.33	27.29	0.12
Little River	3150	95% Exceedance	13.30	8.60	10.55	0.32	1.95	42.18	25.17	0.04
Little River	3150	Base Condition	9.80	8.60	10.48	0.24	1.88	40.29	24.89	0.03
Little River	2979	5% Exceedance	201.70	8.34	12.23	1.94	3.89	104.21	35.54	0.20
Little River	2979	50% Exceedance	56.30	8.34	11.10	0.84	2.76	67.00	30.46	0.10
Little River	2979	95% Exceedance	13.30	8.34	10.55	0.26	2.21	50.80	27.96	0.03
Little River	2979	Base Condition	9.80	8.34	10.48	0.20	2.14	48.74	27.63	0.03
Little River	2805	5% Exceedance	201.70	8.03	12.15	1.86	4.12	108.30	34.56	0.19
Little River	2805	50% Exceedance	56.30	8.03	11.09	0.76	3.06	73.74	30.28	0.09
Little River	2805	95% Exceedance	13.30	8.03	10.55	0.23	2.52	58.07	28.12	0.03
Little River	2805	Base Condition	9.80	8.03	10.48	0.17	2.45	56.02	27.82	0.02
Little River	2775	5% Exceedance	201.70	8.00	12.14	1.76	4.14	114.73	37.40	0.18
Little River	2775	50% Exceedance	56.30	8.00	11.08	0.72	3.08	77.74	32.44	0.08
Little River	2775	95% Exceedance	13.30	8.00	10.55	0.22	2.55	61.07	29.93	0.03
Little River	2775	Base Condition	9.80	8.00	10.47	0.17	2.47	58.89	29.59	0.02
Little River	2645	5% Exceedance	201.70	7.92	12.10	1.84	4.18	109.60	34.45	0.18
Little River	2645	50% Exceedance	56.30	7.92	11.07	0.74	3.15	76.35	30.42	0.08
Little River	2645	95% Exceedance	13.30	7.92	10.55	0.22	2.63	60.87	28.34	0.03
Little River	2645	Base Condition	9.80	7.92	10.47	0.17	2.55	58.82	28.06	0.02
Little River	2567	5% Exceedance	201.70	7.87	12.08	1.82	4.21	110.83	35.62	0.18
Little River	2567	50% Exceedance	56.30	7.87	11.07	0.73	3.20	77.04	31.15	0.08
Little River	2567	95% Exceedance	13.30	7.87	10.55	0.22	2.68	61.34	28.83	0.03
Little River	2567	Base Condition	9.80	7.87	10.47	0.17	2.60	59.26	28.51	0.02

HEC-RAS Plan: Proposed 617 River: Little River Reach: Little River (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Vel Chnl	Max Chl Dpth	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft/s)	(ft)	(sq ft)	(ft)	
Little River	2564		Inl Struct							
Little River	2561	5% Exceedance	201.70	7.50	11.43	2.03	3.93	99.42	33.56	0.21
Little River	2561	50% Exceedance	56.30	7.50	10.39	0.84	2.89	66.65	29.16	0.10
Little River	2561	95% Exceedance	13.30	7.50	9.85	0.26	2.35	51.49	26.88	0.03
Little River	2561	Base Condition	9.80	7.50	9.77	0.20	2.27	49.46	26.56	0.03
Little River	2558	5% Exceedance	201.70	5.50	11.45	1.27	5.95	159.12	38.30	0.11
Little River	2558	50% Exceedance	56.30	5.50	10.39	0.47	4.89	120.69	34.19	0.04
Little River	2558	95% Exceedance	13.30	5.50	9.85	0.13	4.35	102.65	32.09	0.01
Little River	2558	Base Condition	9.80	5.50	9.77	0.10	4.27	100.21	31.79	0.01
Little River	2550	5% Exceedance	201.70	5.50	11.45	1.27	5.95	159.10	38.29	0.11
Little River	2550	50% Exceedance	56.30	5.50	10.39	0.47	4.89	120.69	34.19	0.04
Little River	2550	95% Exceedance	13.30	5.50	9.85	0.13	4.35	102.65	32.09	0.01
Little River	2550	Base Condition	9.80	5.50	9.77	0.10	4.27	100.21	31.79	0.01
Little River	2516	5% Exceedance	201.70	5.50	11.45	1.27	5.95	158.99	38.28	0.11
Little River	2516	50% Exceedance	56.30	5.50	10.39	0.47	4.89	120.67	34.19	0.04
Little River	2516	95% Exceedance	13.30	5.50	9.85	0.13	4.35	102.65	32.08	0.01
Little River	2516	Base Condition	9.80	5.50	9.77	0.10	4.27	100.21	31.79	0.01
Little River	2513	5% Exceedance	201.70	7.50	11.41	1.92	3.91	105.17	33.76	0.19
Little River	2513	50% Exceedance	56.30	7.50	10.38	0.78	2.88	72.31	30.14	0.09
Little River	2513	95% Exceedance	13.30	7.50	9.85	0.23	2.35	56.61	28.25	0.03
Little River	2513	Base Condition	9.80	7.50	9.77	0.18	2.27	54.47	27.98	0.02
Little River	2511		Inl Struct							
Little River	2509	5% Exceedance	201.70	7.25	10.94	1.92	3.69	105.30	39.74	0.21
Little River	2509	50% Exceedance	56.30	7.25	9.75	0.90	2.50	62.45	32.56	0.11
Little River	2509	95% Exceedance	13.30	7.25	9.12	0.31	1.87	43.26	28.76	0.04
Little River	2509	Base Condition	9.80	7.25	9.04	0.24	1.79	40.83	28.25	0.04
Little River	2506	5% Exceedance	201.70	5.20	10.95	1.46	5.75	138.53	35.22	0.13
Little River	2506	50% Exceedance	56.30	5.20	9.75	0.57	4.55	99.29	30.61	0.06
Little River	2506	95% Exceedance	13.30	5.20	9.12	0.16	3.92	80.80	28.17	0.02
Little River	2506	Base Condition	9.80	5.20	9.04	0.12	3.84	78.41	27.85	0.01
Little River	2480	5% Exceedance	201.70	5.20	10.93	1.46	5.73	137.91	35.16	0.13
Little River	2480	50% Exceedance	56.30	5.20	9.75	0.57	4.55	99.21	30.61	0.06
Little River	2480	95% Exceedance	13.30	5.20	9.12	0.16	3.92	80.82	28.19	0.02
Little River	2480	Base Condition	9.80	5.20	9.04	0.12	3.84	78.43	27.86	0.01
Little River	2464	5% Exceedance	201.70	5.20	10.91	1.47	5.71	137.48	35.12	0.13
Little River	2464	50% Exceedance	56.30	5.20	9.75	0.57	4.55	99.14	30.60	0.06
Little River	2464	95% Exceedance	13.30	5.20	9.12	0.16	3.92	80.81	28.19	0.02
Little River	2464	Base Condition	9.80	5.20	9.04	0.12	3.84	78.43	27.86	0.01
Little River	2461	5% Exceedance	201.70	7.25	10.84	2.55	3.59	78.95	31.03	0.28
Little River	2461	50% Exceedance	56.30	7.25	9.73	1.18	2.48	47.67	25.46	0.15
Little River	2461	95% Exceedance	13.30	7.25	9.12	0.40	1.87	33.14	22.41	0.06
Little River	2461	Base Condition	9.80	7.25	9.04	0.31	1.79	31.27	21.99	0.05
Little River	2456		Inl Struct							
Little River	2451	5% Exceedance	201.70	7.25	10.37	3.21	3.12	62.91	27.38	0.37
Little River	2451	50% Exceedance	56.30	7.25	9.13	1.72	1.88	32.70	21.70	0.25
Little River	2451	95% Exceedance	13.30	7.25	8.42	0.72	1.17	18.35	18.39	0.13
Little River	2451	Base Condition	9.80	7.25	8.33	0.58	1.08	16.81	18.00	0.11
Little River	2449	5% Exceedance	201.70	5.00	10.43	1.57	5.43	128.30	33.29	0.14
Little River	2449	50% Exceedance	56.30	5.00	9.15	0.63	4.15	88.85	28.77	0.06
Little River	2449	95% Exceedance	13.30	5.00	8.42	0.19	3.42	68.75	26.17	0.02
Little River	2449	Base Condition	9.80	5.00	8.34	0.15	3.34	66.51	25.86	0.02
Little River	2430	5% Exceedance	201.70	5.00	10.44	0.94	5.44	215.02	51.10	0.08
Little River	2430	50% Exceedance	56.30	5.00	9.16	0.37	4.16	153.08	45.66	0.04
Little River	2430	95% Exceedance	13.30	5.00	8.42	0.11	3.42	120.75	42.55	0.01
Little River	2430	Base Condition	9.80	5.00	8.34	0.08	3.34	117.10	42.18	0.01
Little River	2420	5% Exceedance	201.70	5.00	10.44	0.91	5.44	220.55	52.14	0.08
Little River	2420	50% Exceedance	56.30	5.00	9.16	0.36	4.16	157.29	46.69	0.03
Little River	2420	95% Exceedance	13.30	5.00	8.42	0.11	3.42	124.21	43.57	0.01
Little River	2420	Base Condition	9.80	5.00	8.34	0.08	3.34	120.47	43.20	0.01

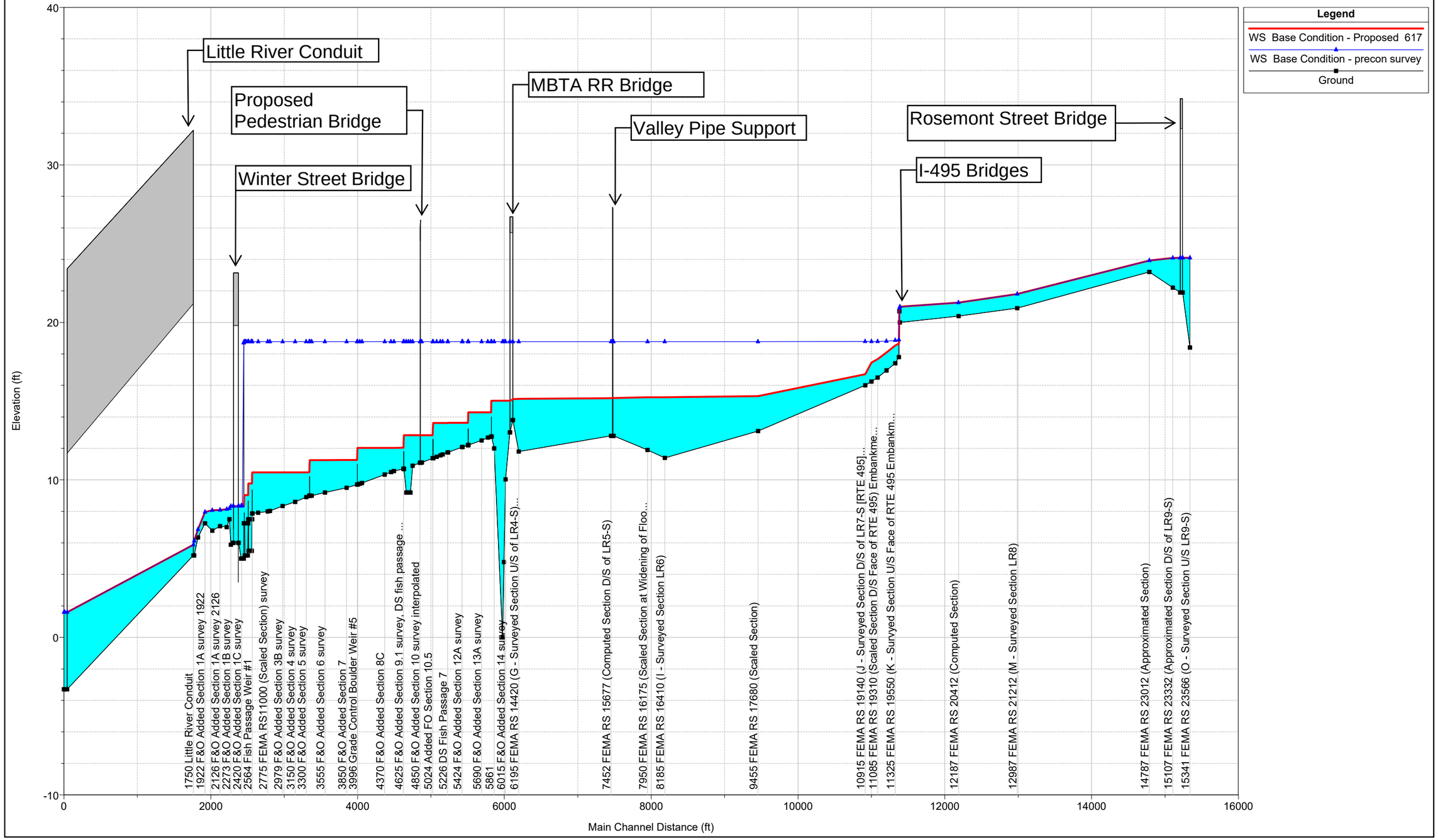
HEC-RAS Plan: Proposed 617 River: Little River Reach: Little River (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Vel Chnl	Max Chl Dpth	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft/s)	(ft)	(sq ft)	(ft)	
Little River	2415	5% Exceedance	201.70	5.00	10.43	1.12	5.43	180.26	45.42	0.10
Little River	2415	50% Exceedance	56.30	5.00	9.15	0.45	4.15	126.09	39.70	0.04
Little River	2415	95% Exceedance	13.30	5.00	8.42	0.14	3.42	98.25	36.40	0.01
Little River	2415	Base Condition	9.80	5.00	8.34	0.10	3.34	95.13	36.02	0.01
Little River	2380	5% Exceedance	201.70	6.00	10.33	2.40	4.33	84.02	34.59	0.24
Little River	2380	50% Exceedance	56.30	6.00	9.13	1.08	3.13	52.36	31.72	0.13
Little River	2380	95% Exceedance	13.30	6.00	8.42	0.38	2.42	34.84	30.01	0.06
Little River	2380	Base Condition	9.80	6.00	8.34	0.30	2.34	32.82	29.80	0.04
Little River	2342.5		Bridge							
Little River	2305	5% Exceedance	201.70	6.00	10.29	2.25	4.29	89.69	45.82	0.22
Little River	2305	50% Exceedance	56.30	6.00	9.12	0.99	3.12	57.02	45.49	0.12
Little River	2305	95% Exceedance	13.30	6.00	8.42	0.36	2.42	37.29	32.06	0.05
Little River	2305	Base Condition	9.80	6.00	8.33	0.28	2.33	34.98	30.42	0.04
Little River	2273	5% Exceedance	201.70	5.89	10.29	1.85	4.40	108.87	46.03	0.21
Little River	2273	50% Exceedance	56.30	5.89	9.11	1.01	3.22	55.65	44.72	0.16
Little River	2273	95% Exceedance	13.30	5.89	8.42	0.44	2.53	30.48	24.74	0.07
Little River	2273	Base Condition	9.80	5.89	8.33	0.34	2.44	28.45	23.85	0.06
Little River	2255	5% Exceedance	201.70	7.50	10.22	2.56	2.72	78.74	44.69	0.34
Little River	2255	50% Exceedance	56.30	7.50	9.04	2.17	1.54	25.96	44.54	0.50
Little River	2255	95% Exceedance	13.30	7.50	8.25	3.06	0.75	4.35	15.70	1.03
Little River	2255	Base Condition	9.80	7.50	8.19	2.84	0.69	3.45	13.65	1.00
Little River	2218	5% Exceedance	201.70	7.00	10.19	2.44	3.19	82.78	34.64	0.28
Little River	2218	50% Exceedance	56.30	7.00	9.03	1.31	2.03	42.85	34.11	0.21
Little River	2218	95% Exceedance	13.30	7.00	8.26	0.73	1.26	18.29	26.30	0.15
Little River	2218	Base Condition	9.80	7.00	8.14	0.64	1.14	15.24	23.78	0.14
Little River	2126	5% Exceedance	201.70	7.06	9.99	3.43	2.93	59.88	30.54	0.41
Little River	2126	50% Exceedance	56.30	7.06	8.93	1.94	1.87	29.13	26.68	0.32
Little River	2126	95% Exceedance	13.30	7.06	8.20	1.09	1.14	12.18	19.24	0.24
Little River	2126	Base Condition	9.80	7.06	8.09	0.97	1.03	10.07	17.73	0.23
Little River	2021	5% Exceedance	201.70	6.78	9.95	2.20	3.17	92.81	42.96	0.26
Little River	2021	50% Exceedance	56.30	6.78	8.88	1.14	2.10	49.33	37.93	0.18
Little River	2021	95% Exceedance	13.30	6.78	8.18	0.53	1.40	25.12	29.29	0.10
Little River	2021	Base Condition	9.80	6.78	8.07	0.45	1.29	22.00	27.40	0.09
Little River	1922	5% Exceedance	201.70	7.24	9.18	5.89	1.94	34.25	33.22	1.02
Little River	1922	50% Exceedance	56.30	7.24	8.50	3.93	1.26	14.34	22.95	0.88
Little River	1922	95% Exceedance	13.30	7.24	8.04	2.28	0.80	5.83	14.28	0.63
Little River	1922	Base Condition	9.80	7.24	7.95	2.11	0.71	4.65	12.63	0.61
Little River	1825	5% Exceedance	201.70	6.34	8.48	3.38	2.14	60.67	36.73	0.46
Little River	1825	50% Exceedance	56.30	6.34	7.21	3.75	0.87	15.03	35.04	1.01
Little River	1825	95% Exceedance	13.30	6.34	6.92	2.57	0.58	5.12	26.39	1.04
Little River	1825	Base Condition	9.80	6.34	6.86	2.58	0.52	3.79	18.37	1.00
Little River	1775 FEMA Section A	5% Exceedance	201.70	5.20	8.45	2.55	3.25	79.24	36.84	0.30
Little River	1775 FEMA Section A	50% Exceedance	56.30	5.20	6.91	2.08	1.71	27.06	28.23	0.37
Little River	1775 FEMA Section A	95% Exceedance	13.30	5.20	6.21	1.46	1.01	9.14	23.73	0.41
Little River	1775 FEMA Section A	Base Condition	9.80	5.20	6.13	1.34	0.93	7.33	21.63	0.41
Little River	1750		Bridge							
Little River	0010	5% Exceedance	201.70	-3.30	1.57	2.03	4.87	99.72	467.48	0.20
Little River	0010	50% Exceedance	56.30	-3.30	1.60	0.56	4.90	100.66	473.31	0.06
Little River	0010	95% Exceedance	13.30	-3.30	1.60	0.13	4.90	100.74	473.77	0.01
Little River	0010	Base Condition	9.80	-3.30	1.60	0.10	4.90	100.74	473.78	0.01
Little River	0	5% Exceedance	201.70	-3.30	1.60	0.26	4.90	1274.63	664.57	0.02
Little River	0	50% Exceedance	56.30	-3.30	1.60	0.07	4.90	1274.63	664.57	0.01
Little River	0	95% Exceedance	13.30	-3.30	1.60	0.02	4.90	1274.63	664.57	0.00
Little River	0	Base Condition	9.80	-3.30	1.60	0.01	4.90	1274.63	664.57	0.00

Attachment 14

Pre- Versus Post-Dam Removal Comparison HEC-RAS Summary Profile and Results (Base Flow)

HEC-RAS Model Plan: 1) Proposed 617 6/20/2022 2) precon survey 6/20/2022



HEC-RAS River: Little River Reach: Little River Profile: Base Condition

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Vel Chnl	Top Width
				(cfs)	(ft)	(ft)	(ft)	(ft/s)	(ft)
Little River	15341	Base Condition	Proposed 617	9.80	18.40	24.10	5.70	0.17	75.83
Little River	15341	Base Condition	precon survey	9.80	18.40	24.10	5.70	0.17	75.83
Little River	15241	Base Condition	Proposed 617	9.80	21.90	24.10	2.20	0.28	18.87
Little River	15241	Base Condition	precon survey	9.80	21.90	24.10	2.20	0.28	18.87
Little River	15224			Bridge					
Little River	15207	Base Condition	Proposed 617	9.80	21.90	24.10	2.20	0.29	18.87
Little River	15207	Base Condition	precon survey	9.80	21.90	24.10	2.20	0.29	18.87
Little River	15107	Base Condition	Proposed 617	9.80	22.20	24.09	1.89	0.44	23.61
Little River	15107	Base Condition	precon survey	9.80	22.20	24.09	1.89	0.44	23.61
Little River	14787	Base Condition	Proposed 617	9.80	23.20	23.93	0.73	1.03	26.16
Little River	14787	Base Condition	precon survey	9.80	23.20	23.93	0.73	1.03	26.16
Little River	12987	Base Condition	Proposed 617	9.80	20.90	21.80	0.90	0.55	35.63
Little River	12987	Base Condition	precon survey	9.80	20.90	21.80	0.90	0.55	35.63
Little River	12187	Base Condition	Proposed 617	9.80	20.40	21.26	0.86	0.60	34.82
Little River	12187	Base Condition	precon survey	9.80	20.40	21.26	0.86	0.60	34.82
Little River	11387	Base Condition	Proposed 617	9.80	20.00	20.99	0.99	0.41	31.95
Little River	11387	Base Condition	precon survey	9.80	20.00	20.99	0.99	0.41	31.95
Little River	11381	Base Condition	Proposed 617	9.80	20.70	20.91	0.21	2.00	30.41
Little River	11381	Base Condition	precon survey	9.80	20.70	20.91	0.21	2.00	30.41
Little River	11375	Base Condition	Proposed 617	9.80	17.80	18.65	0.85	0.70	25.61
Little River	11375	Base Condition	precon survey	9.80	17.80	18.89	1.09	0.48	28.86
Little River	11325	Base Condition	Proposed 617	9.80	17.40	18.54	1.14	1.46	11.75
Little River	11325	Base Condition	precon survey	9.80	17.40	18.86	1.46	0.89	15.06
Little River	11205	Base Condition	Proposed 617	9.80	16.95	18.09	1.14	1.47	11.72
Little River	11205	Base Condition	precon survey	9.80	16.95	18.81	1.86	0.55	19.16
Little River	11085	Base Condition	Proposed 617	9.80	16.50	17.67	1.17	1.39	12.07
Little River	11085	Base Condition	precon survey	9.80	16.50	18.79	2.29	0.36	23.64
Little River	11000	Base Condition	Proposed 617	9.80	16.25	17.44	1.19	1.19	13.81
Little River	11000	Base Condition	precon survey	9.80	16.25	18.79	2.54	0.26	29.17
Little River	10915	Base Condition	Proposed 617	9.80	16.00	16.71	0.71	3.39	8.18
Little River	10915	Base Condition	precon survey	9.80	16.00	18.78	2.78	0.22	31.04
Little River	9455	Base Condition	Proposed 617	9.80	13.10	15.32	2.22	0.51	17.18
Little River	9455	Base Condition	precon survey	9.80	13.10	18.78	5.68	0.07	73.19
Little River	8185	Base Condition	Proposed 617	9.80	11.40	15.25	3.85	0.17	29.78
Little River	8185	Base Condition	precon survey	9.80	11.40	18.78	7.38	0.05	57.04
Little River	7950	Base Condition	Proposed 617	9.80	11.90	15.24	3.34	0.23	25.85
Little River	7950	Base Condition	precon survey	9.80	11.90	18.78	6.88	0.05	53.17
Little River	7488	Base Condition	Proposed 617	9.80	12.80	15.20	2.40	0.31	32.96
Little River	7488	Base Condition	precon survey	9.80	12.80	18.78	5.98	0.05	54.84
Little River	7478	Base Condition	Proposed 617	9.80	12.80	15.20	2.40	0.31	32.92
Little River	7478	Base Condition	precon survey	9.80	12.80	18.78	5.98	0.05	54.84
Little River	7475			Bridge					
Little River	7472	Base Condition	Proposed 617	9.80	12.80	15.19	2.39	0.31	32.87
Little River	7472	Base Condition	precon survey	9.80	12.80	18.78	5.98	0.05	54.84
Little River	7452	Base Condition	Proposed 617	9.80	12.80	15.19	2.39	0.32	32.79
Little River	7452	Base Condition	precon survey	9.80	12.80	18.78	5.98	0.05	54.84
Little River	6195	Base Condition	Proposed 617	9.80	11.80	15.14	3.34	0.12	47.72
Little River	6195	Base Condition	precon survey	9.80	11.80	18.77	6.97	0.03	99.50
Little River	6115	Base Condition	Proposed 617	9.80	13.80	15.13	1.33	0.89	16.59

HEC-RAS River: Little River Reach: Little River Profile: Base Condition (Continued)

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Vel Chnl	Top Width
				(cfs)	(ft)	(ft)	(ft)	(ft/s)	(ft)
Little River	6115	Base Condition	precon survey	9.80	13.80	18.77	4.97	0.07	50.54
Little River	6095			Bridge					
Little River	6075	Base Condition	Proposed 617	9.80	13.02	15.02	2.00	0.84	11.71
Little River	6075	Base Condition	precon survey	9.80	13.02	18.77	5.75	0.08	54.65
Little River	6015	Base Condition	Proposed 617	9.80	10.03	15.02	4.99	0.17	27.93
Little River	6015	Base Condition	precon survey	9.80	10.03	18.77	8.74	0.05	40.93
Little River	5995	Base Condition	Proposed 617	9.80	4.78	15.02	10.24	0.01	109.07
Little River	5995	Base Condition	precon survey	9.80	4.78	18.77	13.99	0.01	164.56
Little River	5975	Base Condition	Proposed 617	9.80	0.00	15.02	15.02	0.01	162.59
Little River	5975	Base Condition	precon survey	9.80	0.00	18.77	18.77	0.00	176.81
Little River	5861	Base Condition	Proposed 617	9.80	12.00	15.02	3.02	0.17	38.37
Little River	5861	Base Condition	precon survey	9.80	12.00	18.77	6.77	0.04	80.43
Little River	5826	Base Condition	Proposed 617	9.80	12.75	15.02	2.27	0.18	32.24
Little River	5826	Base Condition	precon survey	9.80	13.00	18.77	5.77	0.06	50.45
Little River	5823			Inl Struct					
Little River	5820	Base Condition	Proposed 617	9.80	12.75	14.29	1.54	0.32	23.17
Little River	5820	Base Condition	precon survey	9.80	13.00	18.77	5.77	0.06	47.74
Little River	5775	Base Condition	Proposed 617	9.80	12.69	14.29	1.60	0.28	25.42
Little River	5775	Base Condition	precon survey	9.80	13.14	18.77	5.63	0.04	70.57
Little River	5690	Base Condition	Proposed 617	9.80	12.50	14.29	1.79	0.26	24.36
Little River	5690	Base Condition	precon survey	9.80	11.89	18.77	6.88	0.03	145.38
Little River	5510	Base Condition	Proposed 617	9.80	12.21	14.29	2.08	0.22	25.17
Little River	5510	Base Condition	precon survey	9.80	11.73	18.77	7.04	0.03	173.74
Little River	5507			Inl Struct					
Little River	5504	Base Condition	Proposed 617	9.80	12.20	13.63	1.43	0.34	22.92
Little River	5504	Base Condition	precon survey	9.80	11.73	18.77	7.04	0.03	173.74
Little River	5430	Base Condition	Proposed 617	9.80	12.09	13.62	1.53	0.31	22.71
Little River	5430	Base Condition	precon survey	9.80	11.00	18.77	7.77	0.03	83.63
Little River	5424	Base Condition	Proposed 617	9.80	12.08	13.62	1.54	0.31	22.73
Little River	5424	Base Condition	precon survey	9.80	11.00	18.77	7.77	0.03	83.63
Little River	5232	Base Condition	Proposed 617	9.80	11.75	13.62	1.87	0.25	24.48
Little River	5232	Base Condition	precon survey	9.80	11.20	18.77	7.57	0.04	115.80
Little River	5226	Base Condition	Proposed 617	9.80	11.74	13.62	1.88	0.25	24.49
Little River	5226	Base Condition	precon survey	9.80	11.20	18.77	7.57	0.04	115.80
Little River	5160	Base Condition	Proposed 617	9.80	11.62	13.62	2.00	0.23	25.19
Little River	5160	Base Condition	precon survey	9.80	11.20	18.77	7.57	0.01	214.54
Little River	5128	Base Condition	Proposed 617	9.80	11.56	13.62	2.06	0.03	151.54
Little River	5128	Base Condition	precon survey	9.80	11.20	18.77	7.57	0.01	214.54
Little River	5077	Base Condition	Proposed 617	9.80	11.47	13.62	2.15	0.21	25.41
Little River	5077	Base Condition	precon survey	9.80	11.20	18.77	7.57	0.01	214.54
Little River	5030	Base Condition	Proposed 617	9.80	11.38	13.62	2.24	0.19	27.35
Little River	5030	Base Condition	precon survey	9.80	12.76	18.77	6.01	0.05	115.12
Little River	5027			Inl Struct					
Little River	5024	Base Condition	Proposed 617	9.80	11.38	12.84	1.46	0.32	24.10
Little River	5024	Base Condition	precon survey	9.80	12.76	18.77	6.01	0.05	115.12
Little River	4875	Base Condition	Proposed 617	9.80	11.10	12.84	1.74	0.27	23.50
Little River	4875	Base Condition	precon survey	9.80	11.05	18.77	7.72	0.03	99.60
Little River	4859	Base Condition	Proposed 617	9.80	11.09	12.84	1.75	0.27	23.52

HEC-RAS River: Little River Reach: Little River Profile: Base Condition (Continued)

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Vel Chnl	Top Width
				(cfs)	(ft)	(ft)	(ft)	(ft/s)	(ft)
Little River	4859	Base Condition	precon survey	9.80	11.05	18.77	7.72	0.03	99.60
Little River	4854.5			Bridge					
Little River	4850	Base Condition	Proposed 617	9.80	11.08	12.84	1.76	0.27	23.54
Little River	4850	Base Condition	precon survey	9.80	11.26	18.77	7.51	0.03	80.78
Little River	4750	Base Condition	Proposed 617	9.80	10.90	12.83	1.93	0.23	25.53
Little River	4750	Base Condition	precon survey	9.80	12.16	18.77	6.61	0.02	103.49
Little River	4721	Base Condition	Proposed 617	9.80	9.20	12.83	3.63	0.12	78.53
Little River	4721	Base Condition	precon survey	9.80	12.11	18.77	6.66	0.02	103.49
Little River	4692	Base Condition	Proposed 617	9.80	9.20	12.83	3.63	0.12	78.53
Little River	4692	Base Condition	precon survey	9.80	12.06	18.77	6.71	0.02	103.49
Little River	4663	Base Condition	Proposed 617	9.80	9.20	12.83	3.63	0.12	78.53
Little River	4663	Base Condition	precon survey	9.80	12.00	18.77	6.77	0.02	103.49
Little River	4632	Base Condition	Proposed 617	9.80	10.70	12.83	2.13	0.22	25.47
Little River	4632	Base Condition	precon survey	9.80	11.00	18.77	7.77	0.04	42.12
Little River	4629			Inl Struct					
Little River	4625	Base Condition	Proposed 617	9.80	10.70	12.04	1.34	0.38	22.24
Little River	4625	Base Condition	precon survey	9.80	12.58	18.77	6.19	0.04	67.73
Little River	4495	Base Condition	Proposed 617	9.80	10.56	12.03	1.47	0.32	23.55
Little River	4495	Base Condition	precon survey	9.80	13.62	18.77	5.15	0.02	276.61
Little River	4455	Base Condition	Proposed 617	9.80	10.50	12.03	1.53	0.03	199.13
Little River	4455	Base Condition	precon survey	9.80	13.62	18.77	5.15	0.02	276.61
Little River	4370	Base Condition	Proposed 617	9.80	10.34	12.03	1.69	0.28	23.98
Little River	4370	Base Condition	precon survey	9.80	13.22	18.77	5.55	0.05	73.46
Little River	4060	Base Condition	Proposed 617	9.80	9.80	12.03	2.23	0.18	29.71
Little River	4060	Base Condition	precon survey	9.80	13.34	18.77	5.43	0.04	83.87
Little River	4030	Base Condition	Proposed 617	9.80	9.75	12.03	2.28	0.19	27.10
Little River	4030	Base Condition	precon survey	9.80	11.10	18.77	7.67	0.02	117.52
Little River	4000	Base Condition	Proposed 617	9.80	9.70	12.03	2.33	0.19	26.43
Little River	4000	Base Condition	precon survey	9.80	10.13	18.77	8.64	0.02	86.19
Little River	3996			Inl Struct					
Little River	3993	Base Condition	Proposed 617	9.80	9.70	11.26	1.56	0.31	23.27
Little River	3993	Base Condition	precon survey	9.80	10.00	18.77	8.77	0.03	107.90
Little River	3850	Base Condition	Proposed 617	9.80	9.50	11.26	1.76	0.26	24.40
Little River	3850	Base Condition	precon survey	9.80	12.35	18.77	6.42	0.02	107.90
Little River	3555	Base Condition	Proposed 617	9.80	9.20	11.26	2.06	0.21	26.56
Little River	3555	Base Condition	precon survey	9.80	7.58	18.77	11.19	0.02	95.52
Little River	3375	Base Condition	Proposed 617	9.80	9.00	11.25	2.25	0.19	27.01
Little River	3375	Base Condition	precon survey	9.80	7.00	18.77	11.77	0.01	130.32
Little River	3350	Base Condition	Proposed 617	9.80	9.00	11.25	2.25	0.19	27.01
Little River	3350	Base Condition	precon survey	9.80	8.80	18.77	9.97	0.03	100.54
Little River	3346			Inl Struct					
Little River	3342	Base Condition	Proposed 617	9.80	9.00	10.48	1.48	0.32	23.93
Little River	3342	Base Condition	precon survey	9.80	8.80	18.77	9.97	0.03	100.54
Little River	3300	Base Condition	Proposed 617	9.80	8.90	10.48	1.58	0.29	24.17
Little River	3300	Base Condition	precon survey	9.80	8.80	18.77	9.97	0.02	107.14
Little River	3150	Base Condition	Proposed 617	9.80	8.60	10.48	1.88	0.24	24.89
Little River	3150	Base Condition	precon survey	9.80	9.14	18.77	9.63	0.03	63.95
Little River	2979	Base Condition	Proposed 617	9.80	8.34	10.48	2.14	0.20	27.63

HEC-RAS River: Little River Reach: Little River Profile: Base Condition (Continued)

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Vel Chnl	Top Width
				(cfs)	(ft)	(ft)	(ft)	(ft/s)	(ft)
Little River	2979	Base Condition	precon survey	9.80	8.26	18.77	10.51	0.02	76.40
Little River	2805	Base Condition	Proposed 617	9.80	8.03	10.48	2.45	0.17	27.82
Little River	2805	Base Condition	precon survey	9.80	11.68	18.77	7.09	0.04	69.47
Little River	2775	Base Condition	Proposed 617	9.80	8.00	10.47	2.47	0.17	29.59
Little River	2775	Base Condition	precon survey	9.80	12.10	18.77	6.67	0.03	79.85
Little River	2645	Base Condition	Proposed 617	9.80	7.92	10.47	2.55	0.17	28.06
Little River	2645	Base Condition	precon survey	9.80	8.24	18.77	10.53	0.02	81.69
Little River	2567	Base Condition	Proposed 617	9.80	7.87	10.47	2.60	0.17	28.51
Little River	2567	Base Condition	precon survey	9.80	7.30	18.77	11.47	0.02	82.18
Little River	2564			Inl Struct					
Little River	2561	Base Condition	Proposed 617	9.80	7.50	9.77	2.27	0.20	26.56
Little River	2561	Base Condition	precon survey	9.80	7.30	18.77	11.47	0.02	82.18
Little River	2558	Base Condition	Proposed 617	9.80	5.50	9.77	4.27	0.10	31.79
Little River	2558	Base Condition	precon survey	9.80	7.30	18.77	11.47	0.01	93.12
Little River	2550	Base Condition	Proposed 617	9.80	5.50	9.77	4.27	0.10	31.79
Little River	2550	Base Condition	precon survey	9.80	7.30	18.77	11.47	0.01	93.13
Little River	2516	Base Condition	Proposed 617	9.80	5.50	9.77	4.27	0.10	31.79
Little River	2516	Base Condition	precon survey	9.80	7.30	18.77	11.47	0.01	93.13
Little River	2513	Base Condition	Proposed 617	9.80	7.50	9.77	2.27	0.18	27.98
Little River	2513	Base Condition	precon survey	9.80	8.00	18.77	10.77	0.02	70.23
Little River	2511			Inl Struct					
Little River	2509	Base Condition	Proposed 617	9.80	7.25	9.04	1.79	0.24	28.25
Little River	2509	Base Condition	precon survey	9.80	8.00	18.77	10.77	0.02	70.23
Little River	2506	Base Condition	Proposed 617	9.80	5.20	9.04	3.84	0.12	27.85
Little River	2506	Base Condition	precon survey	9.80	9.35	18.77	9.42	0.03	65.85
Little River	2480	Base Condition	Proposed 617	9.80	5.20	9.04	3.84	0.12	27.86
Little River	2480	Base Condition	precon survey	9.80	9.35	18.77	9.42	0.03	65.85
Little River	2464	Base Condition	Proposed 617	9.80	5.20	9.04	3.84	0.12	27.86
Little River	2464	Base Condition	precon survey	9.80	9.35	18.77	9.42	0.03	65.85
Little River	2461	Base Condition	Proposed 617	9.80	7.25	9.04	1.79	0.31	21.99
Little River	2461	Base Condition	precon survey	9.80	8.50	18.77	10.27	0.02	51.26
Little River	2456			Inl Struct					
Little River	2451	Base Condition	Proposed 617	9.80	7.25	8.33	1.08	0.58	18.00
Little River	2451	Base Condition	precon survey	9.80	8.50	18.75	10.25	1.03	75.08
Little River	2449	Base Condition	Proposed 617	9.80	5.00	8.34	3.34	0.15	25.86
Little River	2449	Base Condition	precon survey	9.80	8.50	18.70	10.20	1.72	75.08
Little River	2430	Base Condition	Proposed 617	9.80	5.00	8.34	3.34	0.08	42.18
Little River	2430	Base Condition	precon survey	9.80	6.77	8.35	1.58	0.15	55.96
Little River	2420	Base Condition	Proposed 617	9.80	5.00	8.34	3.34	0.08	43.20
Little River	2420	Base Condition	precon survey	9.80	7.00	8.35	1.35	0.38	31.22
Little River	2415	Base Condition	Proposed 617	9.80	5.00	8.34	3.34	0.10	36.02
Little River	2415	Base Condition	precon survey	9.80	6.75	8.35	1.60	0.24	39.87
Little River	2380	Base Condition	Proposed 617	9.80	6.00	8.34	2.34	0.30	29.80
Little River	2380	Base Condition	precon survey	9.80	3.50	8.35	4.85	0.17	41.10
Little River	2342.5			Bridge					
Little River	2305	Base Condition	Proposed 617	9.80	6.00	8.33	2.33	0.28	30.42
Little River	2305	Base Condition	precon survey	9.80	6.89	8.33	1.44	0.82	22.03
Little River	2273	Base Condition	Proposed 617	9.80	5.89	8.33	2.44	0.34	23.85

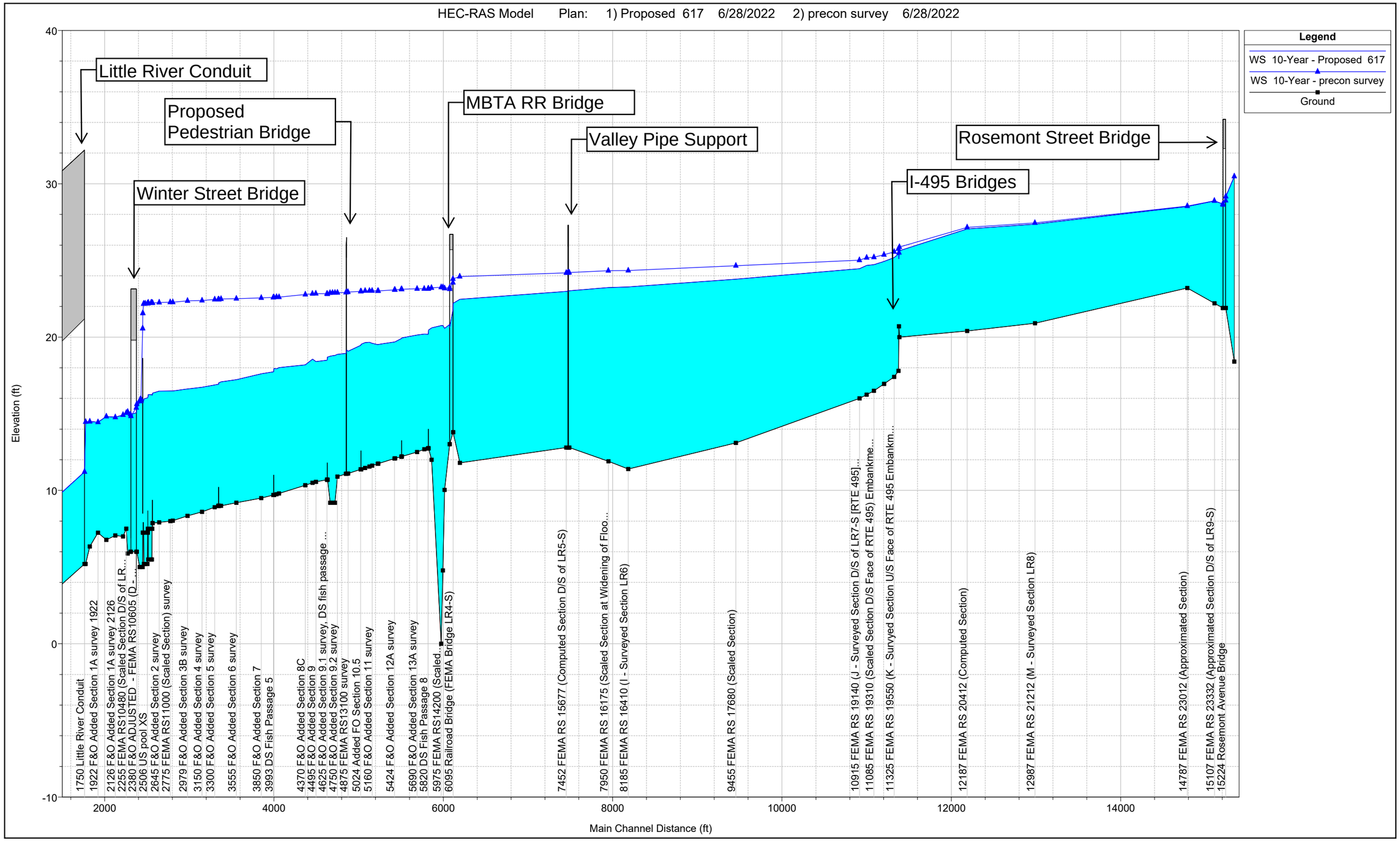
HEC-RAS River: Little River Reach: Little River Profile: Base Condition (Continued)

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Vel Chnl	Top Width
				(cfs)	(ft)	(ft)	(ft)	(ft/s)	(ft)
Little River	2273	Base Condition	precon survey	9.80	5.89	8.33	2.44	0.34	23.85
Little River	2255	Base Condition	Proposed 617	9.80	7.50	8.19	0.69	2.84	13.65
Little River	2255	Base Condition	precon survey	9.80	7.50	8.19	0.69	2.84	13.65
Little River	2218	Base Condition	Proposed 617	9.80	7.00	8.14	1.14	0.64	23.78
Little River	2218	Base Condition	precon survey	9.80	7.00	8.14	1.14	0.64	23.78
Little River	2126	Base Condition	Proposed 617	9.80	7.06	8.09	1.03	0.97	17.73
Little River	2126	Base Condition	precon survey	9.80	7.06	8.09	1.03	0.97	17.73
Little River	2021	Base Condition	Proposed 617	9.80	6.78	8.07	1.29	0.45	27.40
Little River	2021	Base Condition	precon survey	9.80	6.78	8.07	1.29	0.45	27.40
Little River	1922	Base Condition	Proposed 617	9.80	7.24	7.95	0.71	2.11	12.63
Little River	1922	Base Condition	precon survey	9.80	7.24	7.95	0.71	2.11	12.63
Little River	1825	Base Condition	Proposed 617	9.80	6.34	6.86	0.52	2.58	18.37
Little River	1825	Base Condition	precon survey	9.80	6.34	6.86	0.52	2.58	18.37
Little River	1775 FEMA Section A	Base Condition	Proposed 617	9.80	5.20	6.13	0.93	1.34	21.63
Little River	1775 FEMA Section A	Base Condition	precon survey	9.80	5.20	6.13	0.93	1.34	21.63
Little River	1750			Bridge					
Little River	0010	Base Condition	Proposed 617	9.80	-3.30	1.60	4.90	0.10	473.78
Little River	0010	Base Condition	precon survey	9.80	-3.30	1.60	4.90	0.10	473.78
Little River	0	Base Condition	Proposed 617	9.80	-3.30	1.60	4.90	0.01	664.57
Little River	0	Base Condition	precon survey	9.80	-3.30	1.60	4.90	0.01	664.57

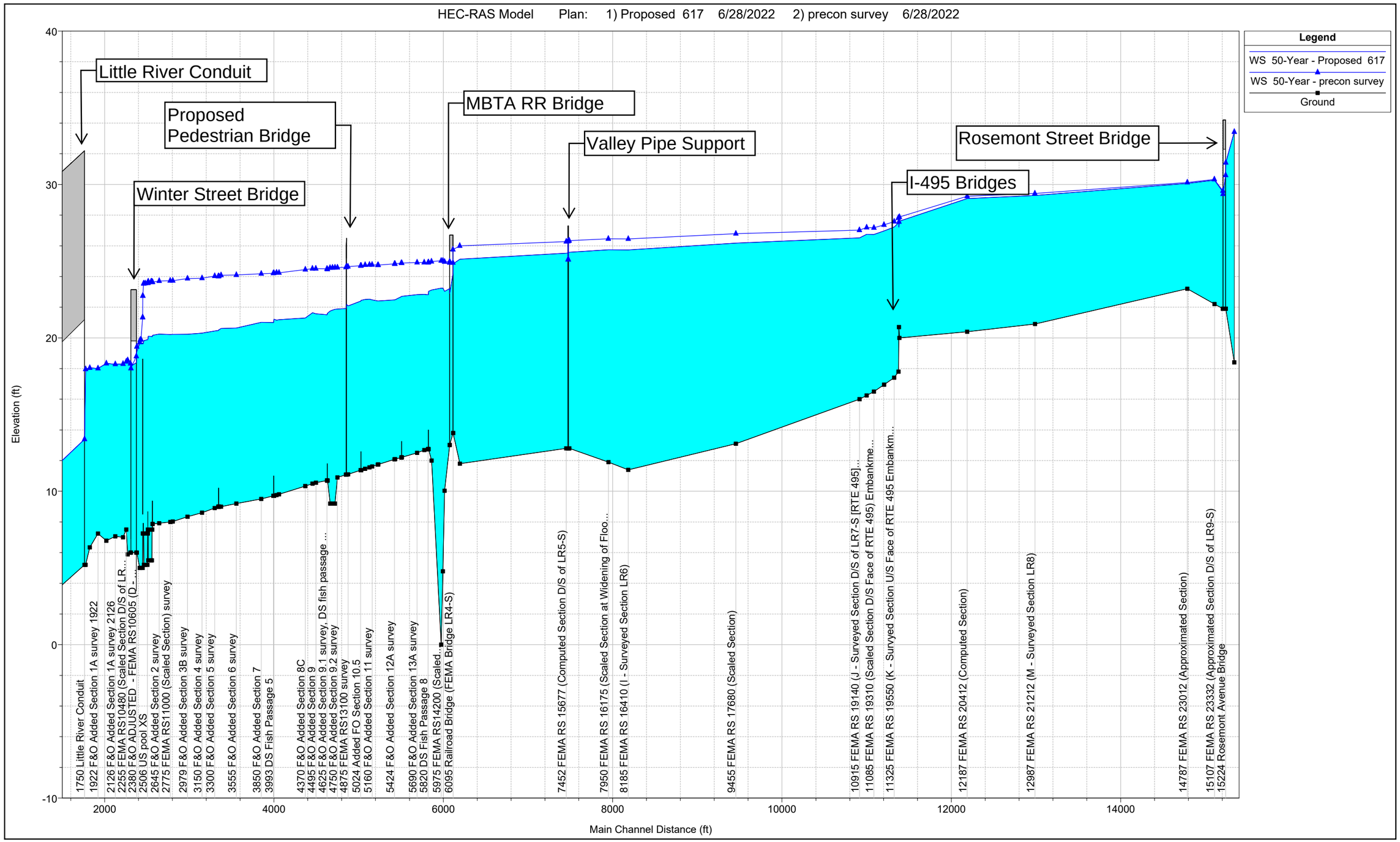
Attachment 15

Pre- Versus Post-Dam Removal Comparison HEC-RAS Results for 10-, 50-, 100-, and 500- Year Inland Flooding Event

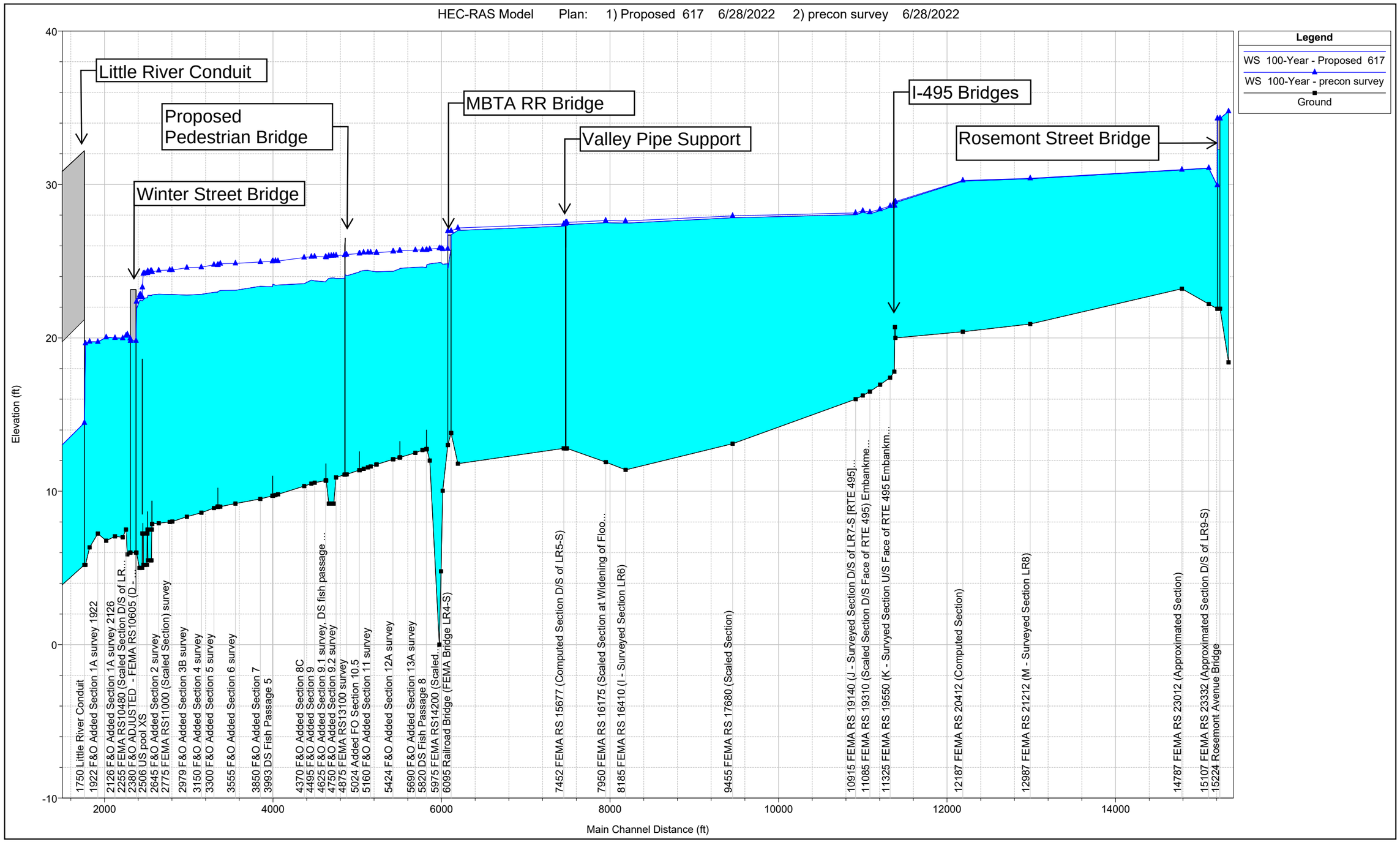
10-Year


HEC-RAS Model Plan: 1) Proposed 617 6/28/2022 2) precon survey 6/28/2022
Legend
WS 10-Year - Proposed 617
WS 10-Year - precon survey
Ground
Little River Conduit
Proposed Pedestrian Bridge
Winter Street Bridge
MBTA RR Bridge
Valley Pipe Support
I-495 Bridges
Rosemont Street Bridge
Elevation (ft)
Main Channel Distance (ft)
1750 Little River Conduit
1922 F&O Added Section 1A survey 1922
2126 F&O Added Section 1A survey 2126
2255 FEMA RS10480 (Scaled Section D/S of LR...
2380 F&O ADJUSTED - FEMA RS10605 (D...
2506 US pool XS
2645 F&O Added Section 2 survey
2775 FEMA RS11000 (Scaled Section) survey
2979 F&O Added Section 3B survey
3150 F&O Added Section 4 survey
3300 F&O Added Section 5 survey
3555 F&O Added Section 6 survey
3850 F&O Added Section 7
3993 DS Fish Passage 5
4370 F&O Added Section 8C
4495 F&O Added Section 9
4625 F&O Added Section 9.1 survey, DS fish passage ...
4750 F&O Added Section 9.2 survey
4875 FEMA RS13100 survey
5024 Added FO Section 10.5
5160 F&O Added Section 11 survey
5424 F&O Added Section 12A survey
5690 F&O Added Section 13A survey
5820 DS Fish Passage 8
5975 FEMA RS14200 (Scaled...
6095 Railroad Bridge (FEMA Bridge LR4-S)
7452 FEMA RS 15677 (Computed Section D/S of LR5-S)
7950 FEMA RS 16175 (Scaled Section at Widening of Floo...
8185 FEMA RS 16410 (I - Surveyed Section LR6)
9455 FEMA RS 17680 (Scaled Section)
10915 FEMA RS 19140 (J - Surveyed Section D/S of LR7-S [RTE 495]...
11085 FEMA RS 19310 (Scaled Section D/S Face of RTE 495) Embankme...
11325 FEMA RS 19550 (K - Surveyed Section U/S Face of RTE 495 Embankm...
12187 FEMA RS 20412 (Computed Section)
12987 FEMA RS 21212 (M - Surveyed Section LR8)
14787 FEMA RS 23012 (Approximated Section)
15107 FEMA RS 23332 (Approximated Section D/S of LR9-S)
15224 Rosemont Avenue Bridge

50-Year


HEC-RAS Model Plan: 1) Proposed 617 6/28/2022 2) precon survey 6/28/2022
Legend
WS 50-Year - Proposed 617
WS 50-Year - precon survey
Ground
Little River Conduit
Proposed Pedestrian Bridge
Winter Street Bridge
MBTA RR Bridge
Valley Pipe Support
I-495 Bridges
Rosemont Street Bridge
Elevation (ft)
Main Channel Distance (ft)
40
30
20
10
0
-10
2000
4000
6000
8000
10000
12000
14000
1750 Little River Conduit
1922 F&O Added Section 1A survey 1922
2126 F&O Added Section 1A survey 2126
2255 FEMA RS10480 (Scaled Section D/S of LR...
2380 F&O ADJUSTED - FEMA RS 10605 (D -...
2506 US pool XS
2645 F&O Added Section 2 survey
2775 FEMA RS11000 (Scaled Section) survey
2979 F&O Added Section 3B survey
3150 F&O Added Section 4 survey
3300 F&O Added Section 5 survey
3555 F&O Added Section 6 survey
3850 F&O Added Section 7
3993 DS Fish Passage 5
4370 F&O Added Section 8C
4495 F&O Added Section 9
4625 F&O Added Section 9.1 survey, DS fish passage ...
4750 F&O Added Section 9.2 survey
4875 FEMA RS13100 survey
5024 Added FO Section 10.5
5160 F&O Added Section 11 survey
5424 F&O Added Section 12A survey
5690 F&O Added Section 13A survey
5820 DS Fish Passage 8
5975 FEMA RS14200 (Scaled...
6095 Railroad Bridge (FEMA Bridge LR4-S)
7452 FEMA RS 15677 (Computed Section D/S of LR5-S)
7950 FEMA RS 16175 (Scaled Section at Widening of Floo...
8185 FEMA RS 16410 (I - Surveyed Section LR6)
9455 FEMA RS 17680 (Scaled Section)
10915 FEMA RS 19140 (J - Surveyed Section D/S of LR7-S [RTE 495]...
11085 FEMA RS 19310 (Scaled Section D/S Face of RTE 495) Embankme...
11325 FEMA RS 19550 (K - Surveyed Section U/S Face of RTE 495 Embankm...
12187 FEMA RS 20412 (Computed Section)
12987 FEMA RS 21212 (M - Surveyed Section LR8)
14787 FEMA RS 23012 (Approximated Section)
15107 FEMA RS 23332 (Approximated Section D/S of LR9-S)
15224 Rosemont Avenue Bridge

100-Year


HEC-RAS Model Plan: 1) Proposed 617 6/28/2022 2) precon survey 6/28/2022
Little River Conduit
Proposed Pedestrian Bridge
Winter Street Bridge
MBTA RR Bridge
Valley Pipe Support
I-495 Bridges
Rosemont Street Bridge
Legend
WS 100-Year - Proposed 617
WS 100-Year - precon survey
Ground
Elevation (ft)
Main Channel Distance (ft)
1750 Little River Conduit
1922 F&O Added Section 1A survey 1922
2126 F&O Added Section 1A survey 2126
2255 FEMA RS10480 (Scaled Section D/S of LR...
2380 F&O ADJUSTED - FEMA RS 10605 (D -...
2506 US pool XS
2645 F&O Added Section 2 survey
2775 FEMA RS11000 (Scaled Section) survey
2979 F&O Added Section 3B survey
3150 F&O Added Section 4 survey
3300 F&O Added Section 5 survey
3555 F&O Added Section 6 survey
3850 F&O Added Section 7
3993 DS Fish Passage 5
4370 F&O Added Section 8C
4495 F&O Added Section 9
4625 F&O Added Section 9.1 survey, DS fish passage ...
4750 F&O Added Section 9.2 survey
4875 FEMA RS13100 survey
5024 Added FO Section 10.5
5160 F&O Added Section 11 survey
5424 F&O Added Section 12A survey
5690 F&O Added Section 13A survey
5820 DS Fish Passage 8
5975 FEMA RS14200 (Scaled...
6095 Railroad Bridge (FEMA Bridge LR4-S)
7452 FEMA RS 15677 (Computed Section D/S of LR5-S)
7950 FEMA RS 16175 (Scaled Section at Widening of Floo...
8185 FEMA RS 16410 (I - Surveyed Section LR6)
9455 FEMA RS 17680 (Scaled Section)
10915 FEMA RS 19140 (J - Surveyed Section D/S of LR7-S [RTE 495]...
11085 FEMA RS 19310 (Scaled Section D/S Face of RTE 495) Embankme...
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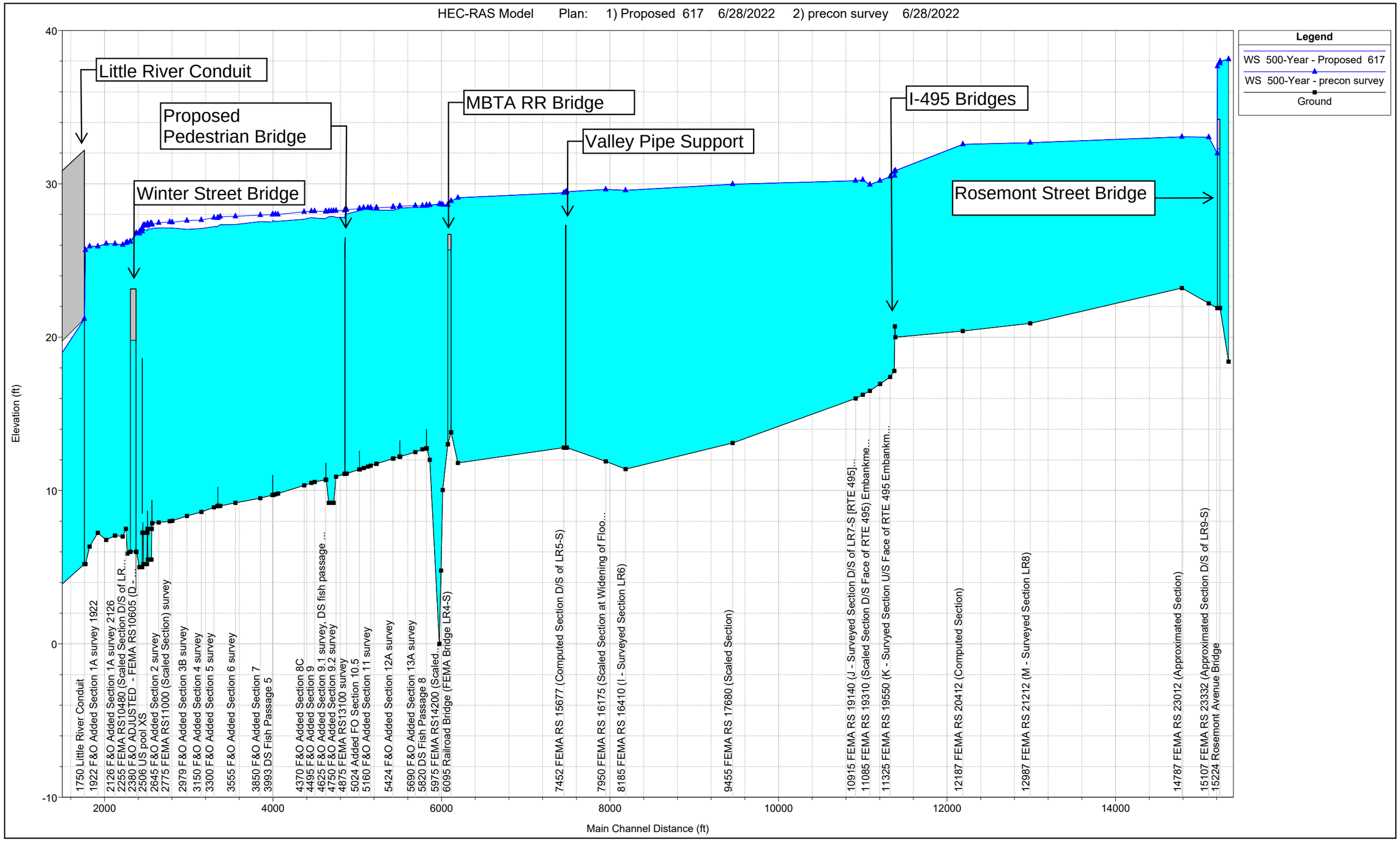
12987 FEMA RS 21212 (M - Surveyed Section LR8)
14787 FEMA RS 23012 (Approximated Section)
15107 FEMA RS 23332 (Approximated Section D/S of LR9-S)
15224 Rosemont Avenue Bridge

500-Year


HEC-RAS Model Plan: 1) Proposed 617 6/28/2022 2) precon survey 6/28/2022
Legend
WS 500-Year - Proposed 617
WS 500-Year - precon survey
Ground
Little River Conduit
Proposed Pedestrian Bridge
Winter Street Bridge
MBTA RR Bridge
Valley Pipe Support
I-495 Bridges
Rosemont Street Bridge
Elevation (ft)
Main Channel Distance (ft)
1750 Little River Conduit
1922 F&O Added Section 1A survey 1922
2126 F&O Added Section 1A survey 2126
2255 FEMA RS10480 (Scaled Section D/S of LR...
2380 F&O ADJUSTED - FEMA RS10605 (D -...
2506 US pool XS
2645 F&O Added Section 2 survey
2775 FEMA RS11000 (Scaled Section) survey
2979 F&O Added Section 3B survey
3150 F&O Added Section 4 survey
3300 F&O Added Section 5 survey
3555 F&O Added Section 6 survey
3850 F&O Added Section 7
3993 DS Fish Passage 5
4370 F&O Added Section 8C
4495 F&O Added Section 9
4625 F&O Added Section 9.1 survey, DS fish passage ...
4750 F&O Added Section 9.2 survey
4875 FEMA RS13100 survey
5024 Added FO Section 10.5
5160 F&O Added Section 11 survey
5424 F&O Added Section 12A survey
5690 F&O Added Section 13A survey
5820 DS Fish Passage 8
5975 FEMA RS14200 (Scaled...
6095 Railroad Bridge (FEMA Bridge LR4-S)
7452 FEMA RS 15677 (Computed Section D/S of LR5-S)
7950 FEMA RS 16175 (Scaled Section at Widening of Floo...
8185 FEMA RS 16410 (I - Surveyed Section LR6)
9455 FEMA RS 17680 (Scaled Section)
10915 FEMA RS 19140 (J - Surveyed Section D/S of LR7-S [RTE 495]...
11085 FEMA RS 19310 (Scaled Section D/S Face of RTE 495) Embankme...
11325 FEMA RS 19550 (K - Surveyed Section U/S Face of RTE 495 Embankm...
12187 FEMA RS 20412 (Computed Section)
12987 FEMA RS 21212 (M - Surveyed Section LR8)
14787 FEMA RS 23012 (Approximated Section)
15107 FEMA RS 23332 (Approximated Section D/S of LR9-S)
15224 Rosemont Avenue Bridge

HEC-RAS River: Little River Reach: Little River

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Vel Chnl	Top Width
				(cfs)	(ft)	(ft)	(ft)	(ft/s)	(ft)
Little River	15341	10-Year	Proposed 617	980.00	18.40	30.47	12.07	1.71	299.55
Little River	15341	10-Year	precon survey	980.00	18.40	30.48	12.08	1.70	299.60
Little River	15341	50-Year	Proposed 617	1640.00	18.40	33.43	15.03	1.80	321.70
Little River	15341	50-Year	precon survey	1640.00	18.40	33.42	15.02	1.80	321.68
Little River	15341	100-Year	Proposed 617	1990.00	18.40	34.76	16.36	1.85	338.51
Little River	15341	100-Year	precon survey	1990.00	18.40	34.77	16.37	1.85	338.55
Little River	15341	500-Year	Proposed 617	3030.00	18.40	38.13	19.73	2.01	404.08
Little River	15341	500-Year	precon survey	3030.00	18.40	38.13	19.73	2.01	404.08
Little River	15241	10-Year	Proposed 617	980.00	21.90	29.16	7.26	8.16	35.68
Little River	15241	10-Year	precon survey	980.00	21.90	29.17	7.27	8.15	36.16
Little River	15241	50-Year	Proposed 617	1640.00	21.90	31.43	9.53	10.21	181.67
Little River	15241	50-Year	precon survey	1640.00	21.90	31.42	9.52	10.22	181.34
Little River	15241	100-Year	Proposed 617	1990.00	21.90	34.30	12.40	6.11	368.92
Little River	15241	100-Year	precon survey	1990.00	21.90	34.30	12.40	6.10	369.09
Little River	15241	500-Year	Proposed 617	3030.00	21.90	37.99	16.09	4.33	542.92
Little River	15241	500-Year	precon survey	3030.00	21.90	37.99	16.09	4.33	542.92
Little River	15224			Bridge					
Little River	15207	10-Year	Proposed 617	980.00	21.90	28.68	6.78	8.78	25.00
Little River	15207	10-Year	precon survey	980.00	21.90	28.69	6.79	8.77	25.02
Little River	15207	50-Year	Proposed 617	1640.00	21.90	29.52	7.62	12.97	55.99
Little River	15207	50-Year	precon survey	1640.00	21.90	29.58	7.68	12.86	59.42
Little River	15207	100-Year	Proposed 617	1990.00	21.90	29.92	8.02	14.91	80.53
Little River	15207	100-Year	precon survey	1990.00	21.90	29.95	8.05	14.85	82.48
Little River	15207	500-Year	Proposed 617	3030.00	21.90	31.99	10.09	17.75	220.02
Little River	15207	500-Year	precon survey	3030.00	21.90	31.99	10.09	17.75	220.02
Little River	15107	10-Year	Proposed 617	980.00	22.20	28.88	6.68	3.97	110.19
Little River	15107	10-Year	precon survey	980.00	22.20	28.89	6.69	3.95	110.51
Little River	15107	50-Year	Proposed 617	1640.00	22.20	30.28	8.08	4.84	142.25
Little River	15107	50-Year	precon survey	1640.00	22.20	30.33	8.13	4.79	143.48
Little River	15107	100-Year	Proposed 617	1990.00	22.20	31.06	8.86	5.04	160.22
Little River	15107	100-Year	precon survey	1990.00	22.20	31.08	8.88	5.02	160.73
Little River	15107	500-Year	Proposed 617	3030.00	22.20	33.05	10.85	5.49	205.95
Little River	15107	500-Year	precon survey	3030.00	22.20	33.05	10.85	5.49	205.97
Little River	14787	10-Year	Proposed 617	980.00	23.20	28.52	5.32	3.43	272.78
Little River	14787	10-Year	precon survey	980.00	23.20	28.54	5.34	3.40	273.93
Little River	14787	50-Year	Proposed 617	1640.00	23.20	30.06	6.86	3.52	468.02
Little River	14787	50-Year	precon survey	1640.00	23.20	30.13	6.93	3.44	471.04
Little River	14787	100-Year	Proposed 617	1990.00	23.20	30.94	7.74	3.30	506.70
Little River	14787	100-Year	precon survey	1990.00	23.20	30.97	7.77	3.28	507.83
Little River	14787	500-Year	Proposed 617	3030.00	23.20	33.06	9.86	3.09	599.95
Little River	14787	500-Year	precon survey	3030.00	23.20	33.06	9.86	3.09	599.99
Little River	12987	10-Year	Proposed 617	980.00	20.90	27.36	6.46	2.43	441.14
Little River	12987	10-Year	precon survey	980.00	20.90	27.45	6.55	2.37	448.07
Little River	12987	50-Year	Proposed 617	1640.00	20.90	29.28	8.38	2.37	603.48
Little River	12987	50-Year	precon survey	1640.00	20.90	29.41	8.51	2.30	611.82
Little River	12987	100-Year	Proposed 617	1990.00	20.90	30.37	9.47	2.22	674.63
Little River	12987	100-Year	precon survey	1990.00	20.90	30.41	9.51	2.20	677.12
Little River	12987	500-Year	Proposed 617	3030.00	20.90	32.68	11.78	2.16	826.22
Little River	12987	500-Year	precon survey	3030.00	20.90	32.68	11.78	2.16	826.29
Little River	12187	10-Year	Proposed 617	980.00	20.40	27.05	6.65	2.29	457.07
Little River	12187	10-Year	precon survey	980.00	20.40	27.16	6.76	2.22	466.08
Little River	12187	50-Year	Proposed 617	1640.00	20.40	29.08	8.68	2.20	623.09
Little River	12187	50-Year	precon survey	1640.00	20.40	29.23	8.83	2.13	632.59
Little River	12187	100-Year	Proposed 617	1990.00	20.40	30.22	9.82	2.06	697.72
Little River	12187	100-Year	precon survey	1990.00	20.40	30.26	9.86	2.04	700.43
Little River	12187	500-Year	Proposed 617	3030.00	20.40	32.57	12.17	2.03	852.12
Little River	12187	500-Year	precon survey	3030.00	20.40	32.57	12.17	2.03	852.20
Little River	11387	10-Year	Proposed 617	1160.00	20.00	25.63	5.63	6.71	48.34
Little River	11387	10-Year	precon survey	1160.00	20.00	25.87	5.87	6.40	49.26
Little River	11387	50-Year	Proposed 617	1920.00	20.00	27.61	7.61	7.93	55.88
Little River	11387	50-Year	precon survey	1920.00	20.00	27.88	7.88	7.63	56.90
Little River	11387	100-Year	Proposed 617	2330.00	20.00	28.82	8.82	8.15	60.49

HEC-RAS River: Little River Reach: Little River (Continued)

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Vel Chnl	Top Width
				(cfs)	(ft)	(ft)	(ft)	(ft/s)	(ft)
Little River	11387	100-Year	precon survey	2330.00	20.00	28.89	8.89	8.08	60.75
Little River	11387	500-Year	Proposed 617	3520.00	20.00	30.86	10.86	9.71	68.23
Little River	11387	500-Year	precon survey	3520.00	20.00	30.86	10.86	9.71	68.24
Little River	11381	10-Year	Proposed 617	1160.00	20.70	25.11	4.41	8.38	45.97
Little River	11381	10-Year	precon survey	1160.00	20.70	25.52	4.82	7.63	47.53
Little River	11381	50-Year	Proposed 617	1920.00	20.70	27.21	6.51	9.09	54.09
Little River	11381	50-Year	precon survey	1920.00	20.70	27.57	6.87	8.57	55.47
Little River	11381	100-Year	Proposed 617	2330.00	20.70	28.53	7.83	9.01	59.17
Little River	11381	100-Year	precon survey	2330.00	20.70	28.61	7.91	8.91	59.49
Little River	11381	500-Year	Proposed 617	3520.00	20.70	30.53	9.83	10.56	66.90
Little River	11381	500-Year	precon survey	3520.00	20.70	30.53	9.83	10.56	66.91
Little River	11375	10-Year	Proposed 617	1160.00	17.80	25.42	7.62	5.05	49.93
Little River	11375	10-Year	precon survey	1160.00	17.80	25.76	7.96	4.81	51.09
Little River	11375	50-Year	Proposed 617	1920.00	17.80	27.50	9.70	6.35	57.11
Little River	11375	50-Year	precon survey	1920.00	17.80	27.82	10.02	6.12	58.20
Little River	11375	100-Year	Proposed 617	2330.00	17.80	28.77	10.97	6.69	61.50
Little River	11375	100-Year	precon survey	2330.00	17.80	28.85	11.05	6.64	61.76
Little River	11375	500-Year	Proposed 617	3520.00	17.80	30.81	13.01	8.30	68.52
Little River	11375	500-Year	precon survey	3520.00	17.80	30.81	13.01	8.30	68.53
Little River	11325	10-Year	Proposed 617	1160.00	17.40	25.18	7.78	5.67	45.06
Little River	11325	10-Year	precon survey	1160.00	17.40	25.56	8.16	5.32	46.42
Little River	11325	50-Year	Proposed 617	1920.00	17.40	27.22	9.82	6.94	52.34
Little River	11325	50-Year	precon survey	1920.00	17.40	27.58	10.18	6.63	53.61
Little River	11325	100-Year	Proposed 617	2330.00	17.40	28.52	11.12	7.19	56.96
Little River	11325	100-Year	precon survey	2330.00	17.40	28.60	11.20	7.13	57.26
Little River	11325	500-Year	Proposed 617	3520.00	17.40	30.47	13.07	8.86	63.93
Little River	11325	500-Year	precon survey	3520.00	17.40	30.47	13.07	8.86	63.94
Little River	11205	10-Year	Proposed 617	1160.00	16.95	24.94	7.99	5.47	45.80
Little River	11205	10-Year	precon survey	1160.00	16.95	25.37	8.42	5.11	47.34
Little River	11205	50-Year	Proposed 617	1920.00	16.95	26.97	10.02	6.77	53.04
Little River	11205	50-Year	precon survey	1920.00	16.95	27.36	10.41	6.44	54.46
Little River	11205	100-Year	Proposed 617	2330.00	16.95	28.30	11.35	7.01	57.79
Little River	11205	100-Year	precon survey	2330.00	16.95	28.39	11.44	6.94	58.11
Little River	11205	500-Year	Proposed 617	3520.00	16.95	30.20	13.25	8.71	64.58
Little River	11205	500-Year	precon survey	3520.00	16.95	30.20	13.25	8.70	64.59
Little River	11085	10-Year	Proposed 617	1160.00	16.50	24.73	8.23	5.27	46.64
Little River	11085	10-Year	precon survey	1160.00	16.50	25.21	8.71	4.90	48.35
Little River	11085	50-Year	Proposed 617	1920.00	16.50	26.74	10.24	6.58	53.83
Little River	11085	50-Year	precon survey	1920.00	16.50	27.17	10.67	6.24	55.38
Little River	11085	100-Year	Proposed 617	2330.00	16.50	28.10	11.60	6.82	58.68
Little River	11085	100-Year	precon survey	2330.00	16.50	28.20	11.70	6.75	59.03
Little River	11085	500-Year	Proposed 617	3520.00	16.50	29.95	13.45	8.54	65.30
Little River	11085	500-Year	precon survey	3520.00	16.50	29.95	13.45	8.54	65.31
Little River	11000	10-Year	Proposed 617	1160.00	16.25	24.68	8.43	3.95	56.10
Little River	11000	10-Year	precon survey	1160.00	16.25	25.18	8.93	3.60	58.23
Little River	11000	50-Year	Proposed 617	1920.00	16.25	26.75	10.50	4.58	122.28
Little River	11000	50-Year	precon survey	1920.00	16.25	27.20	10.95	4.25	188.47
Little River	11000	100-Year	Proposed 617	2330.00	16.25	28.18	11.93	4.32	333.00
Little River	11000	100-Year	precon survey	2330.00	16.25	28.28	12.03	4.23	348.08
Little River	11000	500-Year	Proposed 617	3520.00	16.25	30.25	14.00	4.20	544.25
Little River	11000	500-Year	precon survey	3520.00	16.25	30.26	14.01	4.20	544.49
Little River	10915	10-Year	Proposed 617	1160.00	16.00	24.46	8.46	3.93	56.25
Little River	10915	10-Year	precon survey	1160.00	16.00	25.01	9.01	3.55	58.60
Little River	10915	50-Year	Proposed 617	1920.00	16.00	26.52	10.52	4.56	125.46
Little River	10915	50-Year	precon survey	1920.00	16.00	27.02	11.02	4.16	198.71
Little River	10915	100-Year	Proposed 617	2330.00	16.00	28.03	12.03	4.01	348.41
Little River	10915	100-Year	precon survey	2330.00	16.00	28.15	12.15	3.90	365.09
Little River	10915	500-Year	Proposed 617	3520.00	16.00	30.20	14.20	3.22	560.87
Little River	10915	500-Year	precon survey	3520.00	16.00	30.20	14.20	3.22	561.13
Little River	9455	10-Year	Proposed 617	1160.00	13.10	23.78	10.68	1.51	462.33
Little River	9455	10-Year	precon survey	1160.00	13.10	24.65	11.55	1.22	545.22
Little River	9455	50-Year	Proposed 617	1920.00	13.10	26.18	13.08	1.43	698.15

HEC-RAS River: Little River Reach: Little River (Continued)

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Vel Chnl	Top Width
				(cfs)	(ft)	(ft)	(ft)	(ft/s)	(ft)
Little River	9455	50-Year	precon survey	1920.00	13.10	26.79	13.69	1.27	758.98
Little River	9455	100-Year	Proposed 617	2330.00	13.10	27.83	14.73	1.27	862.78
Little River	9455	100-Year	precon survey	2330.00	13.10	27.95	14.85	1.25	875.07
Little River	9455	500-Year	Proposed 617	3520.00	13.10	29.97	16.87	1.35	1027.76
Little River	9455	500-Year	precon survey	3520.00	13.10	29.97	16.87	1.35	1027.87
Little River	8185	10-Year	Proposed 617	1160.00	11.40	23.27	11.87	2.41	79.26
Little River	8185	10-Year	precon survey	1160.00	11.40	24.34	12.94	2.11	84.85
Little River	8185	50-Year	Proposed 617	1920.00	11.40	25.74	14.34	2.97	106.97
Little River	8185	50-Year	precon survey	1920.00	11.40	26.44	15.04	2.75	118.16
Little River	8185	100-Year	Proposed 617	2330.00	11.40	27.48	16.08	3.00	141.25
Little River	8185	100-Year	precon survey	2330.00	11.40	27.62	16.22	2.96	144.80
Little River	8185	500-Year	Proposed 617	3520.00	11.40	29.57	18.17	3.64	222.62
Little River	8185	500-Year	precon survey	3520.00	11.40	29.58	18.18	3.64	222.81
Little River	7950	10-Year	Proposed 617	1160.00	11.90	23.23	11.33	1.35	412.90
Little River	7950	10-Year	precon survey	1160.00	11.90	24.33	12.43	1.05	422.88
Little River	7950	50-Year	Proposed 617	1920.00	11.90	25.75	13.85	1.32	429.91
Little River	7950	50-Year	precon survey	1920.00	11.90	26.46	14.56	1.18	433.44
Little River	7950	100-Year	Proposed 617	2330.00	11.90	27.51	15.61	1.23	438.63
Little River	7950	100-Year	precon survey	2330.00	11.90	27.65	15.75	1.20	439.31
Little River	7950	500-Year	Proposed 617	3520.00	11.90	29.63	17.73	1.43	447.00
Little River	7950	500-Year	precon survey	3520.00	11.90	29.63	17.73	1.43	447.00
Little River	7488	10-Year	Proposed 617	1160.00	12.80	23.02	10.22	1.99	170.75
Little River	7488	10-Year	precon survey	1160.00	12.80	24.21	11.41	1.60	178.59
Little River	7488	50-Year	Proposed 617	1920.00	12.80	25.58	12.78	2.15	187.55
Little River	7488	50-Year	precon survey	1920.00	12.80	26.34	13.54	1.94	192.51
Little River	7488	100-Year	Proposed 617	2330.00	12.80	27.38	14.58	2.07	198.97
Little River	7488	100-Year	precon survey	2330.00	12.80	27.53	14.73	2.04	199.40
Little River	7488	500-Year	Proposed 617	3520.00	12.80	29.48	16.68	2.47	329.28
Little River	7488	500-Year	precon survey	3520.00	12.80	29.48	16.68	2.47	329.41
Little River	7478	10-Year	Proposed 617	1160.00	12.80	23.01	10.21	2.00	170.70
Little River	7478	10-Year	precon survey	1160.00	12.80	24.21	11.41	1.61	178.56
Little River	7478	50-Year	Proposed 617	1920.00	12.80	25.58	12.78	2.17	187.51
Little River	7478	50-Year	precon survey	1920.00	12.80	26.33	13.53	1.96	192.47
Little River	7478	100-Year	Proposed 617	2330.00	12.80	27.38	14.58	2.10	198.96
Little River	7478	100-Year	precon survey	2330.00	12.80	27.52	14.72	2.06	199.39
Little River	7478	500-Year	Proposed 617	3520.00	12.80	29.47	16.67	2.47	329.13
Little River	7478	500-Year	precon survey	3520.00	12.80	29.48	16.68	2.47	329.26
Little River	7475			Bridge					
Little River	7472	10-Year	Proposed 617	1160.00	12.80	23.00	10.20	2.00	170.61
Little River	7472	10-Year	precon survey	1160.00	12.80	24.20	11.40	1.61	178.51
Little River	7472	50-Year	Proposed 617	1920.00	12.80	25.54	12.74	2.18	187.25
Little River	7472	50-Year	precon survey	1920.00	12.80	26.29	13.49	1.96	192.17
Little River	7472	100-Year	Proposed 617	2330.00	12.80	27.29	14.49	2.10	198.69
Little River	7472	100-Year	precon survey	2330.00	12.80	27.44	14.64	2.06	199.14
Little River	7472	500-Year	Proposed 617	3520.00	12.80	29.42	16.62	2.49	327.37
Little River	7472	500-Year	precon survey	3520.00	12.80	29.43	16.63	2.49	327.49
Little River	7452	10-Year	Proposed 617	1160.00	12.80	22.98	10.18	2.01	170.52
Little River	7452	10-Year	precon survey	1160.00	12.80	24.20	11.40	1.61	178.46
Little River	7452	50-Year	Proposed 617	1920.00	12.80	25.53	12.73	2.17	187.18
Little River	7452	50-Year	precon survey	1920.00	12.80	26.28	13.48	1.96	192.12
Little River	7452	100-Year	Proposed 617	2330.00	12.80	27.29	14.49	2.10	198.64
Little River	7452	100-Year	precon survey	2330.00	12.80	27.43	14.63	2.06	199.12
Little River	7452	500-Year	Proposed 617	3520.00	12.80	29.41	16.61	2.49	327.07
Little River	7452	500-Year	precon survey	3520.00	12.80	29.42	16.62	2.49	327.19
Little River	6195	10-Year	Proposed 617	1160.00	11.80	22.47	10.67	1.40	219.45
Little River	6195	10-Year	precon survey	1160.00	11.80	23.94	12.14	1.09	248.11
Little River	6195	50-Year	Proposed 617	1920.00	11.80	25.13	13.33	1.52	268.65
Little River	6195	50-Year	precon survey	1920.00	11.80	26.00	14.20	1.36	283.63
Little River	6195	100-Year	Proposed 617	2330.00	11.80	27.00	15.20	1.46	304.15
Little River	6195	100-Year	precon survey	2330.00	11.80	27.16	15.36	1.43	311.16
Little River	6195	500-Year	Proposed 617	3520.00	11.80	29.09	17.29	1.74	402.46
Little River	6195	500-Year	precon survey	3520.00	11.80	29.10	17.30	1.74	402.67

HEC-RAS River: Little River Reach: Little River (Continued)

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Vel Chnl	Top Width
				(cfs)	(ft)	(ft)	(ft)	(ft/s)	(ft)
Little River	6115	10-Year	Proposed 617	1160.00	13.80	22.20	8.40	3.64	90.61
Little River	6115	10-Year	precon survey	1160.00	13.80	23.79	9.99	2.82	111.44
Little River	6115	50-Year	Proposed 617	1920.00	13.80	24.83	11.03	4.07	124.95
Little River	6115	50-Year	precon survey	1920.00	13.80	25.76	11.96	3.64	137.12
Little River	6115	100-Year	Proposed 617	2330.00	13.80	26.72	12.92	3.99	149.90
Little River	6115	100-Year	precon survey	2330.00	13.80	26.97	13.17	3.52	182.86
Little River	6115	500-Year	Proposed 617	3520.00	13.80	28.87	15.07	4.01	343.11
Little River	6115	500-Year	precon survey	3520.00	13.80	28.88	15.08	4.01	343.34
Little River	6095			Bridge					
Little River	6075	10-Year	Proposed 617	1160.00	13.02	20.82	7.80	5.48	76.46
Little River	6075	10-Year	precon survey	1160.00	13.02	23.23	10.21	3.42	108.05
Little River	6075	50-Year	Proposed 617	1920.00	13.02	23.21	10.19	5.69	107.71
Little River	6075	50-Year	precon survey	1920.00	13.02	24.98	11.96	4.43	130.83
Little River	6075	100-Year	Proposed 617	2330.00	13.02	24.83	11.81	5.47	128.94
Little River	6075	100-Year	precon survey	2330.00	13.02	25.80	12.78	4.45	141.62
Little River	6075	500-Year	Proposed 617	3520.00	13.02	28.62	15.60	4.37	345.35
Little River	6075	500-Year	precon survey	3520.00	13.02	28.63	15.61	4.37	345.89
Little River	6015	10-Year	Proposed 617	1160.00	10.03	20.57	10.54	4.26	54.80
Little River	6015	10-Year	precon survey	1160.00	10.03	23.18	13.15	2.75	237.27
Little River	6015	50-Year	Proposed 617	1920.00	10.03	23.03	13.00	4.69	225.43
Little River	6015	50-Year	precon survey	1920.00	10.03	24.96	14.93	3.05	328.16
Little River	6015	100-Year	Proposed 617	2330.00	10.03	24.80	14.77	3.85	325.65
Little River	6015	100-Year	precon survey	2330.00	10.03	25.78	15.75	3.08	340.80
Little River	6015	500-Year	Proposed 617	3520.00	10.03	28.63	18.60	2.67	433.58
Little River	6015	500-Year	precon survey	3520.00	10.03	28.64	18.61	2.66	433.65
Little River	5995	10-Year	Proposed 617	1160.00	4.78	20.75	15.97	0.75	295.49
Little River	5995	10-Year	precon survey	1160.00	4.78	23.25	18.47	0.54	354.45
Little River	5995	50-Year	Proposed 617	1920.00	4.78	23.24	18.46	0.89	354.33
Little River	5995	50-Year	precon survey	1920.00	4.78	25.03	20.25	0.72	377.60
Little River	5995	100-Year	Proposed 617	2330.00	4.78	24.91	20.13	0.89	376.24
Little River	5995	100-Year	precon survey	2330.00	4.78	25.85	21.07	0.81	386.85
Little River	5995	500-Year	Proposed 617	3520.00	4.78	28.66	23.88	0.94	482.61
Little River	5995	500-Year	precon survey	3520.00	4.78	28.67	23.89	0.94	482.69
Little River	5975	10-Year	Proposed 617	1160.00	0.00	20.76	20.76	0.44	207.18
Little River	5975	10-Year	precon survey	1160.00	0.00	23.25	23.25	0.38	253.93
Little River	5975	50-Year	Proposed 617	1920.00	0.00	23.24	23.24	0.62	253.82
Little River	5975	50-Year	precon survey	1920.00	0.00	25.03	25.03	0.56	312.31
Little River	5975	100-Year	Proposed 617	2330.00	0.00	24.91	24.91	0.68	306.33
Little River	5975	100-Year	precon survey	2330.00	0.00	25.85	25.85	0.64	353.20
Little River	5975	500-Year	Proposed 617	3520.00	0.00	28.66	28.66	0.82	493.92
Little River	5975	500-Year	precon survey	3520.00	0.00	28.67	28.67	0.82	494.42
Little River	5861	10-Year	Proposed 617	1160.00	12.00	20.60	8.60	3.28	190.27
Little River	5861	10-Year	precon survey	1160.00	12.00	23.21	11.21	1.76	221.81
Little River	5861	50-Year	Proposed 617	1920.00	12.00	23.13	11.13	3.13	220.81
Little River	5861	50-Year	precon survey	1920.00	12.00	24.98	12.98	2.17	264.63
Little River	5861	100-Year	Proposed 617	2330.00	12.00	24.82	12.82	2.84	258.61
Little River	5861	100-Year	precon survey	2330.00	12.00	25.79	13.79	2.33	296.93
Little River	5861	500-Year	Proposed 617	3520.00	12.00	28.61	16.61	2.51	409.10
Little River	5861	500-Year	precon survey	3520.00	12.00	28.62	16.62	2.41	409.49
Little River	5826	10-Year	Proposed 617	1160.00	12.75	20.45	7.70	3.77	167.71
Little River	5826	10-Year	precon survey	1160.00	13.00	23.16	10.16	2.50	202.70
Little River	5826	50-Year	Proposed 617	1920.00	12.75	23.03	10.28	3.57	201.07
Little River	5826	50-Year	precon survey	1920.00	13.00	24.92	11.92	2.95	245.46
Little River	5826	100-Year	Proposed 617	2330.00	12.75	24.76	12.01	3.19	239.05
Little River	5826	100-Year	precon survey	2330.00	13.00	25.73	12.73	3.11	278.47
Little River	5826	500-Year	Proposed 617	3520.00	12.75	28.58	15.83	2.76	393.97
Little River	5826	500-Year	precon survey	3520.00	13.00	28.58	15.58	3.03	394.22
Little River	5823			Inl Struct					
Little River	5820	10-Year	Proposed 617	1160.00	12.75	20.18	7.43	5.22	159.35
Little River	5820	10-Year	precon survey	1160.00	13.00	23.15	10.15	2.55	193.19

HEC-RAS River: Little River Reach: Little River (Continued)

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Vel Chnl	Top Width
				(cfs)	(ft)	(ft)	(ft)	(ft/s)	(ft)
Little River	5820	50-Year	Proposed 617	1920.00	12.75	22.81	10.06	5.18	189.33
Little River	5820	50-Year	precon survey	1920.00	13.00	24.91	11.91	3.02	232.93
Little River	5820	100-Year	Proposed 617	2330.00	12.75	24.59	11.84	4.71	220.58
Little River	5820	100-Year	precon survey	2330.00	13.00	25.72	12.72	3.19	264.66
Little River	5820	500-Year	Proposed 617	3520.00	12.75	28.46	15.71	4.25	371.55
Little River	5820	500-Year	precon survey	3520.00	13.00	28.57	15.57	3.13	376.12
Little River	5775	10-Year	Proposed 617	1160.00	12.69	20.19	7.50	4.47	198.60
Little River	5775	10-Year	precon survey	1160.00	13.14	23.16	10.02	1.59	229.22
Little River	5775	50-Year	Proposed 617	1920.00	12.69	22.84	10.15	4.33	225.93
Little River	5775	50-Year	precon survey	1920.00	13.14	24.92	11.78	1.93	267.28
Little River	5775	100-Year	Proposed 617	2330.00	12.69	24.62	11.93	3.94	255.87
Little River	5775	100-Year	precon survey	2330.00	13.14	25.73	12.59	2.06	298.13
Little River	5775	500-Year	Proposed 617	3520.00	12.69	28.47	15.78	3.60	402.39
Little River	5775	500-Year	precon survey	3520.00	13.14	28.58	15.44	2.12	406.35
Little River	5690	10-Year	Proposed 617	1160.00	12.50	20.13	7.63	4.40	202.27
Little River	5690	10-Year	precon survey	1160.00	11.89	23.15	11.26	0.92	228.48
Little River	5690	50-Year	Proposed 617	1920.00	12.50	22.82	10.32	4.15	224.46
Little River	5690	50-Year	precon survey	1920.00	11.89	24.91	13.02	1.16	244.77
Little River	5690	100-Year	Proposed 617	2330.00	12.50	24.61	12.11	3.80	240.84
Little River	5690	100-Year	precon survey	2330.00	11.89	25.72	13.83	1.27	255.20
Little River	5690	500-Year	Proposed 617	3520.00	12.50	28.47	15.97	3.54	346.45
Little River	5690	500-Year	precon survey	3520.00	11.89	28.57	16.68	1.39	346.58
Little River	5510	10-Year	Proposed 617	1160.00	12.21	19.95	7.74	4.38	178.24
Little River	5510	10-Year	precon survey	1160.00	11.73	23.12	11.39	1.00	202.76
Little River	5510	50-Year	Proposed 617	1920.00	12.21	22.71	10.50	4.12	200.76
Little River	5510	50-Year	precon survey	1920.00	11.73	24.87	13.14	1.28	223.29
Little River	5510	100-Year	Proposed 617	2330.00	12.21	24.53	12.32	3.78	216.91
Little River	5510	100-Year	precon survey	2330.00	11.73	25.68	13.95	1.40	238.29
Little River	5510	500-Year	Proposed 617	3520.00	12.21	28.42	16.21	3.55	353.98
Little River	5510	500-Year	precon survey	3520.00	11.73	28.54	16.81	1.52	355.42
Little River	5507			Inl Struct					
Little River	5504	10-Year	Proposed 617	1160.00	12.20	19.90	7.70	4.42	177.58
Little River	5504	10-Year	precon survey	1160.00	11.73	23.12	11.39	1.00	202.76
Little River	5504	50-Year	Proposed 617	1920.00	12.20	22.69	10.49	4.13	200.64
Little River	5504	50-Year	precon survey	1920.00	11.73	24.87	13.14	1.28	223.27
Little River	5504	100-Year	Proposed 617	2330.00	12.20	24.51	12.31	3.79	216.49
Little River	5504	100-Year	precon survey	2330.00	11.73	25.68	13.95	1.40	238.26
Little River	5504	500-Year	Proposed 617	3520.00	12.20	28.40	16.20	3.56	353.75
Little River	5504	500-Year	precon survey	3520.00	11.73	28.54	16.81	1.52	355.41
Little River	5430	10-Year	Proposed 617	1160.00	12.09	19.70	7.61	5.10	119.14
Little River	5430	10-Year	precon survey	1160.00	11.00	23.09	12.09	1.37	154.96
Little River	5430	50-Year	Proposed 617	1920.00	12.09	22.49	10.40	5.10	149.37
Little River	5430	50-Year	precon survey	1920.00	11.00	24.83	13.83	1.77	171.50
Little River	5430	100-Year	Proposed 617	2330.00	12.09	24.35	12.26	4.75	166.83
Little River	5430	100-Year	precon survey	2330.00	11.00	25.63	14.63	1.94	179.27
Little River	5430	500-Year	Proposed 617	3520.00	12.09	28.27	16.18	4.53	353.35
Little River	5430	500-Year	precon survey	3520.00	11.00	28.49	17.49	2.10	360.07
Little River	5424	10-Year	Proposed 617	1160.00	12.08	19.69	7.61	5.11	118.94
Little River	5424	10-Year	precon survey	1160.00	11.00	23.08	12.08	1.37	154.95
Little River	5424	50-Year	Proposed 617	1920.00	12.08	22.48	10.40	5.10	149.32
Little River	5424	50-Year	precon survey	1920.00	11.00	24.83	13.83	1.77	171.48
Little River	5424	100-Year	Proposed 617	2330.00	12.08	24.34	12.26	4.75	166.79
Little River	5424	100-Year	precon survey	2330.00	11.00	25.63	14.63	1.94	179.25
Little River	5424	500-Year	Proposed 617	3520.00	12.08	28.27	16.19	4.53	353.28
Little River	5424	500-Year	precon survey	3520.00	11.00	28.49	17.49	2.10	360.01
Little River	5232	10-Year	Proposed 617	1160.00	11.75	19.52	7.77	4.69	150.22
Little River	5232	10-Year	precon survey	1160.00	11.20	23.01	11.81	1.96	237.92
Little River	5232	50-Year	Proposed 617	1920.00	11.75	22.41	10.66	4.49	224.81
Little River	5232	50-Year	precon survey	1920.00	11.20	24.75	13.55	2.40	275.58
Little River	5232	100-Year	Proposed 617	2330.00	11.75	24.31	12.56	4.06	266.12
Little River	5232	100-Year	precon survey	2330.00	11.20	25.55	14.35	2.57	293.01
Little River	5232	500-Year	Proposed 617	3520.00	11.75	28.27	16.52	3.72	472.46

HEC-RAS River: Little River Reach: Little River (Continued)

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Vel Chnl	Top Width
				(cfs)	(ft)	(ft)	(ft)	(ft/s)	(ft)
Little River	5232	500-Year	precon survey	3520.00	11.20	28.43	17.23	2.60	476.06
Little River	5226	10-Year	Proposed 617	1160.00	11.74	19.51	7.77	4.69	149.89
Little River	5226	10-Year	precon survey	1160.00	11.20	23.01	11.81	1.96	237.88
Little River	5226	50-Year	Proposed 617	1920.00	11.74	22.41	10.67	4.49	224.73
Little River	5226	50-Year	precon survey	1920.00	11.20	24.75	13.55	2.40	275.52
Little River	5226	100-Year	Proposed 617	2330.00	11.74	24.31	12.57	4.06	266.07
Little River	5226	100-Year	precon survey	2330.00	11.20	25.55	14.35	2.57	292.95
Little River	5226	500-Year	Proposed 617	3520.00	11.74	28.27	16.53	3.72	472.43
Little River	5226	500-Year	precon survey	3520.00	11.20	28.43	17.23	2.60	476.01
Little River	5160	10-Year	Proposed 617	1160.00	11.62	19.59	7.97	3.43	237.76
Little River	5160	10-Year	precon survey	1160.00	11.20	23.03	11.83	0.66	281.34
Little River	5160	50-Year	Proposed 617	1920.00	11.62	22.48	10.86	3.23	277.47
Little River	5160	50-Year	precon survey	1920.00	11.20	24.76	13.56	0.87	300.75
Little River	5160	100-Year	Proposed 617	2330.00	11.62	24.36	12.74	2.98	294.22
Little River	5160	100-Year	precon survey	2330.00	11.20	25.57	14.37	0.96	313.90
Little River	5160	500-Year	Proposed 617	3520.00	11.62	28.30	16.68	2.87	470.22
Little River	5160	500-Year	precon survey	3520.00	11.20	28.44	17.24	1.08	471.47
Little River	5128	10-Year	Proposed 617	1160.00	11.56	19.67	8.11	0.90	265.08
Little River	5128	10-Year	precon survey	1160.00	11.20	23.02	11.82	0.67	281.33
Little River	5128	50-Year	Proposed 617	1920.00	11.56	22.53	10.97	1.05	296.24
Little River	5128	50-Year	precon survey	1920.00	11.20	24.76	13.56	0.87	300.71
Little River	5128	100-Year	Proposed 617	2330.00	11.56	24.40	12.84	1.06	309.57
Little River	5128	100-Year	precon survey	2330.00	11.20	25.56	14.36	0.96	313.86
Little River	5128	500-Year	Proposed 617	3520.00	11.56	28.33	16.77	1.17	470.45
Little River	5128	500-Year	precon survey	3520.00	11.20	28.44	17.24	1.09	471.44
Little River	5077	10-Year	Proposed 617	1160.00	11.47	19.64	8.17	1.51	239.12
Little River	5077	10-Year	precon survey	1160.00	11.20	23.02	11.82	0.67	281.31
Little River	5077	50-Year	Proposed 617	1920.00	11.47	22.51	11.04	1.43	277.70
Little River	5077	50-Year	precon survey	1920.00	11.20	24.76	13.56	0.87	300.64
Little River	5077	100-Year	Proposed 617	2330.00	11.47	24.39	12.92	1.34	294.61
Little River	5077	100-Year	precon survey	2330.00	11.20	25.56	14.36	0.97	313.78
Little River	5077	500-Year	Proposed 617	3520.00	11.47	28.32	16.85	1.35	470.37
Little River	5077	500-Year	precon survey	3520.00	11.20	28.44	17.24	1.09	471.41
Little River	5030	10-Year	Proposed 617	1160.00	11.38	19.53	8.15	2.78	129.45
Little River	5030	10-Year	precon survey	1160.00	12.76	22.98	10.22	1.48	175.11
Little River	5030	50-Year	Proposed 617	1920.00	11.38	22.44	11.06	2.39	171.41
Little River	5030	50-Year	precon survey	1920.00	12.76	24.71	11.95	1.85	185.88
Little River	5030	100-Year	Proposed 617	2330.00	11.38	24.33	12.95	2.18	183.44
Little River	5030	100-Year	precon survey	2330.00	12.76	25.50	12.74	2.00	190.42
Little River	5030	500-Year	Proposed 617	3520.00	11.38	28.27	16.89	2.13	376.82
Little River	5030	500-Year	precon survey	3520.00	12.76	28.38	15.62	2.13	382.59
Little River	5027			Inl Struct					
Little River	5024	10-Year	Proposed 617	1160.00	11.38	19.46	8.08	2.84	129.32
Little River	5024	10-Year	precon survey	1160.00	12.76	22.98	10.22	1.49	175.09
Little River	5024	50-Year	Proposed 617	1920.00	11.38	22.39	11.01	2.41	171.09
Little River	5024	50-Year	precon survey	1920.00	12.76	24.70	11.94	1.85	185.86
Little River	5024	100-Year	Proposed 617	2330.00	11.38	24.30	12.92	2.19	183.20
Little River	5024	100-Year	precon survey	2330.00	12.76	25.50	12.74	2.00	190.41
Little River	5024	500-Year	Proposed 617	3520.00	11.38	28.25	16.87	2.14	375.20
Little River	5024	500-Year	precon survey	3520.00	12.76	28.38	15.62	2.13	382.47
Little River	4875	10-Year	Proposed 617	1160.00	11.10	19.08	7.98	4.68	104.98
Little River	4875	10-Year	precon survey	1160.00	11.05	22.94	11.89	1.35	138.75
Little River	4875	50-Year	Proposed 617	1920.00	11.10	22.08	10.98	4.75	135.91
Little River	4875	50-Year	precon survey	1920.00	11.05	24.65	13.60	1.77	144.44
Little River	4875	100-Year	Proposed 617	2330.00	11.10	24.05	12.95	4.48	142.45
Little River	4875	100-Year	precon survey	2330.00	11.05	25.44	14.39	1.96	155.42
Little River	4875	500-Year	Proposed 617	3520.00	11.10	28.03	16.93	4.52	332.32
Little River	4875	500-Year	precon survey	3520.00	11.05	28.32	17.27	2.20	372.83
Little River	4859	10-Year	Proposed 617	1160.00	11.09	19.16	8.07	3.25	82.92
Little River	4859	10-Year	precon survey	1160.00	11.05	22.93	11.88	1.35	138.74
Little River	4859	50-Year	Proposed 617	1920.00	11.09	22.17	11.08	3.06	121.34

HEC-RAS River: Little River Reach: Little River (Continued)

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Vel Chnl	Top Width
				(cfs)	(ft)	(ft)	(ft)	(ft/s)	(ft)
Little River	4859	50-Year	precon survey	1920.00	11.05	24.64	13.59	1.77	144.42
Little River	4859	100-Year	Proposed 617	2330.00	11.09	24.12	13.03	2.86	137.25
Little River	4859	100-Year	precon survey	2330.00	11.05	25.43	14.38	1.96	155.31
Little River	4859	500-Year	Proposed 617	3520.00	11.09	28.09	17.00	2.86	341.20
Little River	4859	500-Year	precon survey	3520.00	11.05	28.31	17.26	2.20	372.05
Little River	4854.5			Bridge					
Little River	4850	10-Year	Proposed 617	1160.00	11.08	18.94	7.86	4.80	81.91
Little River	4850	10-Year	precon survey	1160.00	11.26	22.91	11.65	1.65	106.39
Little River	4850	50-Year	Proposed 617	1920.00	11.08	21.91	10.83	5.08	98.59
Little River	4850	50-Year	precon survey	1920.00	11.26	24.61	13.35	2.22	119.84
Little River	4850	100-Year	Proposed 617	2330.00	11.08	23.89	12.81	4.89	114.23
Little River	4850	100-Year	precon survey	2330.00	11.26	25.39	14.13	2.47	125.89
Little River	4850	500-Year	Proposed 617	3520.00	11.08	27.81	16.73	5.03	290.12
Little River	4850	500-Year	precon survey	3520.00	11.26	28.26	17.00	2.76	374.38
Little River	4750	10-Year	Proposed 617	1160.00	10.90	18.88	7.98	4.31	95.62
Little River	4750	10-Year	precon survey	1160.00	12.16	22.90	10.74	1.28	111.53
Little River	4750	50-Year	Proposed 617	1920.00	10.90	21.89	10.99	4.54	108.96
Little River	4750	50-Year	precon survey	1920.00	12.16	24.59	12.43	1.77	119.14
Little River	4750	100-Year	Proposed 617	2330.00	10.90	23.87	12.97	4.39	114.03
Little River	4750	100-Year	precon survey	2330.00	12.16	25.37	13.21	1.99	125.49
Little River	4750	500-Year	Proposed 617	3520.00	10.90	27.80	16.90	4.60	289.36
Little River	4750	500-Year	precon survey	3520.00	12.16	28.25	16.09	2.30	372.05
Little River	4721	10-Year	Proposed 617	1160.00	9.20	18.80	9.60	4.46	128.81
Little River	4721	10-Year	precon survey	1160.00	12.11	22.89	10.78	1.28	111.51
Little River	4721	50-Year	Proposed 617	1920.00	9.20	21.86	12.66	4.27	184.37
Little River	4721	50-Year	precon survey	1920.00	12.11	24.58	12.47	1.77	119.07
Little River	4721	100-Year	Proposed 617	2330.00	9.20	23.91	14.71	3.37	193.34
Little River	4721	100-Year	precon survey	2330.00	12.11	25.36	13.25	1.99	125.41
Little River	4721	500-Year	Proposed 617	3520.00	9.20	27.87	18.67	2.96	299.96
Little River	4721	500-Year	precon survey	3520.00	12.11	28.24	16.13	2.30	370.83
Little River	4692	10-Year	Proposed 617	1160.00	9.20	18.78	9.58	4.47	128.31
Little River	4692	10-Year	precon survey	1160.00	12.06	22.89	10.83	1.28	111.50
Little River	4692	50-Year	Proposed 617	1920.00	9.20	21.81	12.61	4.33	183.54
Little River	4692	50-Year	precon survey	1920.00	12.06	24.57	12.51	1.76	119.00
Little River	4692	100-Year	Proposed 617	2330.00	9.20	23.90	14.70	3.38	193.28
Little River	4692	100-Year	precon survey	2330.00	12.06	25.35	13.29	1.99	125.33
Little River	4692	500-Year	Proposed 617	3520.00	9.20	27.87	18.67	2.96	299.65
Little River	4692	500-Year	precon survey	3520.00	12.06	28.23	16.17	2.30	369.61
Little River	4663	10-Year	Proposed 617	1160.00	9.20	18.76	9.56	4.48	127.80
Little River	4663	10-Year	precon survey	1160.00	12.00	22.88	10.88	1.28	111.48
Little River	4663	50-Year	Proposed 617	1920.00	9.20	21.75	12.55	4.39	182.68
Little River	4663	50-Year	precon survey	1920.00	12.00	24.56	12.56	1.76	118.93
Little River	4663	100-Year	Proposed 617	2330.00	9.20	23.88	14.68	3.39	193.22
Little River	4663	100-Year	precon survey	2330.00	12.00	25.34	13.34	1.98	125.25
Little River	4663	500-Year	Proposed 617	3520.00	9.20	27.86	18.66	2.96	299.34
Little River	4663	500-Year	precon survey	3520.00	12.00	28.22	16.22	2.30	368.40
Little River	4632	10-Year	Proposed 617	1160.00	10.70	18.70	8.00	4.63	42.47
Little River	4632	10-Year	precon survey	1160.00	11.00	22.81	11.81	2.56	172.97
Little River	4632	50-Year	Proposed 617	1920.00	10.70	21.61	10.91	4.89	140.72
Little River	4632	50-Year	precon survey	1920.00	11.00	24.47	13.47	3.22	219.68
Little River	4632	100-Year	Proposed 617	2330.00	10.70	23.71	13.01	4.40	202.20
Little River	4632	100-Year	precon survey	2330.00	11.00	25.24	14.24	3.46	233.49
Little River	4632	500-Year	Proposed 617	3520.00	10.70	27.76	17.06	4.01	414.24
Little River	4632	500-Year	precon survey	3520.00	11.00	28.18	17.18	3.36	490.74
Little River	4629			Inl Struct					
Little River	4625	10-Year	Proposed 617	1160.00	10.70	18.49	7.79	4.79	42.02
Little River	4625	10-Year	precon survey	1160.00	12.58	22.83	10.25	1.74	171.24
Little River	4625	50-Year	Proposed 617	1920.00	10.70	21.51	10.81	4.97	139.11
Little River	4625	50-Year	precon survey	1920.00	12.58	24.50	11.92	2.16	220.26
Little River	4625	100-Year	Proposed 617	2330.00	10.70	23.66	12.96	4.44	200.40
Little River	4625	100-Year	precon survey	2330.00	12.58	25.28	12.70	2.32	234.10

HEC-RAS River: Little River Reach: Little River (Continued)

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Vel Chnl	Top Width
				(cfs)	(ft)	(ft)	(ft)	(ft/s)	(ft)
Little River	4625	500-Year	Proposed 617	3520.00	10.70	27.73	17.03	4.03	411.64
Little River	4625	500-Year	precon survey	3520.00	12.58	28.20	15.62	2.32	493.01
Little River	4495	10-Year	Proposed 617	1160.00	10.56	18.40	7.84	4.10	235.37
Little River	4495	10-Year	precon survey	1160.00	13.62	22.84	9.22	0.65	312.46
Little River	4495	50-Year	Proposed 617	1920.00	10.56	21.57	11.01	3.23	288.54
Little River	4495	50-Year	precon survey	1920.00	13.62	24.52	10.90	0.84	327.68
Little River	4495	100-Year	Proposed 617	2330.00	10.56	23.72	13.16	2.76	311.36
Little River	4495	100-Year	precon survey	2330.00	13.62	25.30	11.68	0.92	338.29
Little River	4495	500-Year	Proposed 617	3520.00	10.56	27.77	17.21	2.59	398.86
Little River	4495	500-Year	precon survey	3520.00	13.62	28.22	14.60	1.01	531.62
Little River	4455	10-Year	Proposed 617	1160.00	10.50	18.56	8.06	0.69	250.73
Little River	4455	10-Year	precon survey	1160.00	13.62	22.83	9.21	0.65	312.44
Little River	4455	50-Year	Proposed 617	1920.00	10.50	21.64	11.14	0.80	288.93
Little River	4455	50-Year	precon survey	1920.00	13.62	24.51	10.89	0.84	327.63
Little River	4455	100-Year	Proposed 617	2330.00	10.50	23.76	13.26	0.80	311.88
Little River	4455	100-Year	precon survey	2330.00	13.62	25.29	11.67	0.92	338.24
Little River	4455	500-Year	Proposed 617	3520.00	10.50	27.80	17.30	0.90	399.73
Little River	4455	500-Year	precon survey	3520.00	13.62	28.21	14.59	1.01	531.22
Little River	4370	10-Year	Proposed 617	1160.00	10.34	18.19	7.85	4.73	70.92
Little River	4370	10-Year	precon survey	1160.00	13.22	22.78	9.56	1.71	254.72
Little River	4370	50-Year	Proposed 617	1920.00	10.34	21.30	10.96	4.76	181.26
Little River	4370	50-Year	precon survey	1920.00	13.22	24.45	11.23	1.98	376.56
Little River	4370	100-Year	Proposed 617	2330.00	10.34	23.54	13.20	4.15	312.14
Little River	4370	100-Year	precon survey	2330.00	13.22	25.23	12.01	2.06	411.47
Little River	4370	500-Year	Proposed 617	3520.00	10.34	27.69	17.35	3.45	585.82
Little River	4370	500-Year	precon survey	3520.00	13.22	28.18	14.96	1.86	617.55
Little River	4060	10-Year	Proposed 617	1160.00	9.80	18.01	8.21	3.75	79.64
Little River	4060	10-Year	precon survey	1160.00	13.34	22.61	9.27	1.79	132.95
Little River	4060	50-Year	Proposed 617	1920.00	9.80	21.19	11.39	3.95	117.92
Little River	4060	50-Year	precon survey	1920.00	13.34	24.24	10.90	2.31	152.45
Little River	4060	100-Year	Proposed 617	2330.00	9.80	23.45	13.65	3.71	140.93
Little River	4060	100-Year	precon survey	2330.00	13.34	25.01	11.67	2.53	172.66
Little River	4060	500-Year	Proposed 617	3520.00	9.80	27.56	17.76	3.78	355.22
Little River	4060	500-Year	precon survey	3520.00	13.34	28.00	14.66	2.63	717.84
Little River	4030	10-Year	Proposed 617	1160.00	9.75	17.93	8.18	4.24	100.92
Little River	4030	10-Year	precon survey	1160.00	11.10	22.61	11.51	1.26	141.00
Little River	4030	50-Year	Proposed 617	1920.00	9.75	21.16	11.41	4.25	136.17
Little River	4030	50-Year	precon survey	1920.00	11.10	24.25	13.15	1.69	151.94
Little River	4030	100-Year	Proposed 617	2330.00	9.75	23.44	13.69	3.91	143.75
Little River	4030	100-Year	precon survey	2330.00	11.10	25.02	13.92	1.88	166.52
Little River	4030	500-Year	Proposed 617	3520.00	9.75	27.55	17.80	3.96	406.42
Little River	4030	500-Year	precon survey	3520.00	11.10	28.01	16.91	2.08	472.32
Little River	4000	10-Year	Proposed 617	1160.00	9.70	17.95	8.25	3.58	75.10
Little River	4000	10-Year	precon survey	1160.00	10.13	22.60	12.47	1.35	139.04
Little River	4000	50-Year	Proposed 617	1920.00	9.70	21.22	11.52	2.97	121.65
Little River	4000	50-Year	precon survey	1920.00	10.13	24.24	14.11	1.78	158.17
Little River	4000	100-Year	Proposed 617	2330.00	9.70	23.50	13.80	2.46	148.12
Little River	4000	100-Year	precon survey	2330.00	10.13	25.00	14.87	1.96	174.32
Little River	4000	500-Year	Proposed 617	3520.00	9.70	27.61	17.91	2.31	244.72
Little River	4000	500-Year	precon survey	3520.00	10.13	28.00	17.87	2.14	261.48
Little River	3996			Inl Struct					
Little River	3993	10-Year	Proposed 617	1160.00	9.70	17.74	8.04	4.56	71.45
Little River	3993	10-Year	precon survey	1160.00	10.00	22.58	12.58	1.94	182.18
Little River	3993	50-Year	Proposed 617	1920.00	9.70	21.01	11.31	4.56	160.66
Little River	3993	50-Year	precon survey	1920.00	10.00	24.21	14.21	2.53	219.05
Little River	3993	100-Year	Proposed 617	2330.00	9.70	23.34	13.64	4.06	200.07
Little River	3993	100-Year	precon survey	2330.00	10.00	24.98	14.98	2.76	230.53
Little River	3993	500-Year	Proposed 617	3520.00	9.70	27.50	17.80	3.87	354.58
Little River	3993	500-Year	precon survey	3520.00	10.00	27.99	17.99	2.86	389.89
Little River	3850	10-Year	Proposed 617	1160.00	9.50	17.61	8.11	3.96	68.50
Little River	3850	10-Year	precon survey	1160.00	12.35	22.56	10.21	1.22	181.55

HEC-RAS River: Little River Reach: Little River (Continued)

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Vel Chnl	Top Width
				(cfs)	(ft)	(ft)	(ft)	(ft/s)	(ft)
Little River	3850	50-Year	Proposed 617	1920.00	9.50	21.01	11.51	2.72	160.68
Little River	3850	50-Year	precon survey	1920.00	12.35	24.18	11.83	1.58	218.57
Little River	3850	100-Year	Proposed 617	2330.00	9.50	23.36	13.86	2.17	200.74
Little River	3850	100-Year	precon survey	2330.00	12.35	24.95	12.60	1.72	230.01
Little River	3850	500-Year	Proposed 617	3520.00	9.50	27.54	18.04	1.98	356.79
Little River	3850	500-Year	precon survey	3520.00	12.35	27.96	15.61	1.83	387.88
Little River	3555	10-Year	Proposed 617	1160.00	9.20	17.22	8.02	4.42	66.68
Little River	3555	10-Year	precon survey	1160.00	7.58	22.50	14.92	1.19	139.41
Little River	3555	50-Year	Proposed 617	1920.00	9.20	20.65	11.45	4.55	106.90
Little River	3555	50-Year	precon survey	1920.00	7.58	24.10	16.52	1.66	184.69
Little River	3555	100-Year	Proposed 617	2330.00	9.20	23.11	13.91	4.19	156.38
Little River	3555	100-Year	precon survey	2330.00	7.58	24.86	17.28	1.86	207.83
Little River	3555	500-Year	Proposed 617	3520.00	9.20	27.35	18.15	4.08	367.59
Little River	3555	500-Year	precon survey	3520.00	7.58	27.88	20.30	2.05	381.31
Little River	3375	10-Year	Proposed 617	1160.00	9.00	17.08	8.08	4.38	107.06
Little River	3375	10-Year	precon survey	1160.00	7.00	22.49	15.49	0.91	143.80
Little River	3375	50-Year	Proposed 617	1920.00	9.00	20.61	11.61	4.22	136.97
Little River	3375	50-Year	precon survey	1920.00	7.00	24.08	17.08	1.27	149.56
Little River	3375	100-Year	Proposed 617	2330.00	9.00	23.09	14.09	3.84	145.99
Little River	3375	100-Year	precon survey	2330.00	7.00	24.83	17.83	1.43	210.73
Little River	3375	500-Year	Proposed 617	3520.00	9.00	27.34	18.34	3.85	451.10
Little River	3375	500-Year	precon survey	3520.00	7.00	27.86	20.86	1.62	501.64
Little River	3350	10-Year	Proposed 617	1160.00	9.00	17.02	8.02	4.58	83.99
Little River	3350	10-Year	precon survey	1160.00	8.80	22.45	13.65	1.92	117.10
Little River	3350	50-Year	Proposed 617	1920.00	9.00	20.53	11.53	4.59	111.21
Little River	3350	50-Year	precon survey	1920.00	8.80	24.01	15.21	2.66	124.39
Little River	3350	100-Year	Proposed 617	2330.00	9.00	23.03	14.03	4.21	119.78
Little River	3350	100-Year	precon survey	2330.00	8.80	24.75	15.95	3.00	128.13
Little River	3350	500-Year	Proposed 617	3520.00	9.00	27.26	18.26	4.37	320.61
Little River	3350	500-Year	precon survey	3520.00	8.80	27.78	18.98	3.36	374.90
Little River	3346			Inl Struct					
Little River	3342	10-Year	Proposed 617	1160.00	9.00	16.92	7.92	4.66	82.60
Little River	3342	10-Year	precon survey	1160.00	8.80	22.45	13.65	1.92	117.09
Little River	3342	50-Year	Proposed 617	1920.00	9.00	20.48	11.48	4.62	111.08
Little River	3342	50-Year	precon survey	1920.00	8.80	24.01	15.21	2.67	124.38
Little River	3342	100-Year	Proposed 617	2330.00	9.00	22.98	13.98	4.23	119.58
Little River	3342	100-Year	precon survey	2330.00	8.80	24.75	15.95	3.00	128.11
Little River	3342	500-Year	Proposed 617	3520.00	9.00	27.21	18.21	4.39	316.13
Little River	3342	500-Year	precon survey	3520.00	8.80	27.77	18.97	3.36	374.48
Little River	3300	10-Year	Proposed 617	1160.00	8.90	16.88	7.98	4.64	82.43
Little River	3300	10-Year	precon survey	1160.00	8.80	22.46	13.66	1.11	117.90
Little River	3300	50-Year	Proposed 617	1920.00	8.90	20.45	11.55	4.60	111.85
Little River	3300	50-Year	precon survey	1920.00	8.80	24.03	15.23	1.57	124.46
Little River	3300	100-Year	Proposed 617	2330.00	8.90	22.97	14.07	4.21	120.03
Little River	3300	100-Year	precon survey	2330.00	8.80	24.77	15.97	1.78	128.21
Little River	3300	500-Year	Proposed 617	3520.00	8.90	27.20	18.30	4.37	315.10
Little River	3300	500-Year	precon survey	3520.00	8.80	27.79	18.99	2.08	376.45
Little River	3150	10-Year	Proposed 617	1160.00	8.60	16.73	8.13	4.60	57.24
Little River	3150	10-Year	precon survey	1160.00	9.14	22.38	13.24	1.97	87.80
Little River	3150	50-Year	Proposed 617	1920.00	8.60	20.31	11.71	4.79	69.72
Little River	3150	50-Year	precon survey	1920.00	9.14	23.89	14.75	2.72	115.21
Little River	3150	100-Year	Proposed 617	2330.00	8.60	22.84	14.24	4.54	96.11
Little River	3150	100-Year	precon survey	2330.00	9.14	24.61	15.47	3.05	133.79
Little River	3150	500-Year	Proposed 617	3520.00	8.60	27.08	18.48	4.75	212.26
Little River	3150	500-Year	precon survey	3520.00	9.14	27.64	18.50	3.30	232.99
Little River	2979	10-Year	Proposed 617	1160.00	8.34	16.62	8.28	4.21	47.57
Little River	2979	10-Year	precon survey	1160.00	8.26	22.37	14.11	1.27	101.57
Little River	2979	50-Year	Proposed 617	1920.00	8.34	20.23	11.89	4.52	58.96
Little River	2979	50-Year	precon survey	1920.00	8.26	23.87	15.61	1.84	128.91
Little River	2979	100-Year	Proposed 617	2330.00	8.34	22.78	14.44	4.33	97.90
Little River	2979	100-Year	precon survey	2330.00	8.26	24.58	16.32	2.11	143.05
Little River	2979	500-Year	Proposed 617	3520.00	8.34	27.04	18.70	4.57	210.61

HEC-RAS River: Little River Reach: Little River (Continued)

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Vel Chnl	Top Width
				(cfs)	(ft)	(ft)	(ft)	(ft/s)	(ft)
Little River	2979	500-Year	precon survey	3520.00	8.26	27.60	19.34	2.48	231.78
Little River	2805	10-Year	Proposed 617	1160.00	8.03	16.49	8.46	3.91	54.42
Little River	2805	10-Year	precon survey	1160.00	11.68	22.28	10.60	2.04	108.73
Little River	2805	50-Year	Proposed 617	1920.00	8.03	20.23	12.20	3.44	87.27
Little River	2805	50-Year	precon survey	1920.00	11.68	23.73	12.05	2.70	157.79
Little River	2805	100-Year	Proposed 617	2330.00	8.03	22.83	14.80	2.99	127.33
Little River	2805	100-Year	precon survey	2330.00	11.68	24.42	12.74	2.97	174.62
Little River	2805	500-Year	Proposed 617	3520.00	8.03	27.11	19.08	2.93	290.93
Little River	2805	500-Year	precon survey	3520.00	11.68	27.49	15.81	2.98	315.03
Little River	2775	10-Year	Proposed 617	1160.00	8.00	16.49	8.49	3.61	56.98
Little River	2775	10-Year	precon survey	1160.00	12.10	22.27	10.17	1.87	207.46
Little River	2775	50-Year	Proposed 617	1920.00	8.00	20.22	12.22	3.45	132.55
Little River	2775	50-Year	precon survey	1920.00	12.10	23.73	11.63	2.43	260.57
Little River	2775	100-Year	Proposed 617	2330.00	8.00	22.83	14.83	3.04	227.69
Little River	2775	100-Year	precon survey	2330.00	12.10	24.43	12.33	2.64	285.96
Little River	2775	500-Year	Proposed 617	3520.00	8.00	27.13	19.13	2.90	384.43
Little River	2775	500-Year	precon survey	3520.00	12.10	27.51	15.41	2.58	398.29
Little River	2645	10-Year	Proposed 617	1160.00	7.92	16.48	8.56	2.92	83.96
Little River	2645	10-Year	precon survey	1160.00	8.24	22.26	14.02	1.25	124.74
Little River	2645	50-Year	Proposed 617	1920.00	7.92	20.24	12.32	2.59	113.71
Little River	2645	50-Year	precon survey	1920.00	8.24	23.70	15.46	1.74	126.96
Little River	2645	100-Year	Proposed 617	2330.00	7.92	22.84	14.92	2.32	125.64
Little River	2645	100-Year	precon survey	2330.00	8.24	24.39	16.15	1.96	128.13
Little River	2645	500-Year	Proposed 617	3520.00	7.92	27.12	19.20	2.43	239.67
Little River	2645	500-Year	precon survey	3520.00	8.24	27.46	19.22	2.22	271.60
Little River	2567	10-Year	Proposed 617	1160.00	7.87	16.34	8.47	3.80	56.58
Little River	2567	10-Year	precon survey	1160.00	7.30	22.22	14.92	1.82	124.69
Little River	2567	50-Year	Proposed 617	1920.00	7.87	20.17	12.30	3.22	113.25
Little River	2567	50-Year	precon survey	1920.00	7.30	23.63	16.33	2.63	126.86
Little River	2567	100-Year	Proposed 617	2330.00	7.87	22.81	14.94	2.70	125.58
Little River	2567	100-Year	precon survey	2330.00	7.30	24.30	17.00	3.01	127.97
Little River	2567	500-Year	Proposed 617	3520.00	7.87	27.10	19.23	2.69	237.15
Little River	2567	500-Year	precon survey	3520.00	7.30	27.34	20.04	3.56	260.72
Little River	2564			Inl Struct					
Little River	2561	10-Year	Proposed 617	1160.00	7.50	16.21	8.71	3.74	55.94
Little River	2561	10-Year	precon survey	1160.00	7.30	22.23	14.93	1.80	124.69
Little River	2561	50-Year	Proposed 617	1920.00	7.50	20.08	12.58	3.20	112.70
Little River	2561	50-Year	precon survey	1920.00	7.30	23.64	16.34	2.60	126.86
Little River	2561	100-Year	Proposed 617	2330.00	7.50	22.76	15.26	2.68	125.51
Little River	2561	100-Year	precon survey	2330.00	7.30	24.31	17.01	2.97	127.98
Little River	2561	500-Year	Proposed 617	3520.00	7.50	27.06	19.56	2.67	233.26
Little River	2561	500-Year	precon survey	3520.00	7.30	27.35	20.05	3.50	260.95
Little River	2558	10-Year	Proposed 617	1160.00	5.50	16.25	10.75	3.02	59.34
Little River	2558	10-Year	precon survey	1160.00	7.30	22.25	14.95	1.06	124.72
Little River	2558	50-Year	Proposed 617	1920.00	5.50	20.09	14.59	3.07	112.76
Little River	2558	50-Year	precon survey	1920.00	7.30	23.68	16.38	1.52	126.93
Little River	2558	100-Year	Proposed 617	2330.00	5.50	22.76	17.26	2.73	125.52
Little River	2558	100-Year	precon survey	2330.00	7.30	24.36	17.06	1.73	128.08
Little River	2558	500-Year	Proposed 617	3520.00	5.50	27.06	21.56	2.79	233.72
Little River	2558	500-Year	precon survey	3520.00	7.30	27.42	20.12	2.03	267.85
Little River	2550	10-Year	Proposed 617	1160.00	5.50	16.25	10.75	2.97	59.34
Little River	2550	10-Year	precon survey	1160.00	7.30	22.25	14.95	1.06	124.72
Little River	2550	50-Year	Proposed 617	1920.00	5.50	20.10	14.60	2.80	112.83
Little River	2550	50-Year	precon survey	1920.00	7.30	23.68	16.38	1.52	126.92
Little River	2550	100-Year	Proposed 617	2330.00	5.50	22.77	17.27	2.44	125.53
Little River	2550	100-Year	precon survey	2330.00	7.30	24.36	17.06	1.73	128.07
Little River	2550	500-Year	Proposed 617	3520.00	5.50	27.06	21.56	2.51	233.84
Little River	2550	500-Year	precon survey	3520.00	7.30	27.42	20.12	2.03	267.69
Little River	2516	10-Year	Proposed 617	1160.00	5.50	16.26	10.76	2.74	76.66
Little River	2516	10-Year	precon survey	1160.00	7.30	22.24	14.94	1.06	124.71
Little River	2516	50-Year	Proposed 617	1920.00	5.50	20.11	14.61	2.53	112.89

HEC-RAS River: Little River Reach: Little River (Continued)

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Vel Chnl	Top Width
				(cfs)	(ft)	(ft)	(ft)	(ft/s)	(ft)
Little River	2516	50-Year	precon survey	1920.00	7.30	23.67	16.37	1.52	126.91
Little River	2516	100-Year	Proposed 617	2330.00	5.50	22.78	17.28	2.27	125.56
Little River	2516	100-Year	precon survey	2330.00	7.30	24.35	17.05	1.73	128.06
Little River	2516	500-Year	Proposed 617	3520.00	5.50	27.07	21.57	2.39	234.26
Little River	2516	500-Year	precon survey	3520.00	7.30	27.41	20.11	2.03	266.98
Little River	2513	10-Year	Proposed 617	1160.00	7.50	16.12	8.62	3.89	45.84
Little River	2513	10-Year	precon survey	1160.00	8.00	22.20	14.20	1.98	84.56
Little River	2513	50-Year	Proposed 617	1920.00	7.50	19.95	12.45	3.93	67.91
Little River	2513	50-Year	precon survey	1920.00	8.00	23.58	15.58	2.90	91.18
Little River	2513	100-Year	Proposed 617	2330.00	7.50	22.65	15.15	3.59	84.78
Little River	2513	100-Year	precon survey	2330.00	8.00	24.23	16.23	3.32	185.37
Little River	2513	500-Year	Proposed 617	3520.00	7.50	27.00	19.50	3.39	464.22
Little River	2513	500-Year	precon survey	3520.00	8.00	27.28	19.28	3.71	497.03
Little River	2511			Inl Struct					
Little River	2509	10-Year	Proposed 617	1160.00	7.25	16.03	8.78	3.34	51.24
Little River	2509	10-Year	precon survey	1160.00	8.00	22.20	14.20	1.98	84.56
Little River	2509	50-Year	Proposed 617	1920.00	7.25	19.88	12.63	3.48	70.30
Little River	2509	50-Year	precon survey	1920.00	8.00	23.58	15.58	2.90	91.18
Little River	2509	100-Year	Proposed 617	2330.00	7.25	22.61	15.36	3.27	85.50
Little River	2509	100-Year	precon survey	2330.00	8.00	24.23	16.23	3.32	185.37
Little River	2509	500-Year	Proposed 617	3520.00	7.25	26.95	19.70	3.34	459.06
Little River	2509	500-Year	precon survey	3520.00	8.00	27.28	19.28	3.71	496.98
Little River	2506	10-Year	Proposed 617	1160.00	5.20	16.04	10.84	3.19	50.54
Little River	2506	10-Year	precon survey	1160.00	9.35	22.20	12.85	1.95	83.04
Little River	2506	50-Year	Proposed 617	1920.00	5.20	19.88	14.68	3.31	71.03
Little River	2506	50-Year	precon survey	1920.00	9.35	23.58	14.23	2.69	90.86
Little River	2506	100-Year	Proposed 617	2330.00	5.20	22.62	17.42	3.02	88.09
Little River	2506	100-Year	precon survey	2330.00	9.35	24.24	14.89	2.99	185.47
Little River	2506	500-Year	Proposed 617	3520.00	5.20	26.98	21.78	2.76	462.25
Little River	2506	500-Year	precon survey	3520.00	9.35	27.34	17.99	2.75	503.36
Little River	2480	10-Year	Proposed 617	1160.00	5.20	15.99	10.79	3.25	49.18
Little River	2480	10-Year	precon survey	1160.00	9.35	22.18	12.83	1.96	82.95
Little River	2480	50-Year	Proposed 617	1920.00	5.20	19.85	14.65	3.38	68.69
Little River	2480	50-Year	precon survey	1920.00	9.35	23.56	14.21	2.69	90.72
Little River	2480	100-Year	Proposed 617	2330.00	5.20	22.59	17.39	3.12	78.64
Little River	2480	100-Year	precon survey	2330.00	9.35	24.21	14.86	3.01	185.23
Little River	2480	500-Year	Proposed 617	3520.00	5.20	26.96	21.76	2.87	459.86
Little River	2480	500-Year	precon survey	3520.00	9.35	27.32	17.97	2.76	501.37
Little River	2464	10-Year	Proposed 617	1160.00	5.20	15.96	10.76	3.26	49.12
Little River	2464	10-Year	precon survey	1160.00	9.35	22.17	12.82	1.96	82.90
Little River	2464	50-Year	Proposed 617	1920.00	5.20	19.83	14.63	3.37	72.04
Little River	2464	50-Year	precon survey	1920.00	9.35	23.54	14.19	2.70	90.62
Little River	2464	100-Year	Proposed 617	2330.00	5.20	22.58	17.38	3.07	87.48
Little River	2464	100-Year	precon survey	2330.00	9.35	24.19	14.84	3.02	185.08
Little River	2464	500-Year	Proposed 617	3520.00	5.20	26.96	21.76	2.80	459.43
Little River	2464	500-Year	precon survey	3520.00	9.35	27.31	17.96	2.77	500.08
Little River	2461	10-Year	Proposed 617	1160.00	7.25	15.86	8.61	4.04	46.91
Little River	2461	10-Year	precon survey	1160.00	8.50	22.18	13.68	1.79	55.74
Little River	2461	50-Year	Proposed 617	1920.00	7.25	19.73	12.48	4.04	52.19
Little River	2461	50-Year	precon survey	1920.00	8.50	23.54	15.04	2.64	58.55
Little River	2461	100-Year	Proposed 617	2330.00	7.25	22.49	15.24	3.76	59.50
Little River	2461	100-Year	precon survey	2330.00	8.50	24.18	15.68	3.05	83.54
Little River	2461	500-Year	Proposed 617	3520.00	7.25	26.86	19.61	3.67	347.98
Little River	2461	500-Year	precon survey	3520.00	8.50	27.27	18.77	3.19	386.60
Little River	2456			Inl Struct					
Little River	2451	10-Year	Proposed 617	1160.00	7.25	15.70	8.45	4.30	48.50
Little River	2451	10-Year	precon survey	1160.00	8.50	21.56	13.06	5.26	75.11
Little River	2451	50-Year	Proposed 617	1920.00	7.25	19.62	12.37	3.95	61.36
Little River	2451	50-Year	precon survey	1920.00	8.50	22.74	14.24	6.21	75.12
Little River	2451	100-Year	Proposed 617	2330.00	7.25	22.41	15.16	3.50	75.20
Little River	2451	100-Year	precon survey	2330.00	8.50	23.30	14.80	6.63	75.12

HEC-RAS River: Little River Reach: Little River (Continued)

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Vel Chnl	Top Width
				(cfs)	(ft)	(ft)	(ft)	(ft/s)	(ft)
Little River	2451	500-Year	Proposed 617	3520.00	7.25	26.84	19.59	3.32	252.06
Little River	2451	500-Year	precon survey	3520.00	8.50	27.09	18.59	4.29	277.77
Little River	2449	10-Year	Proposed 617	1160.00	5.00	15.76	10.76	3.31	47.96
Little River	2449	10-Year	precon survey	1160.00	8.50	20.56	12.06	7.94	75.10
Little River	2449	50-Year	Proposed 617	1920.00	5.00	19.64	14.64	3.43	61.42
Little River	2449	50-Year	precon survey	1920.00	8.50	21.34	12.84	9.40	75.10
Little River	2449	100-Year	Proposed 617	2330.00	5.00	22.42	17.42	3.16	75.20
Little River	2449	100-Year	precon survey	2330.00	8.50	22.66	14.16	7.68	75.12
Little River	2449	500-Year	Proposed 617	3520.00	5.00	26.82	21.82	3.13	256.82
Little River	2449	500-Year	precon survey	3520.00	8.50	26.89	18.39	5.07	261.47
Little River	2430	10-Year	Proposed 617	1160.00	5.00	15.81	10.81	2.06	68.00
Little River	2430	10-Year	precon survey	1160.00	6.77	15.96	9.19	1.90	76.74
Little River	2430	50-Year	Proposed 617	1920.00	5.00	19.69	14.69	2.29	79.88
Little River	2430	50-Year	precon survey	1920.00	6.77	19.89	13.12	2.08	81.38
Little River	2430	100-Year	Proposed 617	2330.00	5.00	22.45	17.45	2.23	79.88
Little River	2430	100-Year	precon survey	2330.00	6.77	22.83	16.06	2.00	84.85
Little River	2430	500-Year	Proposed 617	3520.00	5.00	26.84	21.84	2.53	112.98
Little River	2430	500-Year	precon survey	3520.00	6.77	26.94	20.17	2.29	113.12
Little River	2420	10-Year	Proposed 617	1160.00	5.00	15.80	10.80	2.17	65.00
Little River	2420	10-Year	precon survey	1160.00	7.00	15.93	8.93	2.22	68.99
Little River	2420	50-Year	Proposed 617	1920.00	5.00	19.67	14.67	2.49	73.90
Little River	2420	50-Year	precon survey	1920.00	7.00	19.86	12.86	2.41	71.23
Little River	2420	100-Year	Proposed 617	2330.00	5.00	22.43	17.43	2.45	73.90
Little River	2420	100-Year	precon survey	2330.00	7.00	22.80	15.80	2.31	72.90
Little River	2420	500-Year	Proposed 617	3520.00	5.00	26.82	21.82	2.78	331.30
Little River	2420	500-Year	precon survey	3520.00	7.00	26.92	19.92	2.59	340.53
Little River	2415	10-Year	Proposed 617	1160.00	5.00	15.77	10.77	2.43	58.00
Little River	2415	10-Year	precon survey	1160.00	6.75	15.82	9.07	3.27	43.97
Little River	2415	50-Year	Proposed 617	1920.00	5.00	19.65	14.65	2.68	65.01
Little River	2415	50-Year	precon survey	1920.00	6.75	19.71	12.96	3.62	46.10
Little River	2415	100-Year	Proposed 617	2330.00	5.00	22.42	17.42	2.60	65.02
Little River	2415	100-Year	precon survey	2330.00	6.75	22.66	15.91	3.49	47.72
Little River	2415	500-Year	Proposed 617	3520.00	5.00	26.79	21.79	2.94	242.40
Little River	2415	500-Year	precon survey	3520.00	6.75	26.76	20.01	3.78	240.17
Little River	2380	10-Year	Proposed 617	1160.00	6.00	15.34	9.34	5.17	41.94
Little River	2380	10-Year	precon survey	1160.00	3.50	15.63	12.13	4.49	45.90
Little River	2380	50-Year	Proposed 617	1920.00	6.00	19.10	13.10	5.83	46.00
Little River	2380	50-Year	precon survey	1920.00	3.50	19.42	15.92	5.25	45.94
Little River	2380	100-Year	Proposed 617	2330.00	6.00	21.88	15.88	5.72	46.00
Little River	2380	100-Year	precon survey	2330.00	3.50	22.36	18.86	5.19	45.98
Little River	2380	500-Year	Proposed 617	3520.00	6.00	26.67	20.67	3.99	265.73
Little River	2380	500-Year	precon survey	3520.00	3.50	26.78	23.28	3.58	271.38
Little River	2342.5			Bridge					
Little River	2305	10-Year	Proposed 617	1160.00	6.00	15.02	9.02	5.22	45.88
Little River	2305	10-Year	precon survey	1160.00	6.89	14.96	8.07	5.96	45.88
Little River	2305	50-Year	Proposed 617	1920.00	6.00	18.37	12.37	6.08	45.93
Little River	2305	50-Year	precon survey	1920.00	6.89	18.32	11.43	6.65	45.92
Little River	2305	100-Year	Proposed 617	2330.00	6.00	20.02	14.02	6.43	45.95
Little River	2305	100-Year	precon survey	2330.00	6.89	19.97	13.08	6.96	45.95
Little River	2305	500-Year	Proposed 617	3520.00	6.00	26.19	20.19	3.33	559.70
Little River	2305	500-Year	precon survey	3520.00	6.89	26.24	19.35	3.44	564.61
Little River	2273	10-Year	Proposed 617	1160.00	5.89	15.13	9.24	3.37	51.24
Little River	2273	10-Year	precon survey	1160.00	5.89	15.13	9.24	3.37	51.24
Little River	2273	50-Year	Proposed 617	1920.00	5.89	18.54	12.65	3.64	57.39
Little River	2273	50-Year	precon survey	1920.00	5.89	18.54	12.65	3.64	57.39
Little River	2273	100-Year	Proposed 617	2330.00	5.89	20.23	14.34	3.71	62.08
Little River	2273	100-Year	precon survey	2330.00	5.89	20.23	14.34	3.71	62.08
Little River	2273	500-Year	Proposed 617	3520.00	5.89	26.19	20.30	3.16	311.80
Little River	2273	500-Year	precon survey	3520.00	5.89	26.19	20.30	3.16	311.80
Little River	2255	10-Year	Proposed 617	1160.00	7.50	15.05	7.55	3.92	45.30
Little River	2255	10-Year	precon survey	1160.00	7.50	15.05	7.55	3.92	45.30

HEC-RAS River: Little River Reach: Little River (Continued)

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Vel Chnl	Top Width
				(cfs)	(ft)	(ft)	(ft)	(ft/s)	(ft)
Little River	2255	50-Year	Proposed 617	1920.00	7.50	18.46	10.96	4.24	52.24
Little River	2255	50-Year	precon survey	1920.00	7.50	18.46	10.96	4.24	52.24
Little River	2255	100-Year	Proposed 617	2330.00	7.50	20.14	12.64	4.33	58.32
Little River	2255	100-Year	precon survey	2330.00	7.50	20.14	12.64	4.33	58.32
Little River	2255	500-Year	Proposed 617	3520.00	7.50	26.15	18.65	3.58	223.03
Little River	2255	500-Year	precon survey	3520.00	7.50	26.15	18.65	3.58	223.03
Little River	2218	10-Year	Proposed 617	1160.00	7.00	14.92	7.92	4.61	36.79
Little River	2218	10-Year	precon survey	1160.00	7.00	14.92	7.92	4.61	36.79
Little River	2218	50-Year	Proposed 617	1920.00	7.00	18.30	11.30	5.07	39.51
Little River	2218	50-Year	precon survey	1920.00	7.00	18.30	11.30	5.07	39.51
Little River	2218	100-Year	Proposed 617	2330.00	7.00	19.97	12.97	5.20	43.44
Little River	2218	100-Year	precon survey	2330.00	7.00	19.97	12.97	5.20	43.44
Little River	2218	500-Year	Proposed 617	3520.00	7.00	26.02	19.02	4.44	287.47
Little River	2218	500-Year	precon survey	3520.00	7.00	26.02	19.02	4.44	287.47
Little River	2126	10-Year	Proposed 617	1160.00	7.06	14.78	7.72	5.28	45.66
Little River	2126	10-Year	precon survey	1160.00	7.06	14.78	7.72	5.28	45.66
Little River	2126	50-Year	Proposed 617	1920.00	7.06	18.28	11.22	5.13	62.17
Little River	2126	50-Year	precon survey	1920.00	7.06	18.28	11.22	5.13	62.17
Little River	2126	100-Year	Proposed 617	2330.00	7.06	20.00	12.94	5.01	71.64
Little River	2126	100-Year	precon survey	2330.00	7.06	20.00	12.94	5.01	71.64
Little River	2126	500-Year	Proposed 617	3520.00	7.06	26.09	19.03	3.87	297.44
Little River	2126	500-Year	precon survey	3520.00	7.06	26.09	19.03	3.87	297.44
Little River	2021	10-Year	Proposed 617	1160.00	6.78	14.83	8.05	3.59	60.53
Little River	2021	10-Year	precon survey	1160.00	6.78	14.83	8.05	3.59	60.53
Little River	2021	50-Year	Proposed 617	1920.00	6.78	18.34	11.56	3.64	71.85
Little River	2021	50-Year	precon survey	1920.00	6.78	18.34	11.56	3.64	71.85
Little River	2021	100-Year	Proposed 617	2330.00	6.78	20.04	13.26	3.65	78.96
Little River	2021	100-Year	precon survey	2330.00	6.78	20.04	13.26	3.65	78.96
Little River	2021	500-Year	Proposed 617	3520.00	6.78	26.10	19.32	3.12	116.86
Little River	2021	500-Year	precon survey	3520.00	6.78	26.10	19.32	3.12	116.86
Little River	1922	10-Year	Proposed 617	1160.00	7.24	14.45	7.21	5.35	40.86
Little River	1922	10-Year	precon survey	1160.00	7.24	14.45	7.21	5.35	40.86
Little River	1922	50-Year	Proposed 617	1920.00	7.24	18.01	10.77	5.33	52.18
Little River	1922	50-Year	precon survey	1920.00	7.24	18.01	10.77	5.33	52.18
Little River	1922	100-Year	Proposed 617	2330.00	7.24	19.74	12.50	5.30	59.02
Little River	1922	100-Year	precon survey	2330.00	7.24	19.74	12.50	5.30	59.02
Little River	1922	500-Year	Proposed 617	3520.00	7.24	25.92	18.68	4.43	86.59
Little River	1922	500-Year	precon survey	3520.00	7.24	25.92	18.68	4.43	86.59
Little River	1825	10-Year	Proposed 617	1160.00	6.34	14.49	8.15	4.05	44.70
Little River	1825	10-Year	precon survey	1160.00	6.34	14.49	8.15	4.05	44.70
Little River	1825	50-Year	Proposed 617	1920.00	6.34	18.04	11.70	4.42	53.99
Little River	1825	50-Year	precon survey	1920.00	6.34	18.04	11.70	4.42	53.99
Little River	1825	100-Year	Proposed 617	2330.00	6.34	19.76	13.42	4.53	59.46
Little River	1825	100-Year	precon survey	2330.00	6.34	19.76	13.42	4.53	59.46
Little River	1825	500-Year	Proposed 617	3520.00	6.34	25.92	19.58	4.08	77.85
Little River	1825	500-Year	precon survey	3520.00	6.34	25.92	19.58	4.08	77.85
Little River	1775 FEMA Section A	10-Year	Proposed 617	1160.00	5.20	14.47	9.27	3.95	41.24
Little River	1775 FEMA Section A	10-Year	precon survey	1160.00	5.20	14.47	9.27	3.95	41.24
Little River	1775 FEMA Section A	50-Year	Proposed 617	1920.00	5.20	17.96	12.76	4.60	43.80
Little River	1775 FEMA Section A	50-Year	precon survey	1920.00	5.20	17.96	12.76	4.60	43.80
Little River	1775 FEMA Section A	100-Year	Proposed 617	2330.00	5.20	19.64	14.44	4.88	45.03
Little River	1775 FEMA Section A	100-Year	precon survey	2330.00	5.20	19.64	14.44	4.88	45.03
Little River	1775 FEMA Section A	500-Year	Proposed 617	3520.00	5.20	25.68	20.48	5.08	49.45
Little River	1775 FEMA Section A	500-Year	precon survey	3520.00	5.20	25.68	20.48	5.08	49.45
Little River	1750			Bridge					
Little River	0010	10-Year	Proposed 617	1160.00	-3.30	1.03	4.33	14.14	360.14
Little River	0010	10-Year	precon survey	1160.00	-3.30	1.03	4.33	14.14	360.14
Little River	0010	50-Year	Proposed 617	1920.00	-3.30	1.90	5.20	17.39	535.00
Little River	0010	50-Year	precon survey	1920.00	-3.30	1.90	5.20	17.39	535.00
Little River	0010	100-Year	Proposed 617	2330.00	-3.30	2.33	5.63	18.77	619.45
Little River	0010	100-Year	precon survey	2330.00	-3.30	2.33	5.63	18.77	619.45
Little River	0010	500-Year	Proposed 617	3520.00	-3.30	3.26	6.56	22.78	806.71

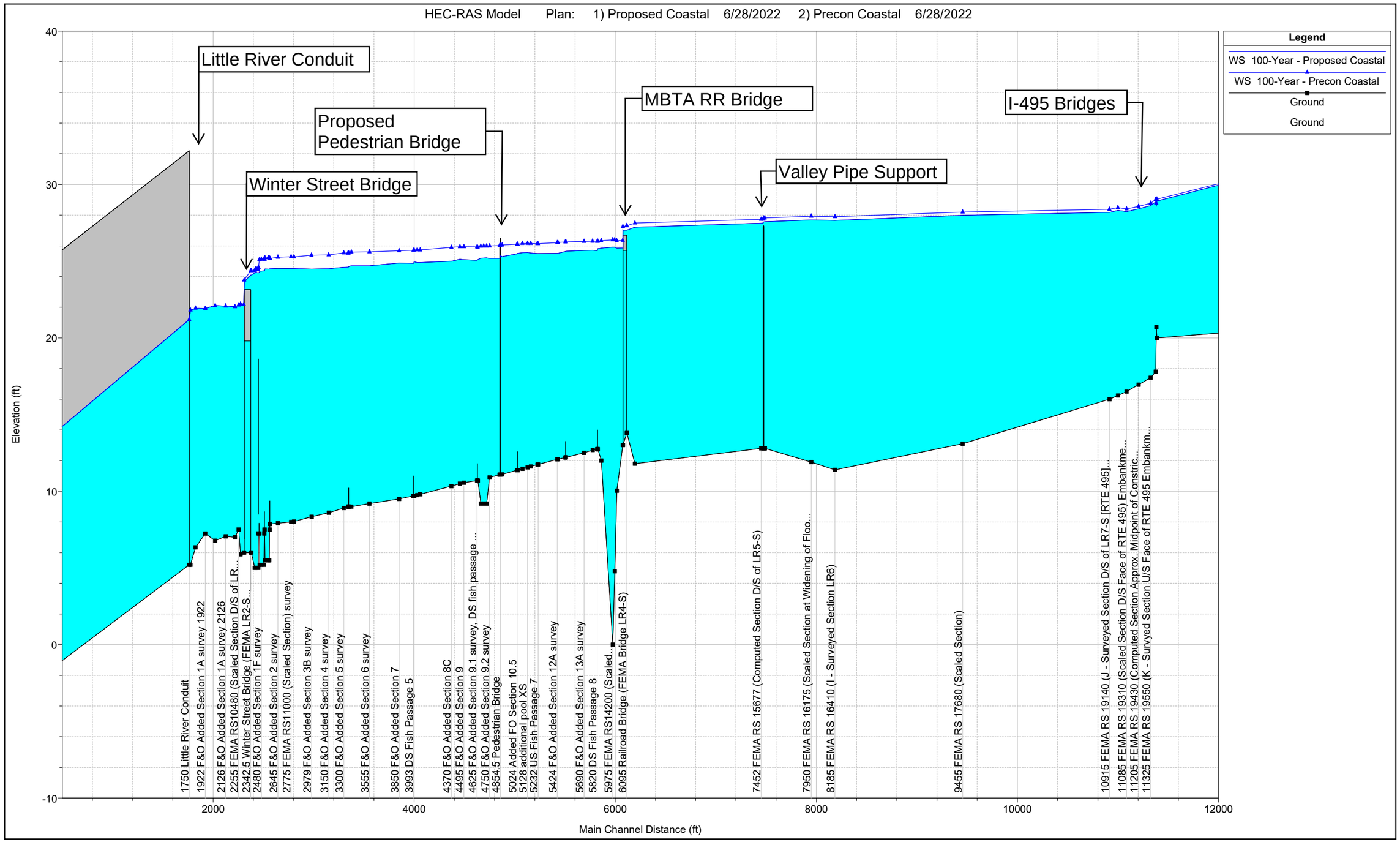
HEC-RAS River: Little River Reach: Little River (Continued)

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Max Chl Dpth	Vel Chnl	Top Width
				(cfs)	(ft)	(ft)	(ft)	(ft/s)	(ft)
Little River	0010	500-Year	precon survey	3520.00	-3.30	3.26	6.56	22.78	806.71
Little River	0	10-Year	Proposed 617	1160.00	-3.30	1.60	4.90	1.49	664.57
Little River	0	10-Year	precon survey	1160.00	-3.30	1.60	4.90	1.49	664.57
Little River	0	50-Year	Proposed 617	1920.00	-3.30	1.60	4.90	2.46	664.57
Little River	0	50-Year	precon survey	1920.00	-3.30	1.60	4.90	2.46	664.57
Little River	0	100-Year	Proposed 617	2330.00	-3.30	1.60	4.90	2.99	664.57
Little River	0	100-Year	precon survey	2330.00	-3.30	1.60	4.90	2.99	664.57
Little River	0	500-Year	Proposed 617	3520.00	-3.30	-0.89	2.41	33.20	226.32
Little River	0	500-Year	precon survey	3520.00	-3.30	-0.89	2.41	33.20	226.32

Attachment 16

Pre- Versus Post-Dam Removal Comparison HEC-RAS Results for 100-Year Coastal Flooding Event

Coastal Flooding



Coastal Flooding

HEC-RAS River: Little River Reach: Little River Profile: 100-Year

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Vel Chnl	Flow Area	Top Width
				(cfs)	(ft)	(ft)	(ft/s)	(sq ft)	(ft)
Little River	15341	100-Year	Proposed Coastal	1990.00	18.40	34.77	1.85	3002.10	338.58
Little River	15341	100-Year	Precon Coastal	1990.00	18.40	34.76	1.86	2997.79	338.33
Little River	15241	100-Year	Proposed Coastal	1990.00	21.90	34.30	6.10	1090.83	369.15
Little River	15241	100-Year	Precon Coastal	1990.00	21.90	34.29	6.12	1085.16	368.34
Little River	15224			Bridge					
Little River	15207	100-Year	Proposed Coastal	1990.00	21.90	29.96	14.83	170.28	83.16
Little River	15207	100-Year	Precon Coastal	1990.00	21.90	30.02	14.71	171.78	86.94
Little River	15107	100-Year	Proposed Coastal	1990.00	22.20	31.09	5.02	614.01	160.91
Little River	15107	100-Year	Precon Coastal	1990.00	22.20	31.13	4.98	621.02	161.91
Little River	14787	100-Year	Proposed Coastal	1990.00	23.20	30.98	3.27	1717.04	508.23
Little River	14787	100-Year	Precon Coastal	1990.00	23.20	31.03	3.23	1742.49	510.43
Little River	12987	100-Year	Proposed Coastal	1990.00	20.90	30.42	2.20	2819.24	677.98
Little River	12987	100-Year	Precon Coastal	1990.00	20.90	30.49	2.16	2868.37	682.72
Little River	12187	100-Year	Proposed Coastal	1990.00	20.40	30.28	2.04	3065.07	701.37
Little River	12187	100-Year	Precon Coastal	1990.00	20.40	30.35	2.00	3120.19	706.50
Little River	11387	100-Year	Proposed Coastal	2330.00	20.00	28.92	8.05	388.97	60.84
Little River	11387	100-Year	Precon Coastal	2330.00	20.00	29.04	7.93	396.63	61.32
Little River	11381	100-Year	Proposed Coastal	2330.00	20.70	28.64	8.87	351.39	59.60
Little River	11381	100-Year	Precon Coastal	2330.00	20.70	28.79	8.69	360.29	60.18
Little River	11375	100-Year	Proposed Coastal	2330.00	17.80	28.87	6.62	475.45	61.85
Little River	11375	100-Year	Precon Coastal	2330.00	17.80	29.01	6.53	483.83	62.31
Little River	11325	100-Year	Proposed Coastal	2330.00	17.40	28.63	7.10	406.37	57.37
Little River	11325	100-Year	Precon Coastal	2330.00	17.40	28.78	6.99	414.94	57.90
Little River	11205	100-Year	Proposed Coastal	2330.00	16.95	28.42	6.92	420.24	58.22
Little River	11205	100-Year	Precon Coastal	2330.00	16.95	28.58	6.79	429.66	58.80
Little River	11085	100-Year	Proposed Coastal	2330.00	16.50	28.23	6.72	435.47	59.15
Little River	11085	100-Year	Precon Coastal	2330.00	16.50	28.40	6.60	445.75	59.77
Little River	11000	100-Year	Proposed Coastal	2330.00	16.25	28.32	4.21	802.57	353.19
Little River	11000	100-Year	Precon Coastal	2330.00	16.25	28.49	4.06	868.08	379.56
Little River	10915	100-Year	Proposed Coastal	2330.00	16.00	28.19	3.86	845.59	370.72
Little River	10915	100-Year	Precon Coastal	2330.00	16.00	28.38	3.66	921.01	399.60
Little River	9455	100-Year	Proposed Coastal	2330.00	13.10	27.99	1.24	4161.07	879.20
Little River	9455	100-Year	Precon Coastal	2330.00	13.10	28.20	1.19	4348.14	900.23
Little River	8185	100-Year	Proposed Coastal	2330.00	11.40	27.66	2.94	978.04	145.99
Little River	8185	100-Year	Precon Coastal	2330.00	11.40	27.90	2.87	1012.90	152.01
Little River	7950	100-Year	Proposed Coastal	2330.00	11.90	27.69	1.20	3546.39	439.54
Little River	7950	100-Year	Precon Coastal	2330.00	11.90	27.93	1.16	3649.29	440.70
Little River	7488	100-Year	Proposed Coastal	2330.00	12.80	27.57	2.03	1643.87	199.55
Little River	7488	100-Year	Precon Coastal	2330.00	12.80	27.82	1.97	1692.53	202.76
Little River	7478	100-Year	Proposed Coastal	2330.00	12.80	27.57	2.05	1598.93	199.53
Little River	7478	100-Year	Precon Coastal	2330.00	12.80	27.81	1.97	1691.84	202.68
Little River	7475			Bridge					
Little River	7472	100-Year	Proposed Coastal	2330.00	12.80	27.49	2.05	1626.30	199.28
Little River	7472	100-Year	Precon Coastal	2330.00	12.80	27.74	1.99	1676.84	200.88
Little River	7452	100-Year	Proposed Coastal	2330.00	12.80	27.48	2.05	1624.80	199.26
Little River	7452	100-Year	Precon Coastal	2330.00	12.80	27.73	1.99	1675.46	200.71

HEC-RAS River: Little River Reach: Little River Profile: 100-Year (Continued)

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Vel Chnl	Flow Area	Top Width
				(cfs)	(ft)	(ft)	(ft/s)	(sq ft)	(ft)
Little River	6195	100-Year	Proposed Coastal	2330.00	11.80	27.21	1.42	2270.51	313.52
Little River	6195	100-Year	Precon Coastal	2330.00	11.80	27.49	1.38	2359.30	325.73
Little River	6115	100-Year	Proposed Coastal	2330.00	13.80	27.02	3.49	968.83	193.53
Little River	6115	100-Year	Precon Coastal	2330.00	13.80	27.32	3.35	1036.33	262.97
Little River	6095			Bridge					
Little River	6075	100-Year	Proposed Coastal	2330.00	13.02	25.87	4.41	813.84	142.50
Little River	6075	100-Year	Precon Coastal	2330.00	13.02	26.34	4.13	883.19	148.73
Little River	6015	100-Year	Proposed Coastal	2330.00	10.03	25.85	3.04	1390.78	344.56
Little River	6015	100-Year	Precon Coastal	2330.00	10.03	26.34	2.74	1577.48	400.02
Little River	5995	100-Year	Proposed Coastal	2330.00	4.78	25.91	0.80	3394.22	387.61
Little River	5995	100-Year	Precon Coastal	2330.00	4.78	26.39	0.76	3608.32	467.95
Little River	5975	100-Year	Proposed Coastal	2330.00	0.00	25.91	0.64	3997.21	356.53
Little River	5975	100-Year	Precon Coastal	2330.00	0.00	26.39	0.62	4171.44	380.18
Little River	5861	100-Year	Proposed Coastal	2330.00	12.00	25.86	2.42	1708.03	299.61
Little River	5861	100-Year	Precon Coastal	2330.00	12.00	26.34	2.16	1857.23	318.80
Little River	5826	100-Year	Proposed Coastal	2330.00	12.75	25.82	2.70	1505.20	281.83
Little River	5826	100-Year	Precon Coastal	2330.00	13.00	26.30	2.83	1584.06	301.32
Little River	5823			Inl Struct					
Little River	5820	100-Year	Proposed Coastal	2330.00	12.75	25.69	4.02	1356.56	263.58
Little River	5820	100-Year	Precon Coastal	2330.00	13.00	26.29	2.91	1515.27	286.74
Little River	5775	100-Year	Proposed Coastal	2330.00	12.69	25.71	3.37	1658.01	297.42
Little River	5775	100-Year	Precon Coastal	2330.00	13.14	26.29	1.90	1849.32	319.52
Little River	5690	100-Year	Proposed Coastal	2330.00	12.50	25.70	3.27	1763.01	254.92
Little River	5690	100-Year	Precon Coastal	2330.00	11.89	26.29	1.19	2070.10	338.66
Little River	5510	100-Year	Proposed Coastal	2330.00	12.21	25.65	3.27	1610.21	237.69
Little River	5510	100-Year	Precon Coastal	2330.00	11.73	26.25	1.31	1892.59	329.69
Little River	5507			Inl Struct					
Little River	5504	100-Year	Proposed Coastal	2330.00	12.20	25.63	3.28	1605.22	237.28
Little River	5504	100-Year	Precon Coastal	2330.00	11.73	26.25	1.31	1892.24	329.68
Little River	5430	100-Year	Proposed Coastal	2330.00	12.09	25.52	4.11	1245.24	178.14
Little River	5430	100-Year	Precon Coastal	2330.00	11.00	26.21	1.81	1419.85	236.29
Little River	5424	100-Year	Proposed Coastal	2330.00	12.08	25.51	4.11	1245.09	178.12
Little River	5424	100-Year	Precon Coastal	2330.00	11.00	26.21	1.81	1419.40	236.17
Little River	5232	100-Year	Proposed Coastal	2330.00	11.75	25.50	3.46	1763.78	291.96
Little River	5232	100-Year	Precon Coastal	2330.00	11.20	26.15	2.36	1963.55	332.58
Little River	5226	100-Year	Proposed Coastal	2330.00	11.74	25.50	3.46	1763.60	291.93
Little River	5226	100-Year	Precon Coastal	2330.00	11.20	26.15	2.36	1962.84	332.45
Little River	5160	100-Year	Proposed Coastal	2330.00	11.62	25.54	2.58	2451.08	313.42
Little River	5160	100-Year	Precon Coastal	2330.00	11.20	26.16	0.90	2728.03	350.18
Little River	5128	100-Year	Proposed Coastal	2330.00	11.56	25.56	0.96	3166.75	317.87
Little River	5128	100-Year	Precon Coastal	2330.00	11.20	26.16	0.90	2727.21	350.05
Little River	5077	100-Year	Proposed Coastal	2330.00	11.47	25.55	1.18	2454.98	313.68
Little River	5077	100-Year	Precon Coastal	2330.00	11.20	26.16	0.90	2725.90	349.84
Little River	5030	100-Year	Proposed Coastal	2330.00	11.38	25.51	1.88	1411.25	190.49
Little River	5030	100-Year	Precon Coastal	2330.00	12.76	26.11	1.85	1417.83	214.94
Little River	5027			Inl Struct					

HEC-RAS River: Little River Reach: Little River Profile: 100-Year (Continued)

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Vel Chnl	Flow Area	Top Width
				(cfs)	(ft)	(ft)	(ft/s)	(sq ft)	(ft)
Little River	5024	100-Year	Proposed Coastal	2330.00	11.38	25.48	1.89	1405.19	190.32
Little River	5024	100-Year	Precon Coastal	2330.00	12.76	26.11	1.85	1417.35	214.83
Little River	4875	100-Year	Proposed Coastal	2330.00	11.10	25.30	3.90	1205.53	152.94
Little River	4875	100-Year	Precon Coastal	2330.00	11.05	26.05	1.83	1338.79	167.14
Little River	4859	100-Year	Proposed Coastal	2330.00	11.09	25.36	2.48	1100.87	153.91
Little River	4859	100-Year	Precon Coastal	2330.00	11.05	26.05	1.83	1337.96	167.04
Little River	4854.5			Bridge					
Little River	4850	100-Year	Proposed Coastal	2330.00	11.08	25.18	4.28	976.49	124.30
Little River	4850	100-Year	Precon Coastal	2330.00	11.26	26.01	2.32	1090.35	146.69
Little River	4750	100-Year	Proposed Coastal	2330.00	10.90	25.17	3.86	1096.27	123.91
Little River	4750	100-Year	Precon Coastal	2330.00	12.16	26.00	1.88	1279.04	130.61
Little River	4721	100-Year	Proposed Coastal	2330.00	9.20	25.22	2.74	1220.66	197.33
Little River	4721	100-Year	Precon Coastal	2330.00	12.11	25.99	1.88	1279.99	130.54
Little River	4692	100-Year	Proposed Coastal	2330.00	9.20	25.21	2.74	1218.95	197.30
Little River	4692	100-Year	Precon Coastal	2330.00	12.06	25.98	1.87	1280.93	130.48
Little River	4663	100-Year	Proposed Coastal	2330.00	9.20	25.20	2.74	1217.24	197.28
Little River	4663	100-Year	Precon Coastal	2330.00	12.00	25.97	1.87	1282.29	130.41
Little River	4632	100-Year	Proposed Coastal	2330.00	10.70	25.09	3.67	1170.85	230.80
Little River	4632	100-Year	Precon Coastal	2330.00	11.00	25.91	3.12	1356.36	245.25
Little River	4629			Inl Struct					
Little River	4625	100-Year	Proposed Coastal	2330.00	10.70	25.06	3.69	1162.45	230.15
Little River	4625	100-Year	Precon Coastal	2330.00	12.58	25.93	2.10	1390.43	245.70
Little River	4495	100-Year	Proposed Coastal	2330.00	10.56	25.10	2.30	2427.11	332.89
Little River	4495	100-Year	Precon Coastal	2330.00	13.62	25.95	0.85	2814.49	347.11
Little River	4455	100-Year	Proposed Coastal	2330.00	10.50	25.13	0.72	3628.82	333.35
Little River	4455	100-Year	Precon Coastal	2330.00	13.62	25.94	0.85	2813.44	347.07
Little River	4370	100-Year	Proposed Coastal	2330.00	10.34	24.99	3.34	1716.41	400.78
Little River	4370	100-Year	Precon Coastal	2330.00	13.22	25.90	1.82	1955.41	441.26
Little River	4060	100-Year	Proposed Coastal	2330.00	9.80	24.92	3.20	1185.44	170.36
Little River	4060	100-Year	Precon Coastal	2330.00	13.34	25.73	2.30	1174.71	191.64
Little River	4030	100-Year	Proposed Coastal	2330.00	9.75	24.91	3.36	1306.02	164.50
Little River	4030	100-Year	Precon Coastal	2330.00	11.10	25.74	1.75	1427.74	180.12
Little River	4000	100-Year	Proposed Coastal	2330.00	9.70	24.96	2.03	1189.93	173.38
Little River	4000	100-Year	Precon Coastal	2330.00	10.13	25.73	1.81	1359.45	189.49
Little River	3996			Inl Struct					
Little River	3993	100-Year	Proposed Coastal	2330.00	9.70	24.86	3.40	1455.10	228.61
Little River	3993	100-Year	Precon Coastal	2330.00	10.00	25.71	2.51	1648.81	241.41
Little River	3850	100-Year	Proposed Coastal	2330.00	9.50	24.88	1.77	1453.01	228.96
Little River	3850	100-Year	Precon Coastal	2330.00	12.35	25.69	1.57	1643.39	241.02
Little River	3555	100-Year	Proposed Coastal	2330.00	9.20	24.71	3.54	1198.85	203.35
Little River	3555	100-Year	Precon Coastal	2330.00	7.58	25.61	1.72	1581.95	231.06
Little River	3375	100-Year	Proposed Coastal	2330.00	9.00	24.70	3.29	1447.92	198.27
Little River	3375	100-Year	Precon Coastal	2330.00	7.00	25.60	1.33	1832.67	284.01
Little River	3350	100-Year	Proposed Coastal	2330.00	9.00	24.66	3.61	1173.33	127.64
Little River	3350	100-Year	Precon Coastal	2330.00	8.80	25.53	2.78	1288.52	132.06

HEC-RAS River: Little River Reach: Little River Profile: 100-Year (Continued)

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Vel Chnl	Flow Area	Top Width
				(cfs)	(ft)	(ft)	(ft/s)	(sq ft)	(ft)
Little River	3346			Inl Struct					
Little River	3342	100-Year	Proposed Coastal	2330.00	9.00	24.62	3.63	1168.37	127.44
Little River	3342	100-Year	Precon Coastal	2330.00	8.80	25.53	2.78	1288.08	132.05
Little River	3300	100-Year	Proposed Coastal	2330.00	8.90	24.61	3.61	1175.00	127.40
Little River	3300	100-Year	Precon Coastal	2330.00	8.80	25.54	1.67	1434.16	132.13
Little River	3150	100-Year	Proposed Coastal	2330.00	8.60	24.51	3.91	897.68	131.28
Little River	3150	100-Year	Precon Coastal	2330.00	9.14	25.41	2.79	961.65	155.90
Little River	2979	100-Year	Proposed Coastal	2330.00	8.34	24.48	3.75	868.39	135.72
Little River	2979	100-Year	Precon Coastal	2330.00	8.26	25.39	1.97	1329.38	159.57
Little River	2805	100-Year	Proposed Coastal	2330.00	8.03	24.52	2.50	1083.98	176.50
Little River	2805	100-Year	Precon Coastal	2330.00	11.68	25.28	2.63	1045.46	190.22
Little River	2775	100-Year	Proposed Coastal	2330.00	8.00	24.53	2.51	1532.07	289.67
Little River	2775	100-Year	Precon Coastal	2330.00	12.10	25.28	2.32	1603.13	317.28
Little River	2645	100-Year	Proposed Coastal	2330.00	7.92	24.54	1.98	1274.51	128.39
Little River	2645	100-Year	Precon Coastal	2330.00	8.24	25.25	1.80	1322.45	129.70
Little River	2567	100-Year	Proposed Coastal	2330.00	7.87	24.51	2.25	1134.21	128.35
Little River	2567	100-Year	Precon Coastal	2330.00	7.30	25.18	2.79	1226.22	129.57
Little River	2564			Inl Struct					
Little River	2561	100-Year	Proposed Coastal	2330.00	7.50	24.48	2.23	1142.79	128.30
Little River	2561	100-Year	Precon Coastal	2330.00	7.30	25.18	2.75	1226.41	129.57
Little River	2558	100-Year	Proposed Coastal	2330.00	5.50	24.48	2.30	1227.61	128.30
Little River	2558	100-Year	Precon Coastal	2330.00	7.30	25.23	1.60	1488.60	129.66
Little River	2550	100-Year	Proposed Coastal	2330.00	5.50	24.49	2.06	1228.05	128.31
Little River	2550	100-Year	Precon Coastal	2330.00	7.30	25.23	1.60	1488.44	129.66
Little River	2516	100-Year	Proposed Coastal	2330.00	5.50	24.49	1.94	1300.90	128.32
Little River	2516	100-Year	Precon Coastal	2330.00	7.30	25.22	1.60	1487.73	129.65
Little River	2513	100-Year	Proposed Coastal	2330.00	7.50	24.41	3.03	913.90	186.77
Little River	2513	100-Year	Precon Coastal	2330.00	8.00	25.12	3.05	1078.45	192.40
Little River	2511			Inl Struct					
Little River	2509	100-Year	Proposed Coastal	2330.00	7.25	24.36	2.82	981.33	186.43
Little River	2509	100-Year	Precon Coastal	2330.00	8.00	25.12	3.05	1078.39	192.39
Little River	2506	100-Year	Proposed Coastal	2330.00	5.20	24.37	2.55	1010.87	188.64
Little River	2506	100-Year	Precon Coastal	2330.00	9.35	25.14	2.63	967.93	192.54
Little River	2480	100-Year	Proposed Coastal	2330.00	5.20	24.35	2.65	970.33	188.16
Little River	2480	100-Year	Precon Coastal	2330.00	9.35	25.12	2.63	964.00	192.38
Little River	2464	100-Year	Proposed Coastal	2330.00	5.20	24.35	2.58	1000.70	188.14
Little River	2464	100-Year	Precon Coastal	2330.00	9.35	25.11	2.64	961.48	192.28
Little River	2461	100-Year	Proposed Coastal	2330.00	7.25	24.28	3.24	751.28	90.58
Little River	2461	100-Year	Precon Coastal	2330.00	8.50	25.09	2.82	874.51	153.15
Little River	2456			Inl Struct					
Little River	2451	100-Year	Proposed Coastal	2330.00	7.25	24.25	2.94	834.01	90.63
Little River	2451	100-Year	Precon Coastal	2330.00	8.50	24.61	5.16	462.07	130.01
Little River	2449	100-Year	Proposed Coastal	2330.00	5.00	24.24	2.71	908.51	91.23
Little River	2449	100-Year	Precon Coastal	2330.00	8.50	24.43	5.33	443.07	100.01
Little River	2430	100-Year	Proposed Coastal	2330.00	5.00	24.27	1.97	1222.07	94.39
Little River	2430	100-Year	Precon Coastal	2330.00	6.77	24.51	1.78	1315.44	99.25

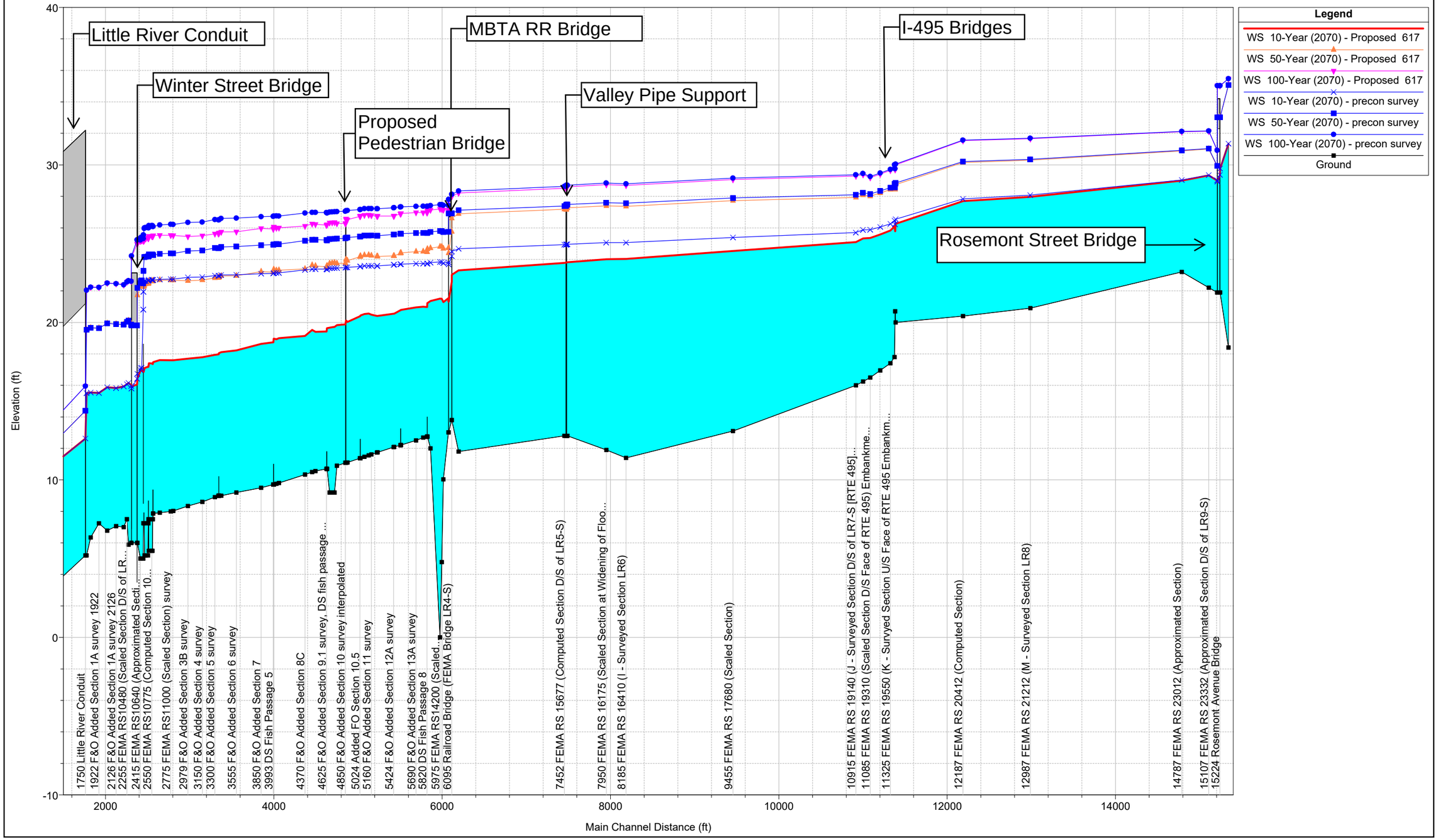
HEC-RAS River: Little River Reach: Little River Profile: 100-Year (Continued)

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Vel Chnl	Flow Area	Top Width
				(cfs)	(ft)	(ft)	(ft/s)	(sq ft)	(ft)
Little River	2420	100-Year	Proposed Coastal	2330.00	5.00	24.25	2.18	1169.40	83.81
Little River	2420	100-Year	Precon Coastal	2330.00	7.00	24.49	2.05	1138.22	83.99
Little River	2415	100-Year	Proposed Coastal	2330.00	5.00	24.24	2.30	1020.77	65.02
Little River	2415	100-Year	Precon Coastal	2330.00	6.75	24.38	3.07	758.24	61.40
Little River	2380	100-Year	Proposed Coastal	2330.00	6.00	24.10	3.43	692.28	57.25
Little River	2380	100-Year	Precon Coastal	2330.00	3.50	24.38	2.93	817.44	88.21
Little River	2342.5			Bridge					
Little River	2305	100-Year	Proposed Coastal	2330.00	6.00	22.19	3.50	667.52	45.98
Little River	2305	100-Year	Precon Coastal	2330.00	6.89	22.17	3.75	631.07	45.98
Little River	2273	100-Year	Proposed Coastal	2330.00	5.89	22.20	3.10	757.50	69.16
Little River	2273	100-Year	Precon Coastal	2330.00	5.89	22.20	3.10	757.50	69.16
Little River	2255	100-Year	Proposed Coastal	2330.00	7.50	22.15	3.59	674.32	65.58
Little River	2255	100-Year	Precon Coastal	2330.00	7.50	22.15	3.59	674.32	65.58
Little River	2218	100-Year	Proposed Coastal	2330.00	7.00	22.03	4.31	544.85	50.24
Little River	2218	100-Year	Precon Coastal	2330.00	7.00	22.03	4.31	544.85	50.24
Little River	2126	100-Year	Proposed Coastal	2330.00	7.06	22.08	3.96	703.37	83.15
Little River	2126	100-Year	Precon Coastal	2330.00	7.06	22.08	3.96	703.37	83.15
Little River	2021	100-Year	Proposed Coastal	2330.00	6.78	22.10	2.98	881.26	90.55
Little River	2021	100-Year	Precon Coastal	2330.00	6.78	22.10	2.98	881.26	90.55
Little River	1922	100-Year	Proposed Coastal	2330.00	7.24	21.92	4.22	625.90	65.76
Little River	1922	100-Year	Precon Coastal	2330.00	7.24	21.92	4.22	625.90	65.76
Little River	1825	100-Year	Proposed Coastal	2330.00	6.34	21.93	3.70	713.17	66.10
Little River	1825	100-Year	Precon Coastal	2330.00	6.34	21.93	3.70	713.17	66.10
Little River	1775 FEMA Section A	100-Year	Proposed Coastal	2330.00	5.20	21.81	4.20	554.83	46.62
Little River	1775 FEMA Section A	100-Year	Precon Coastal	2330.00	5.20	21.81	4.20	554.83	46.62
Little River	1750			Bridge					
Little River	0010	100-Year	Proposed Coastal	2330.00	-3.30	19.40	0.09	30385.82	2000.00
Little River	0010	100-Year	Precon Coastal	2330.00	-3.30	19.40	0.09	30385.82	2000.00
Little River	0	100-Year	Proposed Coastal	2330.00	-3.30	19.40	0.09	31800.00	2000.00
Little River	0	100-Year	Precon Coastal	2330.00	-3.30	19.40	0.09	31800.00	2000.00

Attachment 17

Climate Change Pre-Versus Post-Dam Removal HEC-RAS Summary Profiles and Results

HEC-RAS Model Plan: 1) Proposed 617 6/27/2022 2) precon survey 6/27/2022



HEC-RAS River: Little River Reach: Little River

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Vel Chnl	Flow Area	Top Width
				(cfs)	(ft)	(ft)	(ft/s)	(sq ft)	(ft)
Little River	15341	10-Year (2070)	Proposed 617	1176.00	18.40	31.34	1.75	1905.61	306.02
Little River	15341	10-Year (2070)	precon survey	1176.00	18.40	31.34	1.75	1908.26	306.08
Little River	15341	50-Year (2070)	Proposed 617	1968.00	18.40	35.07	1.77	3105.06	344.45
Little River	15341	50-Year (2070)	precon survey	1968.00	18.40	35.07	1.77	3106.27	344.52
Little River	15341	100-Year (2070)	Proposed 617	2527.30	18.40	35.47	2.18	3245.83	352.33
Little River	15341	100-Year (2070)	precon survey	2527.30	18.40	35.47	2.18	3245.83	352.33
Little River	15241	10-Year (2070)	Proposed 617	1176.00	21.90	29.75	9.02	164.78	69.27
Little River	15241	10-Year (2070)	precon survey	1176.00	21.90	29.76	9.00	165.19	70.30
Little River	15241	50-Year (2070)	Proposed 617	1968.00	21.90	33.02	10.39	249.57	287.45
Little River	15241	50-Year (2070)	precon survey	1968.00	21.90	33.03	10.38	249.73	287.83
Little River	15241	100-Year (2070)	Proposed 617	2527.30	21.90	35.03	6.39	1467.99	403.35
Little River	15241	100-Year (2070)	precon survey	2527.30	21.90	35.03	6.39	1467.99	403.35
Little River	15224			Bridge					
Little River	15207	10-Year (2070)	Proposed 617	1176.00	21.90	29.00	10.04	145.51	28.80
Little River	15207	10-Year (2070)	precon survey	1176.00	21.90	29.02	10.00	146.26	29.84
Little River	15207	50-Year (2070)	Proposed 617	1968.00	21.90	29.89	14.80	168.50	78.65
Little River	15207	50-Year (2070)	precon survey	1968.00	21.90	29.93	14.72	169.57	81.36
Little River	15207	100-Year (2070)	Proposed 617	2527.30	21.90	30.92	16.68	195.19	145.59
Little River	15207	100-Year (2070)	precon survey	2527.30	21.90	30.92	16.68	195.19	145.59
Little River	15107	10-Year (2070)	Proposed 617	1176.00	22.20	29.33	4.27	366.44	120.44
Little River	15107	10-Year (2070)	precon survey	1176.00	22.20	29.36	4.24	370.06	121.13
Little River	15107	50-Year (2070)	Proposed 617	1968.00	22.20	31.00	5.04	600.76	159.01
Little River	15107	50-Year (2070)	precon survey	1968.00	22.20	31.04	5.01	605.72	159.72
Little River	15107	100-Year (2070)	Proposed 617	2527.30	22.20	32.14	5.30	795.37	185.03
Little River	15107	100-Year (2070)	precon survey	2527.30	22.20	32.16	5.28	799.41	185.53
Little River	14787	10-Year (2070)	Proposed 617	1176.00	23.20	29.00	3.56	822.64	299.14
Little River	14787	10-Year (2070)	precon survey	1176.00	23.20	29.04	3.51	835.17	301.43
Little River	14787	50-Year (2070)	Proposed 617	1968.00	23.20	30.88	3.32	1669.73	504.11
Little River	14787	50-Year (2070)	precon survey	1968.00	23.20	30.92	3.29	1688.20	505.72
Little River	14787	100-Year (2070)	Proposed 617	2527.30	23.20	32.11	3.15	2318.08	557.84
Little River	14787	100-Year (2070)	precon survey	2527.30	23.20	32.13	3.13	2331.17	558.87
Little River	12987	10-Year (2070)	Proposed 617	1176.00	20.90	27.97	2.42	1369.85	492.81
Little River	12987	10-Year (2070)	precon survey	1176.00	20.90	28.08	2.34	1425.95	502.44
Little River	12987	50-Year (2070)	Proposed 617	1968.00	20.90	30.30	2.23	2737.34	670.01
Little River	12987	50-Year (2070)	precon survey	1968.00	20.90	30.35	2.21	2773.90	673.58
Little River	12987	100-Year (2070)	Proposed 617	2527.30	20.90	31.66	2.17	3710.64	759.35
Little River	12987	100-Year (2070)	precon survey	2527.30	20.90	31.69	2.16	3733.53	761.33
Little River	12187	10-Year (2070)	Proposed 617	1176.00	20.40	27.70	2.27	1484.90	512.37
Little River	12187	10-Year (2070)	precon survey	1176.00	20.40	27.84	2.18	1556.49	524.17
Little River	12187	50-Year (2070)	Proposed 617	1968.00	20.40	30.15	2.07	2975.17	692.91
Little River	12187	50-Year (2070)	precon survey	1968.00	20.40	30.21	2.04	3016.42	696.80
Little River	12187	100-Year (2070)	Proposed 617	2527.30	20.40	31.54	2.02	4005.00	784.37
Little River	12187	100-Year (2070)	precon survey	2527.30	20.40	31.57	2.01	4030.09	786.46
Little River	11387	10-Year (2070)	Proposed 617	1392.00	20.00	26.26	7.15	240.73	50.73
Little River	11387	10-Year (2070)	precon survey	1392.00	20.00	26.55	6.80	255.75	51.85
Little River	11387	50-Year (2070)	Proposed 617	2304.00	20.00	28.74	8.14	378.60	60.19
Little River	11387	50-Year (2070)	precon survey	2304.00	20.00	28.84	8.04	384.62	60.57
Little River	11387	100-Year (2070)	Proposed 617	2959.10	20.00	29.99	8.98	456.80	64.94
Little River	11387	100-Year (2070)	precon survey	2959.10	20.00	30.05	8.93	460.22	65.14
Little River	11381	10-Year (2070)	Proposed 617	1392.00	20.70	25.79	8.63	196.84	48.58
Little River	11381	10-Year (2070)	precon survey	1392.00	20.70	26.22	7.89	218.48	50.27
Little River	11381	50-Year (2070)	Proposed 617	2304.00	20.70	28.45	9.02	339.77	58.85
Little River	11381	50-Year (2070)	precon survey	2304.00	20.70	28.57	8.86	346.93	59.31
Little River	11381	100-Year (2070)	Proposed 617	2959.10	20.70	29.69	9.81	416.03	63.65
Little River	11381	100-Year (2070)	precon survey	2959.10	20.70	29.75	9.74	420.06	63.90
Little River	11375	10-Year (2070)	Proposed 617	1392.00	17.80	26.09	5.51	316.70	52.24
Little River	11375	10-Year (2070)	precon survey	1392.00	17.80	26.46	5.24	336.38	53.52
Little River	11375	50-Year (2070)	Proposed 617	2304.00	17.80	28.69	6.67	464.22	61.22
Little River	11375	50-Year (2070)	precon survey	2304.00	17.80	28.80	6.60	470.92	61.59
Little River	11375	100-Year (2070)	Proposed 617	2959.10	17.80	29.95	7.55	543.83	65.55
Little River	11375	100-Year (2070)	precon survey	2959.10	17.80	30.00	7.51	547.58	65.75

HEC-RAS River: Little River Reach: Little River (Continued)

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Vel Chnl	Flow Area	Top Width
				(cfs)	(ft)	(ft)	(ft/s)	(sq ft)	(ft)
Little River	11325	10-Year (2070)	Proposed 617	1392.00	17.40	25.84	6.12	260.04	47.39
Little River	11325	10-Year (2070)	precon survey	1392.00	17.40	26.26	5.75	280.27	48.89
Little River	11325	50-Year (2070)	Proposed 617	2304.00	17.40	28.43	7.18	395.23	56.67
Little River	11325	50-Year (2070)	precon survey	2304.00	17.40	28.56	7.08	402.13	57.10
Little River	11325	100-Year (2070)	Proposed 617	2959.10	17.40	29.65	8.08	466.92	61.02
Little River	11325	100-Year (2070)	precon survey	2959.10	17.40	29.72	8.03	470.84	61.25
Little River	11205	10-Year (2070)	Proposed 617	1392.00	16.95	25.59	5.94	269.57	48.10
Little River	11205	10-Year (2070)	precon survey	1392.00	16.95	26.06	5.54	292.71	49.79
Little River	11205	50-Year (2070)	Proposed 617	2304.00	16.95	28.21	7.00	408.24	57.48
Little River	11205	50-Year (2070)	precon survey	2304.00	16.95	28.34	6.90	415.88	57.96
Little River	11205	100-Year (2070)	Proposed 617	2959.10	16.95	29.41	7.91	479.69	61.76
Little River	11205	100-Year (2070)	precon survey	2959.10	16.95	29.48	7.85	484.02	62.01
Little River	11085	10-Year (2070)	Proposed 617	1392.00	16.50	25.36	5.74	280.57	48.91
Little River	11085	10-Year (2070)	precon survey	1392.00	16.50	25.88	5.33	306.61	50.78
Little River	11085	50-Year (2070)	Proposed 617	2304.00	16.50	28.01	6.81	422.61	58.37
Little River	11085	50-Year (2070)	precon survey	2304.00	16.50	28.15	6.70	430.99	58.88
Little River	11085	100-Year (2070)	Proposed 617	2959.10	16.50	29.19	7.73	493.76	62.57
Little River	11085	100-Year (2070)	precon survey	2959.10	16.50	29.26	7.67	498.51	62.84
Little River	11000	10-Year (2070)	Proposed 617	1392.00	16.25	25.33	4.21	330.79	58.87
Little River	11000	10-Year (2070)	precon survey	1392.00	16.25	25.87	3.83	363.38	61.18
Little River	11000	50-Year (2070)	Proposed 617	2304.00	16.25	28.09	4.35	725.53	319.41
Little River	11000	50-Year (2070)	precon survey	2304.00	16.25	28.24	4.22	774.51	341.28
Little River	11000	100-Year (2070)	Proposed 617	2959.10	16.25	29.38	4.28	1246.57	468.15
Little River	11000	100-Year (2070)	precon survey	2959.10	16.25	29.46	4.21	1283.25	475.15
Little River	10915	10-Year (2070)	Proposed 617	1392.00	16.00	25.10	4.19	332.23	58.98
Little River	10915	10-Year (2070)	precon survey	1392.00	16.00	25.70	3.78	368.13	61.51
Little River	10915	50-Year (2070)	Proposed 617	2304.00	16.00	27.94	4.07	757.57	333.87
Little River	10915	50-Year (2070)	precon survey	2304.00	16.00	28.10	3.90	814.37	358.09
Little River	10915	100-Year (2070)	Proposed 617	2959.10	16.00	29.29	3.58	1323.68	482.75
Little River	10915	100-Year (2070)	precon survey	2959.10	16.00	29.38	3.49	1364.39	490.28
Little River	9455	10-Year (2070)	Proposed 617	1392.00	13.10	24.53	1.50	1716.57	533.00
Little River	9455	10-Year (2070)	precon survey	1392.00	13.10	25.39	1.23	2213.67	619.29
Little River	9455	50-Year (2070)	Proposed 617	2304.00	13.10	27.73	1.28	3930.26	852.54
Little River	9455	50-Year (2070)	precon survey	2304.00	13.10	27.90	1.24	4084.43	870.44
Little River	9455	100-Year (2070)	Proposed 617	2959.10	13.10	29.07	1.31	5169.95	987.30
Little River	9455	100-Year (2070)	precon survey	2959.10	13.10	29.16	1.30	5259.71	996.35
Little River	8185	10-Year (2070)	Proposed 617	1392.00	11.40	24.03	2.62	579.34	82.96
Little River	8185	10-Year (2070)	precon survey	1392.00	11.40	25.07	2.32	671.33	96.46
Little River	8185	50-Year (2070)	Proposed 617	2304.00	11.40	27.37	3.00	936.56	138.49
Little River	8185	50-Year (2070)	precon survey	2304.00	11.40	27.57	2.94	964.97	143.67
Little River	8185	100-Year (2070)	Proposed 617	2959.10	11.40	28.70	3.36	1146.96	185.63
Little River	8185	100-Year (2070)	precon survey	2959.10	11.40	28.80	3.32	1166.01	188.42
Little River	7950	10-Year (2070)	Proposed 617	1392.00	11.90	24.01	1.34	1961.16	420.42
Little River	7950	10-Year (2070)	precon survey	1392.00	11.90	25.07	1.08	2410.76	426.56
Little River	7950	50-Year (2070)	Proposed 617	2304.00	11.90	27.40	1.23	3418.08	438.09
Little River	7950	50-Year (2070)	precon survey	2304.00	11.90	27.60	1.20	3506.44	439.09
Little River	7950	100-Year (2070)	Proposed 617	2959.10	11.90	28.75	1.33	4011.44	444.75
Little River	7950	100-Year (2070)	precon survey	2959.10	11.90	28.85	1.32	4056.47	445.25
Little River	7488	10-Year (2070)	Proposed 617	1392.00	12.80	23.81	2.06	936.02	175.96
Little River	7488	10-Year (2070)	precon survey	1392.00	12.80	24.96	1.71	1141.25	183.45
Little River	7488	50-Year (2070)	Proposed 617	2304.00	12.80	27.27	2.08	1583.76	198.55
Little River	7488	50-Year (2070)	precon survey	2304.00	12.80	27.48	2.03	1625.55	199.27
Little River	7488	100-Year (2070)	Proposed 617	2959.10	12.80	28.61	2.29	1867.88	255.42
Little River	7488	100-Year (2070)	precon survey	2959.10	12.80	28.71	2.26	1895.48	267.98
Little River	7478	10-Year (2070)	Proposed 617	1392.00	12.80	23.81	2.07	926.78	175.92
Little River	7478	10-Year (2070)	precon survey	1392.00	12.80	24.95	1.72	1124.58	183.42
Little River	7478	50-Year (2070)	Proposed 617	2304.00	12.80	27.27	2.10	1542.68	198.52
Little River	7478	50-Year (2070)	precon survey	2304.00	12.80	27.48	2.05	1581.82	199.26
Little River	7478	100-Year (2070)	Proposed 617	2959.10	12.80	28.60	2.29	1866.80	254.91
Little River	7478	100-Year (2070)	precon survey	2959.10	12.80	28.71	2.26	1894.39	267.49
Little River	7475			Bridge					

HEC-RAS River: Little River Reach: Little River (Continued)

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Vel Chnl	Flow Area	Top Width
				(cfs)	(ft)	(ft)	(ft/s)	(sq ft)	(ft)
Little River	7472	10-Year (2070)	Proposed 617	1392.00	12.80	23.79	2.07	924.52	175.83
Little River	7472	10-Year (2070)	precon survey	1392.00	12.80	24.94	1.72	1122.51	183.34
Little River	7472	50-Year (2070)	Proposed 617	2304.00	12.80	27.19	2.10	1567.10	198.02
Little River	7472	50-Year (2070)	precon survey	2304.00	12.80	27.40	2.05	1608.32	199.01
Little River	7472	100-Year (2070)	Proposed 617	2959.10	12.80	28.53	2.31	1848.27	246.11
Little River	7472	100-Year (2070)	precon survey	2959.10	12.80	28.64	2.28	1876.75	259.52
Little River	7452	10-Year (2070)	Proposed 617	1392.00	12.80	23.78	2.07	930.24	175.75
Little River	7452	10-Year (2070)	precon survey	1392.00	12.80	24.93	1.72	1136.99	183.30
Little River	7452	50-Year (2070)	Proposed 617	2304.00	12.80	27.18	2.10	1565.47	197.97
Little River	7452	50-Year (2070)	precon survey	2304.00	12.80	27.39	2.05	1606.80	198.99
Little River	7452	100-Year (2070)	Proposed 617	2959.10	12.80	28.52	2.31	1846.16	245.09
Little River	7452	100-Year (2070)	precon survey	2959.10	12.80	28.63	2.28	1874.61	258.54
Little River	6195	10-Year (2070)	Proposed 617	1392.00	11.80	23.30	1.45	1210.24	237.03
Little River	6195	10-Year (2070)	precon survey	1392.00	11.80	24.68	1.17	1551.36	260.76
Little River	6195	50-Year (2070)	Proposed 617	2304.00	11.80	26.89	1.46	2171.29	299.55
Little River	6195	50-Year (2070)	precon survey	2304.00	11.80	27.12	1.42	2241.49	309.42
Little River	6195	100-Year (2070)	Proposed 617	2959.10	11.80	28.22	1.61	2607.51	357.66
Little River	6195	100-Year (2070)	precon survey	2959.10	11.80	28.34	1.59	2652.52	363.49
Little River	6115	10-Year (2070)	Proposed 617	1392.00	13.80	23.02	3.80	416.58	101.37
Little River	6115	10-Year (2070)	precon survey	1392.00	13.80	24.50	3.07	520.01	120.68
Little River	6115	50-Year (2070)	Proposed 617	2304.00	13.80	26.61	3.99	667.62	148.23
Little River	6115	50-Year (2070)	precon survey	2304.00	13.80	26.93	3.49	951.30	175.81
Little River	6115	100-Year (2070)	Proposed 617	2959.10	13.80	28.00	3.84	1227.87	298.18
Little River	6115	100-Year (2070)	precon survey	2959.10	13.80	28.14	3.76	1268.83	305.18
Little River	6095			Bridge					
Little River	6075	10-Year (2070)	Proposed 617	1392.00	13.02	21.54	5.60	309.53	85.83
Little River	6075	10-Year (2070)	precon survey	1392.00	13.02	23.81	3.76	469.11	115.62
Little River	6075	50-Year (2070)	Proposed 617	2304.00	13.02	24.73	5.48	533.12	127.57
Little River	6075	50-Year (2070)	precon survey	2304.00	13.02	25.75	4.43	797.64	141.00
Little River	6075	100-Year (2070)	Proposed 617	2959.10	13.02	27.13	4.66	1043.06	268.89
Little River	6075	100-Year (2070)	precon survey	2959.10	13.02	27.42	4.45	1123.32	283.87
Little River	6015	10-Year (2070)	Proposed 617	1392.00	10.03	21.29	4.56	320.20	69.74
Little River	6015	10-Year (2070)	precon survey	1392.00	10.03	23.76	2.92	714.87	271.32
Little River	6015	50-Year (2070)	Proposed 617	2304.00	10.03	24.68	3.91	1001.35	323.92
Little River	6015	50-Year (2070)	precon survey	2304.00	10.03	25.74	3.08	1350.69	340.06
Little River	6015	100-Year (2070)	Proposed 617	2959.10	10.03	27.14	2.95	1903.78	414.04
Little River	6015	100-Year (2070)	precon survey	2959.10	10.03	27.43	2.79	2025.35	419.14
Little River	5995	10-Year (2070)	Proposed 617	1392.00	4.78	21.50	0.81	1812.17	312.36
Little River	5995	10-Year (2070)	precon survey	1392.00	4.78	23.84	0.60	2614.29	363.48
Little River	5995	50-Year (2070)	Proposed 617	2304.00	4.78	24.80	0.89	2970.14	375.03
Little River	5995	50-Year (2070)	precon survey	2304.00	4.78	25.80	0.80	3349.87	386.31
Little River	5995	100-Year (2070)	Proposed 617	2959.10	4.78	27.19	0.90	3986.05	472.61
Little River	5995	100-Year (2070)	precon survey	2959.10	4.78	27.47	0.88	4121.03	474.26
Little River	5975	10-Year (2070)	Proposed 617	1392.00	0.00	21.50	0.51	2795.08	221.21
Little River	5975	10-Year (2070)	precon survey	1392.00	0.00	23.84	0.44	3362.68	264.99
Little River	5975	50-Year (2070)	Proposed 617	2304.00	0.00	24.80	0.68	3631.90	300.97
Little River	5975	50-Year (2070)	precon survey	2304.00	0.00	25.80	0.64	3956.69	350.80
Little River	5975	100-Year (2070)	Proposed 617	2959.10	0.00	27.19	0.76	4492.97	420.34
Little River	5975	100-Year (2070)	precon survey	2959.10	0.00	27.48	0.74	4614.76	434.59
Little River	5861	10-Year (2070)	Proposed 617	1392.00	12.00	21.36	3.29	650.78	199.41
Little River	5861	10-Year (2070)	precon survey	1392.00	12.00	23.79	1.91	1172.61	228.88
Little River	5861	50-Year (2070)	Proposed 617	2304.00	12.00	24.72	2.86	1392.25	254.28
Little River	5861	50-Year (2070)	precon survey	2304.00	12.00	25.74	2.32	1673.80	295.04
Little River	5861	100-Year (2070)	Proposed 617	2959.10	12.00	27.13	2.57	2122.06	350.27
Little River	5861	100-Year (2070)	precon survey	2959.10	12.00	27.42	2.37	2225.50	361.83
Little River	5826	10-Year (2070)	Proposed 617	1392.00	12.75	21.22	3.79	516.40	177.65
Little River	5826	10-Year (2070)	precon survey	1392.00	13.00	23.74	2.66	943.74	210.24
Little River	5826	50-Year (2070)	Proposed 617	2304.00	12.75	24.65	3.22	1204.65	234.56
Little River	5826	50-Year (2070)	precon survey	2304.00	13.00	25.69	3.10	1407.73	276.54
Little River	5826	100-Year (2070)	Proposed 617	2959.10	12.75	27.09	2.85	1897.58	333.61
Little River	5826	100-Year (2070)	precon survey	2959.10	13.00	27.38	3.04	1934.05	345.28

HEC-RAS River: Little River Reach: Little River (Continued)

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Vel Chnl	Flow Area	Top Width
				(cfs)	(ft)	(ft)	(ft/s)	(sq ft)	(ft)
Little River	5823			Inl Struct					
Little River	5820	10-Year (2070)	Proposed 617	1392.00	12.75	20.97	5.34	403.27	168.32
Little River	5820	10-Year (2070)	precon survey	1392.00	13.00	23.73	2.72	907.15	199.83
Little River	5820	50-Year (2070)	Proposed 617	2304.00	12.75	24.48	4.74	1064.76	216.02
Little River	5820	50-Year (2070)	precon survey	2304.00	13.00	25.67	3.18	1346.96	262.80
Little River	5820	100-Year (2070)	Proposed 617	2959.10	12.75	26.96	4.31	1721.42	313.03
Little River	5820	100-Year (2070)	precon survey	2959.10	13.00	27.37	3.13	1848.23	329.00
Little River	5775	10-Year (2070)	Proposed 617	1392.00	12.69	20.99	4.52	535.09	206.84
Little River	5775	10-Year (2070)	precon survey	1392.00	13.14	23.74	1.71	1154.28	235.23
Little River	5775	50-Year (2070)	Proposed 617	2304.00	12.69	24.50	3.97	1326.05	251.46
Little River	5775	50-Year (2070)	precon survey	2304.00	13.14	25.68	2.06	1661.29	296.32
Little River	5775	100-Year (2070)	Proposed 617	2959.10	12.69	26.98	3.63	2065.36	345.57
Little River	5775	100-Year (2070)	precon survey	2959.10	13.14	27.37	2.08	2216.88	360.60
Little River	5690	10-Year (2070)	Proposed 617	1392.00	12.50	20.95	4.35	672.12	209.39
Little River	5690	10-Year (2070)	precon survey	1392.00	11.89	23.73	1.00	1418.82	231.61
Little River	5690	50-Year (2070)	Proposed 617	2304.00	12.50	24.49	3.82	1463.24	239.35
Little River	5690	50-Year (2070)	precon survey	2304.00	11.89	25.68	1.26	1889.63	254.58
Little River	5690	100-Year (2070)	Proposed 617	2959.10	12.50	26.97	3.54	2168.38	341.53
Little River	5690	100-Year (2070)	precon survey	2959.10	11.89	27.37	1.33	2438.49	343.22
Little River	5510	10-Year (2070)	Proposed 617	1392.00	12.21	20.80	4.31	607.77	186.33
Little River	5510	10-Year (2070)	precon survey	1392.00	11.73	23.70	1.09	1295.52	205.61
Little River	5510	50-Year (2070)	Proposed 617	2304.00	12.21	24.41	3.80	1329.86	214.72
Little River	5510	50-Year (2070)	precon survey	2304.00	11.73	25.64	1.39	1721.16	237.41
Little River	5510	100-Year (2070)	Proposed 617	2959.10	12.21	26.91	3.56	1997.37	337.01
Little River	5510	100-Year (2070)	precon survey	2959.10	11.73	27.33	1.46	2254.17	341.66
Little River	5507			Inl Struct					
Little River	5504	10-Year (2070)	Proposed 617	1392.00	12.20	20.77	4.34	603.37	186.10
Little River	5504	10-Year (2070)	precon survey	1392.00	11.73	23.70	1.09	1295.29	205.61
Little River	5504	50-Year (2070)	Proposed 617	2304.00	12.20	24.39	3.81	1325.20	214.29
Little River	5504	50-Year (2070)	precon survey	2304.00	11.73	25.63	1.39	1720.85	237.38
Little River	5504	100-Year (2070)	Proposed 617	2959.10	12.20	26.89	3.57	1990.49	336.77
Little River	5504	100-Year (2070)	precon survey	2959.10	11.73	27.33	1.46	2253.78	341.65
Little River	5430	10-Year (2070)	Proposed 617	1392.00	12.09	20.55	5.17	478.27	131.54
Little River	5430	10-Year (2070)	precon survey	1392.00	11.00	23.66	1.51	970.11	160.33
Little River	5430	50-Year (2070)	Proposed 617	2304.00	12.09	24.23	4.78	1023.51	165.66
Little River	5430	50-Year (2070)	precon survey	2304.00	11.00	25.58	1.93	1296.03	178.81
Little River	5430	100-Year (2070)	Proposed 617	2959.10	12.09	26.76	4.53	1519.61	269.48
Little River	5430	100-Year (2070)	precon survey	2959.10	11.00	27.28	2.03	1707.35	301.25
Little River	5424	10-Year (2070)	Proposed 617	1392.00	12.08	20.55	5.17	477.50	131.47
Little River	5424	10-Year (2070)	precon survey	1392.00	11.00	23.66	1.51	969.80	160.31
Little River	5424	50-Year (2070)	Proposed 617	2304.00	12.08	24.22	4.78	1023.15	165.63
Little River	5424	50-Year (2070)	precon survey	2304.00	11.00	25.58	1.93	1295.61	178.79
Little River	5424	100-Year (2070)	Proposed 617	2959.10	12.08	26.76	4.53	1519.21	269.33
Little River	5424	100-Year (2070)	precon survey	2959.10	11.00	27.28	2.03	1706.73	301.13
Little River	5232	10-Year (2070)	Proposed 617	1392.00	11.75	20.41	4.70	558.49	181.47
Little River	5232	10-Year (2070)	precon survey	1392.00	11.20	23.59	2.12	1247.04	250.33
Little River	5232	50-Year (2070)	Proposed 617	2304.00	11.75	24.19	4.09	1399.60	263.46
Little River	5232	50-Year (2070)	precon survey	2304.00	11.20	25.50	2.56	1767.07	291.99
Little River	5232	100-Year (2070)	Proposed 617	2959.10	11.75	26.75	3.75	2173.09	370.86
Little River	5232	100-Year (2070)	precon survey	2959.10	11.20	27.22	2.58	2354.91	400.29
Little River	5226	10-Year (2070)	Proposed 617	1392.00	11.74	20.40	4.70	557.61	181.34
Little River	5226	10-Year (2070)	precon survey	1392.00	11.20	23.58	2.12	1246.48	250.28
Little River	5226	50-Year (2070)	Proposed 617	2304.00	11.74	24.19	4.09	1399.20	263.41
Little River	5226	50-Year (2070)	precon survey	2304.00	11.20	25.50	2.56	1766.28	291.93
Little River	5226	100-Year (2070)	Proposed 617	2959.10	11.74	26.75	3.75	2172.76	370.76
Little River	5226	100-Year (2070)	precon survey	2959.10	11.20	27.22	2.58	2353.99	400.15
Little River	5160	10-Year (2070)	Proposed 617	1392.00	11.62	20.49	3.37	1026.65	255.44
Little River	5160	10-Year (2070)	precon survey	1392.00	11.20	23.60	0.73	1947.78	285.41
Little River	5160	50-Year (2070)	Proposed 617	2304.00	11.62	24.24	2.99	2059.36	292.23
Little River	5160	50-Year (2070)	precon survey	2304.00	11.20	25.52	0.96	2519.71	313.13
Little River	5160	100-Year (2070)	Proposed 617	2959.10	11.62	26.79	2.84	2884.73	384.63

HEC-RAS River: Little River Reach: Little River (Continued)

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Vel Chnl	Flow Area	Top Width
				(cfs)	(ft)	(ft)	(ft/s)	(sq ft)	(ft)
Little River	5160	100-Year (2070)	precon survey	2959.10	11.20	27.23	1.03	3133.46	408.80
Little River	5128	10-Year (2070)	Proposed 617	1392.00	11.56	20.56	0.96	1665.06	282.24
Little River	5128	10-Year (2070)	precon survey	1392.00	11.20	23.60	0.74	1947.12	285.40
Little River	5128	50-Year (2070)	Proposed 617	2304.00	11.56	24.28	1.06	2765.31	308.71
Little River	5128	50-Year (2070)	precon survey	2304.00	11.20	25.52	0.96	2518.80	313.09
Little River	5128	100-Year (2070)	Proposed 617	2959.10	11.56	26.82	1.11	3604.16	386.16
Little River	5128	100-Year (2070)	precon survey	2959.10	11.20	27.23	1.03	3132.38	408.65
Little River	5077	10-Year (2070)	Proposed 617	1392.00	11.47	20.53	1.48	1036.26	255.97
Little River	5077	10-Year (2070)	precon survey	1392.00	11.20	23.59	0.74	1946.08	285.37
Little River	5077	50-Year (2070)	Proposed 617	2304.00	11.47	24.27	1.35	2065.20	292.63
Little River	5077	50-Year (2070)	precon survey	2304.00	11.20	25.51	0.96	2517.36	313.01
Little River	5077	100-Year (2070)	Proposed 617	2959.10	11.47	26.81	1.31	2890.56	385.64
Little River	5077	100-Year (2070)	precon survey	2959.10	11.20	27.22	1.03	3130.65	408.42
Little River	5030	10-Year (2070)	Proposed 617	1392.00	11.38	20.44	2.60	537.64	139.96
Little River	5030	10-Year (2070)	precon survey	1392.00	12.76	23.55	1.61	939.48	178.56
Little River	5030	50-Year (2070)	Proposed 617	2304.00	11.38	24.21	2.19	1168.14	182.65
Little River	5030	50-Year (2070)	precon survey	2304.00	12.76	25.45	1.99	1290.52	190.18
Little River	5030	100-Year (2070)	Proposed 617	2959.10	11.38	26.76	2.09	1678.53	247.76
Little River	5030	100-Year (2070)	precon survey	2959.10	12.76	27.17	2.06	1673.77	272.10
Little River	5027			Inl Struct					
Little River	5024	10-Year (2070)	Proposed 617	1392.00	11.38	20.39	2.63	530.53	138.85
Little River	5024	10-Year (2070)	precon survey	1392.00	12.76	23.55	1.61	939.00	178.54
Little River	5024	50-Year (2070)	Proposed 617	2304.00	11.38	24.17	2.20	1161.16	182.40
Little River	5024	50-Year (2070)	precon survey	2304.00	12.76	25.45	1.99	1289.97	190.17
Little River	5024	100-Year (2070)	Proposed 617	2959.10	11.38	26.74	2.09	1672.18	246.47
Little River	5024	100-Year (2070)	precon survey	2959.10	12.76	27.16	2.07	1673.12	271.93
Little River	4875	10-Year (2070)	Proposed 617	1392.00	11.10	20.02	4.76	478.65	121.83
Little River	4875	10-Year (2070)	precon survey	1392.00	11.05	23.50	1.49	958.31	140.63
Little River	4875	50-Year (2070)	Proposed 617	2304.00	11.10	23.92	4.50	1004.76	142.03
Little River	4875	50-Year (2070)	precon survey	2304.00	11.05	25.39	1.95	1231.86	154.55
Little River	4875	100-Year (2070)	Proposed 617	2959.10	11.10	26.52	4.39	1405.67	175.97
Little River	4875	100-Year (2070)	precon survey	2959.10	11.05	27.10	2.09	1525.14	199.73
Little River	4859	10-Year (2070)	Proposed 617	1392.00	11.09	20.12	3.17	439.45	92.57
Little River	4859	10-Year (2070)	precon survey	1392.00	11.05	23.49	1.49	957.63	140.61
Little River	4859	50-Year (2070)	Proposed 617	2304.00	11.09	23.99	2.87	905.33	135.98
Little River	4859	50-Year (2070)	precon survey	2304.00	11.05	25.38	1.95	1230.91	154.44
Little River	4859	100-Year (2070)	Proposed 617	2959.10	11.09	26.58	2.78	1304.17	177.16
Little River	4859	100-Year (2070)	precon survey	2959.10	11.05	27.10	2.09	1524.02	198.92
Little River	4854.5			Bridge					
Little River	4850	10-Year (2070)	Proposed 617	1392.00	11.08	19.87	4.93	421.43	88.20
Little River	4850	10-Year (2070)	precon survey	1392.00	11.26	23.47	1.84	782.98	110.89
Little River	4850	50-Year (2070)	Proposed 617	2304.00	11.08	23.76	4.91	807.57	113.21
Little River	4850	50-Year (2070)	precon survey	2304.00	11.26	25.34	2.45	1004.20	125.54
Little River	4850	100-Year (2070)	Proposed 617	2959.10	11.08	26.29	4.89	1126.57	168.98
Little River	4850	100-Year (2070)	precon survey	2959.10	11.26	27.05	2.64	1285.89	229.82
Little River	4750	10-Year (2070)	Proposed 617	1392.00	10.90	19.83	4.42	500.73	103.45
Little River	4750	10-Year (2070)	precon survey	1392.00	12.16	23.46	1.44	972.62	112.96
Little River	4750	50-Year (2070)	Proposed 617	2304.00	10.90	23.75	4.40	927.38	113.70
Little River	4750	50-Year (2070)	precon survey	2304.00	12.16	25.32	1.98	1192.76	125.12
Little River	4750	100-Year (2070)	Proposed 617	2959.10	10.90	26.28	4.43	1245.64	168.20
Little River	4750	100-Year (2070)	precon survey	2959.10	12.16	27.03	2.17	1472.66	228.34
Little River	4721	10-Year (2070)	Proposed 617	1392.00	9.20	19.71	4.77	341.08	148.70
Little River	4721	10-Year (2070)	precon survey	1392.00	12.11	23.45	1.44	973.87	112.94
Little River	4721	50-Year (2070)	Proposed 617	2304.00	9.20	23.78	3.41	940.66	192.88
Little River	4721	50-Year (2070)	precon survey	2304.00	12.11	25.31	1.97	1193.54	125.04
Little River	4721	100-Year (2070)	Proposed 617	2959.10	9.20	26.35	2.98	1453.69	230.60
Little River	4721	100-Year (2070)	precon survey	2959.10	12.11	27.02	2.17	1472.46	227.57
Little River	4692	10-Year (2070)	Proposed 617	1392.00	9.20	19.69	4.78	339.69	148.20
Little River	4692	10-Year (2070)	precon survey	1392.00	12.06	23.44	1.44	975.13	112.93
Little River	4692	50-Year (2070)	Proposed 617	2304.00	9.20	23.77	3.42	937.13	192.82

HEC-RAS River: Little River Reach: Little River (Continued)

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Vel Chnl	Flow Area	Top Width
				(cfs)	(ft)	(ft)	(ft/s)	(sq ft)	(ft)
Little River	4692	50-Year (2070)	precon survey	2304.00	12.06	25.30	1.97	1194.33	124.96
Little River	4692	100-Year (2070)	Proposed 617	2959.10	9.20	26.34	2.99	1451.72	230.21
Little River	4692	100-Year (2070)	precon survey	2959.10	12.06	27.01	2.17	1472.27	226.80
Little River	4663	10-Year (2070)	Proposed 617	1392.00	9.20	19.67	4.79	338.26	147.69
Little River	4663	10-Year (2070)	precon survey	1392.00	12.00	23.44	1.44	976.79	112.91
Little River	4663	50-Year (2070)	Proposed 617	2304.00	9.20	23.75	3.43	933.57	192.75
Little River	4663	50-Year (2070)	precon survey	2304.00	12.00	25.29	1.97	1195.53	124.88
Little River	4663	100-Year (2070)	Proposed 617	2959.10	9.20	26.33	2.99	1449.73	229.82
Little River	4663	100-Year (2070)	precon survey	2959.10	12.00	27.00	2.17	1472.49	226.03
Little River	4632	10-Year (2070)	Proposed 617	1392.00	10.70	19.63	4.79	292.31	44.54
Little River	4632	10-Year (2070)	precon survey	1392.00	11.00	23.35	2.81	790.76	190.50
Little River	4632	50-Year (2070)	Proposed 617	2304.00	10.70	23.58	4.43	843.56	197.92
Little River	4632	50-Year (2070)	precon survey	2304.00	11.00	25.20	3.44	1187.44	232.68
Little River	4632	100-Year (2070)	Proposed 617	2959.10	10.70	26.21	4.06	1443.84	279.98
Little River	4632	100-Year (2070)	precon survey	2959.10	11.00	26.94	3.40	1665.13	343.77
Little River	4629			Inl Struct					
Little River	4625	10-Year (2070)	Proposed 617	1392.00	10.70	19.43	4.94	283.19	44.08
Little River	4625	10-Year (2070)	precon survey	1392.00	12.58	23.38	1.89	824.31	190.06
Little River	4625	50-Year (2070)	Proposed 617	2304.00	10.70	23.53	4.47	832.47	196.11
Little River	4625	50-Year (2070)	precon survey	2304.00	12.58	25.23	2.31	1223.27	233.29
Little River	4625	100-Year (2070)	Proposed 617	2959.10	10.70	26.17	4.08	1434.44	277.05
Little River	4625	100-Year (2070)	precon survey	2959.10	12.58	26.97	2.31	1701.89	346.01
Little River	4495	10-Year (2070)	Proposed 617	1392.00	10.56	19.40	3.77	732.71	263.24
Little River	4495	10-Year (2070)	precon survey	1392.00	13.62	23.39	0.71	1969.52	316.36
Little River	4495	50-Year (2070)	Proposed 617	2304.00	10.56	23.59	2.79	1942.32	309.78
Little River	4495	50-Year (2070)	precon survey	2304.00	13.62	25.25	0.91	2576.40	337.68
Little River	4495	100-Year (2070)	Proposed 617	2959.10	10.56	26.22	2.56	2812.66	354.29
Little River	4495	100-Year (2070)	precon survey	2959.10	13.62	26.99	0.96	3190.52	376.31
Little River	4455	10-Year (2070)	Proposed 617	1392.00	10.50	19.52	0.73	1955.88	270.21
Little River	4455	10-Year (2070)	precon survey	1392.00	13.62	23.39	0.71	1968.48	316.34
Little River	4455	50-Year (2070)	Proposed 617	2304.00	10.50	23.63	0.80	3148.64	310.31
Little River	4455	50-Year (2070)	precon survey	2304.00	13.62	25.25	0.91	2575.08	337.62
Little River	4455	100-Year (2070)	Proposed 617	2959.10	10.50	26.26	0.84	4016.55	355.22
Little River	4455	100-Year (2070)	precon survey	2959.10	13.62	26.98	0.96	3189.25	376.21
Little River	4370	10-Year (2070)	Proposed 617	1392.00	10.34	19.14	4.84	356.23	94.34
Little River	4370	10-Year (2070)	precon survey	1392.00	13.22	23.33	1.82	981.21	296.33
Little River	4370	50-Year (2070)	Proposed 617	2304.00	10.34	23.40	4.18	1144.79	301.65
Little River	4370	50-Year (2070)	precon survey	2304.00	13.22	25.19	2.05	1652.35	409.44
Little River	4370	100-Year (2070)	Proposed 617	2959.10	10.34	26.12	3.61	2195.28	463.41
Little River	4370	100-Year (2070)	precon survey	2959.10	13.22	26.94	1.92	2461.68	527.65
Little River	4060	10-Year (2070)	Proposed 617	1392.00	9.80	18.99	3.86	436.45	91.81
Little River	4060	10-Year (2070)	precon survey	1392.00	13.34	23.14	1.97	760.53	138.01
Little River	4060	50-Year (2070)	Proposed 617	2304.00	9.80	23.31	3.72	941.26	139.62
Little River	4060	50-Year (2070)	precon survey	2304.00	13.34	24.96	2.51	1035.71	171.49
Little River	4060	100-Year (2070)	Proposed 617	2959.10	9.80	26.00	3.67	1385.35	199.06
Little River	4060	100-Year (2070)	precon survey	2959.10	13.34	26.75	2.58	1405.01	274.18
Little River	4030	10-Year (2070)	Proposed 617	1392.00	9.75	18.93	4.31	470.71	119.82
Little River	4030	10-Year (2070)	precon survey	1392.00	11.10	23.15	1.41	1020.20	142.79
Little River	4030	50-Year (2070)	Proposed 617	2304.00	9.75	23.30	3.93	1062.15	143.29
Little River	4030	50-Year (2070)	precon survey	2304.00	11.10	24.98	1.87	1295.88	165.68
Little River	4030	100-Year (2070)	Proposed 617	2959.10	9.75	26.00	3.86	1495.13	184.99
Little River	4030	100-Year (2070)	precon survey	2959.10	11.10	26.76	2.00	1657.76	293.81
Little River	4000	10-Year (2070)	Proposed 617	1392.00	9.70	18.96	3.40	408.92	90.89
Little River	4000	10-Year (2070)	precon survey	1392.00	10.13	23.14	1.50	934.81	144.45
Little River	4000	50-Year (2070)	Proposed 617	2304.00	9.70	23.36	2.48	936.89	146.71
Little River	4000	50-Year (2070)	precon survey	2304.00	10.13	24.96	1.95	1220.30	173.38
Little River	4000	100-Year (2070)	Proposed 617	2959.10	9.70	26.06	2.28	1392.82	196.98
Little River	4000	100-Year (2070)	precon survey	2959.10	10.13	26.75	2.05	1566.63	218.20
Little River	3996			Inl Struct					
Little River	3993	10-Year (2070)	Proposed 617	1392.00	9.70	18.74	4.66	395.85	106.57

HEC-RAS River: Little River Reach: Little River (Continued)

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Vel Chnl	Flow Area	Top Width
				(cfs)	(ft)	(ft)	(ft/s)	(sq ft)	(ft)
Little River	3993	10-Year (2070)	precon survey	1392.00	10.00	23.12	2.15	1075.57	194.82
Little River	3993	50-Year (2070)	Proposed 617	2304.00	9.70	23.19	4.09	1098.89	196.70
Little River	3993	50-Year (2070)	precon survey	2304.00	10.00	24.94	2.74	1466.43	229.86
Little River	3993	100-Year (2070)	Proposed 617	2959.10	9.70	25.93	3.83	1710.07	244.68
Little River	3993	100-Year (2070)	precon survey	2959.10	10.00	26.74	2.80	1919.17	298.95
Little River	3850	10-Year (2070)	Proposed 617	1392.00	9.50	18.64	3.68	378.20	102.96
Little River	3850	10-Year (2070)	precon survey	1392.00	12.35	23.09	1.35	1070.81	194.15
Little River	3850	50-Year (2070)	Proposed 617	2304.00	9.50	23.22	2.19	1097.03	197.36
Little River	3850	50-Year (2070)	precon survey	2304.00	12.35	24.90	1.72	1459.34	229.35
Little River	3850	100-Year (2070)	Proposed 617	2959.10	9.50	25.96	1.97	1710.17	245.14
Little River	3850	100-Year (2070)	precon survey	2959.10	12.35	26.71	1.77	1911.31	296.84
Little River	3555	10-Year (2070)	Proposed 617	1392.00	9.20	18.22	4.55	374.43	79.24
Little River	3555	10-Year (2070)	precon survey	1392.00	7.58	23.02	1.35	1085.19	154.09
Little River	3555	50-Year (2070)	Proposed 617	2304.00	9.20	22.96	4.21	888.48	152.25
Little River	3555	50-Year (2070)	precon survey	2304.00	7.58	24.81	1.85	1406.58	206.50
Little River	3555	100-Year (2070)	Proposed 617	2959.10	9.20	25.76	4.05	1428.29	235.40
Little River	3555	100-Year (2070)	precon survey	2959.10	7.58	26.62	1.98	1885.25	349.10
Little River	3375	10-Year (2070)	Proposed 617	1392.00	9.00	18.11	4.43	514.96	124.85
Little River	3375	10-Year (2070)	precon survey	1392.00	7.00	23.01	1.03	1353.60	145.68
Little River	3375	50-Year (2070)	Proposed 617	2304.00	9.00	22.95	3.86	1175.21	145.46
Little River	3375	50-Year (2070)	precon survey	2304.00	7.00	24.79	1.42	1634.80	206.56
Little River	3375	100-Year (2070)	Proposed 617	2959.10	9.00	25.75	3.78	1707.27	298.51
Little River	3375	100-Year (2070)	precon survey	2959.10	7.00	26.60	1.54	2166.17	380.38
Little River	3350	10-Year (2070)	Proposed 617	1392.00	9.00	18.05	4.67	426.60	95.03
Little River	3350	10-Year (2070)	precon survey	1392.00	8.80	22.96	2.17	966.13	119.48
Little River	3350	50-Year (2070)	Proposed 617	2304.00	9.00	22.88	4.23	954.56	119.09
Little River	3350	50-Year (2070)	precon survey	2304.00	8.80	24.71	2.98	1182.06	127.92
Little River	3350	100-Year (2070)	Proposed 617	2959.10	9.00	25.68	4.20	1306.68	132.83
Little River	3350	100-Year (2070)	precon survey	2959.10	8.80	26.51	3.22	1462.30	243.05
Little River	3346			Inl Struct					
Little River	3342	10-Year (2070)	Proposed 617	1392.00	9.00	17.97	4.73	419.09	94.43
Little River	3342	10-Year (2070)	precon survey	1392.00	8.80	22.96	2.17	965.83	119.46
Little River	3342	50-Year (2070)	Proposed 617	2304.00	9.00	22.84	4.25	949.21	118.88
Little River	3342	50-Year (2070)	precon survey	2304.00	8.80	24.71	2.98	1181.54	127.90
Little River	3342	100-Year (2070)	Proposed 617	2959.10	9.00	25.63	4.22	1300.64	132.60
Little River	3342	100-Year (2070)	precon survey	2959.10	8.80	26.51	3.22	1461.30	242.63
Little River	3300	10-Year (2070)	Proposed 617	1392.00	8.90	17.93	4.71	419.51	94.68
Little River	3300	10-Year (2070)	precon survey	1392.00	8.80	22.97	1.26	1110.76	120.03
Little River	3300	50-Year (2070)	Proposed 617	2304.00	8.90	22.82	4.23	954.91	119.41
Little River	3300	50-Year (2070)	precon survey	2304.00	8.80	24.73	1.77	1327.97	128.00
Little River	3300	100-Year (2070)	Proposed 617	2959.10	8.90	25.62	4.20	1306.96	132.54
Little River	3300	100-Year (2070)	precon survey	2959.10	8.80	26.53	1.95	1610.32	244.84
Little River	3150	10-Year (2070)	Proposed 617	1392.00	8.60	17.79	4.72	345.18	60.97
Little River	3150	10-Year (2070)	precon survey	1392.00	9.14	22.88	2.22	648.34	96.75
Little River	3150	50-Year (2070)	Proposed 617	2304.00	8.60	22.69	4.55	695.86	93.39
Little River	3150	50-Year (2070)	precon survey	2304.00	9.14	24.57	3.03	839.27	132.67
Little River	3150	100-Year (2070)	Proposed 617	2959.10	8.60	25.50	4.57	1040.42	158.28
Little River	3150	100-Year (2070)	precon survey	2959.10	9.14	26.37	3.19	1124.45	185.87
Little River	2979	10-Year (2070)	Proposed 617	1392.00	8.34	17.69	4.36	341.34	50.27
Little River	2979	10-Year (2070)	precon survey	1392.00	8.26	22.86	1.46	988.98	110.49
Little River	2979	50-Year (2070)	Proposed 617	2304.00	8.34	22.63	4.34	656.54	94.63
Little River	2979	50-Year (2070)	precon survey	2304.00	8.26	24.54	2.09	1200.56	142.23
Little River	2979	100-Year (2070)	Proposed 617	2959.10	8.34	25.45	4.39	1012.18	158.97
Little River	2979	100-Year (2070)	precon survey	2959.10	8.26	26.34	2.32	1491.57	184.76
Little River	2805	10-Year (2070)	Proposed 617	1392.00	8.03	17.60	3.84	362.60	64.44
Little River	2805	10-Year (2070)	precon survey	1392.00	11.68	22.75	2.27	635.32	124.71
Little River	2805	50-Year (2070)	Proposed 617	2304.00	8.03	22.68	3.01	802.74	122.19
Little River	2805	50-Year (2070)	precon survey	2304.00	11.68	24.38	2.95	882.29	173.90
Little River	2805	100-Year (2070)	Proposed 617	2959.10	8.03	25.52	2.87	1269.26	194.68
Little River	2805	100-Year (2070)	precon survey	2959.10	11.68	26.21	2.95	1236.05	233.25
Little River	2775	10-Year (2070)	Proposed 617	1392.00	8.00	17.60	3.61	387.07	63.59

HEC-RAS River: Little River Reach: Little River (Continued)

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Vel Chnl	Flow Area	Top Width
				(cfs)	(ft)	(ft)	(ft/s)	(sq ft)	(ft)
Little River	2775	10-Year (2070)	precon survey	1392.00	12.10	22.75	2.07	915.25	224.73
Little River	2775	50-Year (2070)	Proposed 617	2304.00	8.00	22.67	3.06	1057.99	222.12
Little River	2775	50-Year (2070)	precon survey	2304.00	12.10	24.39	2.63	1332.69	284.51
Little River	2775	100-Year (2070)	Proposed 617	2959.10	8.00	25.53	2.86	1840.87	326.23
Little River	2775	100-Year (2070)	precon survey	2959.10	12.10	26.23	2.58	1918.31	351.64
Little River	2645	10-Year (2070)	Proposed 617	1392.00	7.92	17.60	2.81	494.66	88.40
Little River	2645	10-Year (2070)	precon survey	1392.00	8.24	22.73	1.41	1000.28	125.46
Little River	2645	50-Year (2070)	Proposed 617	2304.00	7.92	22.69	2.33	1040.82	125.41
Little River	2645	50-Year (2070)	precon survey	2304.00	8.24	24.35	1.94	1206.00	128.06
Little River	2645	100-Year (2070)	Proposed 617	2959.10	7.92	25.54	2.31	1403.92	130.22
Little River	2645	100-Year (2070)	precon survey	2959.10	8.24	26.18	2.09	1445.52	148.91
Little River	2567	10-Year (2070)	Proposed 617	1392.00	7.87	17.48	3.73	373.67	66.08
Little River	2567	10-Year (2070)	precon survey	1392.00	7.30	22.69	2.09	908.11	125.40
Little River	2567	50-Year (2070)	Proposed 617	2304.00	7.87	22.65	2.72	898.32	125.34
Little River	2567	50-Year (2070)	precon survey	2304.00	7.30	24.27	2.99	1108.33	127.90
Little River	2567	100-Year (2070)	Proposed 617	2959.10	7.87	25.51	2.59	1262.91	130.16
Little River	2567	100-Year (2070)	precon survey	2959.10	7.30	26.09	3.30	1344.35	139.30
Little River	2564			Inl Struct					
Little River	2561	10-Year (2070)	Proposed 617	1392.00	7.50	17.36	3.68	378.50	64.59
Little River	2561	10-Year (2070)	precon survey	1392.00	7.30	22.69	2.06	908.20	125.40
Little River	2561	50-Year (2070)	Proposed 617	2304.00	7.50	22.61	2.70	905.23	125.27
Little River	2561	50-Year (2070)	precon survey	2304.00	7.30	24.27	2.94	1108.54	127.91
Little River	2561	100-Year (2070)	Proposed 617	2959.10	7.50	25.47	2.58	1269.94	130.09
Little River	2561	100-Year (2070)	precon survey	2959.10	7.30	26.09	3.25	1344.64	139.51
Little River	2558	10-Year (2070)	Proposed 617	1392.00	5.50	17.39	3.09	461.59	67.59
Little River	2558	10-Year (2070)	precon survey	1392.00	7.30	22.71	1.21	1167.82	125.44
Little River	2558	50-Year (2070)	Proposed 617	2304.00	5.50	22.61	2.75	990.19	125.28
Little River	2558	50-Year (2070)	precon survey	2304.00	7.30	24.32	1.72	1371.65	128.01
Little River	2558	100-Year (2070)	Proposed 617	2959.10	5.50	25.47	2.68	1354.91	130.09
Little River	2558	100-Year (2070)	precon survey	2959.10	7.30	26.15	1.89	1609.86	145.62
Little River	2550	10-Year (2070)	Proposed 617	1392.00	5.50	17.39	3.01	461.75	67.62
Little River	2550	10-Year (2070)	precon survey	1392.00	7.30	22.71	1.21	1167.70	125.44
Little River	2550	50-Year (2070)	Proposed 617	2304.00	5.50	22.62	2.45	991.10	125.29
Little River	2550	50-Year (2070)	precon survey	2304.00	7.30	24.32	1.72	1371.45	128.00
Little River	2550	100-Year (2070)	Proposed 617	2959.10	5.50	25.47	2.40	1355.36	130.10
Little River	2550	100-Year (2070)	precon survey	2959.10	7.30	26.15	1.89	1609.63	145.47
Little River	2516	10-Year (2070)	Proposed 617	1392.00	5.50	17.40	2.70	515.17	82.95
Little River	2516	10-Year (2070)	precon survey	1392.00	7.30	22.71	1.21	1167.19	125.43
Little River	2516	50-Year (2070)	Proposed 617	2304.00	5.50	22.62	2.28	1064.20	125.32
Little River	2516	50-Year (2070)	precon survey	2304.00	7.30	24.31	1.72	1370.56	127.99
Little River	2516	100-Year (2070)	Proposed 617	2959.10	5.50	25.48	2.27	1428.34	130.11
Little River	2516	100-Year (2070)	precon survey	2959.10	7.30	26.14	1.89	1608.62	144.79
Little River	2513	10-Year (2070)	Proposed 617	1392.00	7.50	17.26	3.96	352.50	51.04
Little River	2513	10-Year (2070)	precon survey	1392.00	8.00	22.65	2.28	746.04	86.73
Little River	2513	50-Year (2070)	Proposed 617	2304.00	7.50	22.50	3.61	705.63	83.82
Little River	2513	50-Year (2070)	precon survey	2304.00	8.00	24.19	3.29	902.77	185.08
Little River	2513	100-Year (2070)	Proposed 617	2959.10	7.50	25.38	3.47	1098.81	194.40
Little River	2513	100-Year (2070)	precon survey	2959.10	8.00	26.01	3.57	1253.83	349.55
Little River	2511			Inl Struct					
Little River	2509	10-Year (2070)	Proposed 617	1392.00	7.25	17.18	3.43	407.47	55.24
Little River	2509	10-Year (2070)	precon survey	1392.00	8.00	22.65	2.28	746.01	86.73
Little River	2509	50-Year (2070)	Proposed 617	2304.00	7.25	22.45	3.28	776.56	84.65
Little River	2509	50-Year (2070)	precon survey	2304.00	8.00	24.19	3.29	902.69	185.08
Little River	2509	100-Year (2070)	Proposed 617	2959.10	7.25	25.33	3.28	1165.46	194.04
Little River	2509	100-Year (2070)	precon survey	2959.10	8.00	26.01	3.57	1253.68	349.50
Little River	2506	10-Year (2070)	Proposed 617	1392.00	5.20	17.18	3.29	423.90	55.33
Little River	2506	10-Year (2070)	precon survey	1392.00	9.35	22.65	2.20	632.69	85.60
Little River	2506	50-Year (2070)	Proposed 617	2304.00	5.20	22.46	3.03	800.12	87.23
Little River	2506	50-Year (2070)	precon survey	2304.00	9.35	24.20	2.98	790.99	185.18
Little River	2506	100-Year (2070)	Proposed 617	2959.10	5.20	25.35	2.89	1198.09	195.04
Little River	2506	100-Year (2070)	precon survey	2959.10	9.35	26.04	2.92	1152.12	353.65

HEC-RAS River: Little River Reach: Little River (Continued)

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Vel Chnl	Flow Area	Top Width
				(cfs)	(ft)	(ft)	(ft/s)	(sq ft)	(ft)
Little River	2480	10-Year (2070)	Proposed 617	1392.00	5.20	17.13	3.36	415.39	53.69
Little River	2480	10-Year (2070)	precon survey	1392.00	9.35	22.63	2.21	631.08	85.49
Little River	2480	50-Year (2070)	Proposed 617	2304.00	5.20	22.43	3.13	771.65	78.10
Little River	2480	50-Year (2070)	precon survey	2304.00	9.35	24.17	2.99	785.34	184.94
Little River	2480	100-Year (2070)	Proposed 617	2959.10	5.20	25.32	3.01	1156.11	194.64
Little River	2480	100-Year (2070)	precon survey	2959.10	9.35	26.02	2.93	1144.20	351.04
Little River	2464	10-Year (2070)	Proposed 617	1392.00	5.20	17.10	3.37	414.04	54.16
Little River	2464	10-Year (2070)	precon survey	1392.00	9.35	22.62	2.21	630.05	85.42
Little River	2464	50-Year (2070)	Proposed 617	2304.00	5.20	22.42	3.08	791.87	86.61
Little River	2464	50-Year (2070)	precon survey	2304.00	9.35	24.15	3.00	781.72	184.78
Little River	2464	100-Year (2070)	Proposed 617	2959.10	5.20	25.32	2.93	1186.38	194.61
Little River	2464	100-Year (2070)	precon survey	2959.10	9.35	26.01	2.94	1139.11	349.35
Little River	2461	10-Year (2070)	Proposed 617	1392.00	7.25	17.01	4.07	341.71	47.88
Little River	2461	10-Year (2070)	precon survey	1392.00	8.50	22.62	2.07	673.70	56.66
Little River	2461	50-Year (2070)	Proposed 617	2304.00	7.25	22.34	3.76	630.13	59.50
Little River	2461	50-Year (2070)	precon survey	2304.00	8.50	24.15	3.02	764.77	80.74
Little River	2461	100-Year (2070)	Proposed 617	2959.10	7.25	25.21	3.79	869.78	162.86
Little River	2461	100-Year (2070)	precon survey	2959.10	8.50	25.97	3.26	1039.89	221.31
Little River	2456			Inl Struct					
Little River	2451	10-Year (2070)	Proposed 617	1392.00	7.25	16.86	4.24	328.37	52.82
Little River	2451	10-Year (2070)	precon survey	1392.00	8.50	21.94	5.58	249.46	75.11
Little River	2451	50-Year (2070)	Proposed 617	2304.00	7.25	22.26	3.51	681.82	75.20
Little River	2451	50-Year (2070)	precon survey	2304.00	8.50	23.27	6.60	349.14	75.12
Little River	2451	100-Year (2070)	Proposed 617	2959.10	7.25	25.18	3.41	972.37	194.32
Little River	2451	100-Year (2070)	precon survey	2959.10	8.50	25.55	5.29	637.63	207.12
Little River	2449	10-Year (2070)	Proposed 617	1392.00	5.00	16.91	3.42	406.95	50.80
Little River	2449	10-Year (2070)	precon survey	1392.00	8.50	20.81	8.45	164.79	75.10
Little River	2449	50-Year (2070)	Proposed 617	2304.00	5.00	22.26	3.17	756.93	75.20
Little River	2449	50-Year (2070)	precon survey	2304.00	8.50	22.48	7.94	290.20	75.11
Little River	2449	100-Year (2070)	Proposed 617	2959.10	5.00	25.17	3.17	1047.14	197.02
Little River	2449	100-Year (2070)	precon survey	2959.10	8.50	25.32	5.74	594.02	202.76
Little River	2430	10-Year (2070)	Proposed 617	1392.00	5.00	16.96	2.17	643.21	70.09
Little River	2430	10-Year (2070)	precon survey	1392.00	6.77	17.13	1.99	701.22	78.11
Little River	2430	50-Year (2070)	Proposed 617	2304.00	5.00	22.30	2.23	1061.74	79.88
Little River	2430	50-Year (2070)	precon survey	2304.00	6.77	22.66	2.00	1151.78	84.65
Little River	2430	100-Year (2070)	Proposed 617	2959.10	5.00	25.20	2.36	1315.63	103.05
Little River	2430	100-Year (2070)	precon survey	2959.10	6.77	25.41	2.13	1406.98	104.16
Little River	2420	10-Year (2070)	Proposed 617	1392.00	5.00	16.95	2.31	632.18	67.28
Little River	2420	10-Year (2070)	precon survey	1392.00	7.00	17.10	2.31	603.34	69.65
Little River	2420	50-Year (2070)	Proposed 617	2304.00	5.00	22.28	2.45	1021.38	73.90
Little River	2420	50-Year (2070)	precon survey	2304.00	7.00	22.64	2.31	997.80	72.81
Little River	2420	100-Year (2070)	Proposed 617	2959.10	5.00	25.18	2.62	1270.53	157.87
Little River	2420	100-Year (2070)	precon survey	2959.10	7.00	25.38	2.46	1253.17	181.16
Little River	2415	10-Year (2070)	Proposed 617	1392.00	5.00	16.92	2.55	545.35	61.60
Little River	2415	10-Year (2070)	precon survey	1392.00	6.75	16.97	3.43	405.25	44.60
Little River	2415	50-Year (2070)	Proposed 617	2304.00	5.00	22.26	2.60	892.37	65.01
Little River	2415	50-Year (2070)	precon survey	2304.00	6.75	22.50	3.49	660.30	47.63
Little River	2415	100-Year (2070)	Proposed 617	2959.10	5.00	25.16	2.75	1089.62	103.91
Little River	2415	100-Year (2070)	precon survey	2959.10	6.75	25.23	3.64	824.89	110.00
Little River	2380	10-Year (2070)	Proposed 617	1392.00	6.00	16.44	5.46	255.01	42.38
Little River	2380	10-Year (2070)	precon survey	1392.00	3.50	16.74	4.80	294.45	45.91
Little River	2380	50-Year (2070)	Proposed 617	2304.00	6.00	21.73	5.71	403.21	46.00
Little River	2380	50-Year (2070)	precon survey	2304.00	3.50	22.20	5.18	447.31	45.98
Little River	2380	100-Year (2070)	Proposed 617	2959.10	6.00	24.97	4.09	783.76	152.98
Little River	2380	100-Year (2070)	precon survey	2959.10	3.50	25.23	3.51	932.29	181.79
Little River	2342.5			Bridge					
Little River	2305	10-Year (2070)	Proposed 617	1392.00	6.00	16.03	5.56	250.31	45.89
Little River	2305	10-Year (2070)	precon survey	1392.00	6.89	15.97	6.25	222.83	45.89
Little River	2305	50-Year (2070)	Proposed 617	2304.00	6.00	19.92	6.41	359.42	45.95
Little River	2305	50-Year (2070)	precon survey	2304.00	6.89	19.87	6.94	332.13	45.95

HEC-RAS River: Little River Reach: Little River (Continued)

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Vel Chnl	Flow Area	Top Width
				(cfs)	(ft)	(ft)	(ft/s)	(sq ft)	(ft)
Little River	2305	100-Year (2070)	Proposed 617	2959.10	6.00	22.62	4.31	687.50	45.98
Little River	2305	100-Year (2070)	precon survey	2959.10	6.89	22.60	4.62	650.82	45.98
Little River	2273	10-Year (2070)	Proposed 617	1392.00	5.89	16.15	3.50	397.74	52.25
Little River	2273	10-Year (2070)	precon survey	1392.00	5.89	16.15	3.50	397.74	52.25
Little River	2273	50-Year (2070)	Proposed 617	2304.00	5.89	20.12	3.71	621.56	61.72
Little River	2273	50-Year (2070)	precon survey	2304.00	5.89	20.12	3.71	621.56	61.72
Little River	2273	100-Year (2070)	Proposed 617	2959.10	5.89	22.65	3.78	788.72	71.05
Little River	2273	100-Year (2070)	precon survey	2959.10	5.89	22.65	3.78	788.72	71.05
Little River	2255	10-Year (2070)	Proposed 617	1392.00	7.50	16.07	4.07	342.39	45.43
Little River	2255	10-Year (2070)	precon survey	1392.00	7.50	16.07	4.07	342.39	45.43
Little River	2255	50-Year (2070)	Proposed 617	2304.00	7.50	20.03	4.33	543.76	57.94
Little River	2255	50-Year (2070)	precon survey	2304.00	7.50	20.03	4.33	543.76	57.94
Little River	2255	100-Year (2070)	Proposed 617	2959.10	7.50	22.57	4.38	702.18	67.10
Little River	2255	100-Year (2070)	precon survey	2959.10	7.50	22.57	4.38	702.18	67.10
Little River	2218	10-Year (2070)	Proposed 617	1392.00	7.00	15.93	4.81	289.16	37.25
Little River	2218	10-Year (2070)	precon survey	1392.00	7.00	15.93	4.81	289.16	37.25
Little River	2218	50-Year (2070)	Proposed 617	2304.00	7.00	19.87	5.19	443.89	43.20
Little River	2218	50-Year (2070)	precon survey	2304.00	7.00	19.87	5.19	443.89	43.20
Little River	2218	100-Year (2070)	Proposed 617	2959.10	7.00	22.39	5.30	562.96	51.52
Little River	2218	100-Year (2070)	precon survey	2959.10	7.00	22.39	5.30	562.96	51.52
Little River	2126	10-Year (2070)	Proposed 617	1392.00	7.06	15.83	5.33	291.93	48.99
Little River	2126	10-Year (2070)	precon survey	1392.00	7.06	15.83	5.33	291.93	48.99
Little River	2126	50-Year (2070)	Proposed 617	2304.00	7.06	19.89	5.02	534.94	71.06
Little River	2126	50-Year (2070)	precon survey	2304.00	7.06	19.89	5.02	534.94	71.06
Little River	2126	100-Year (2070)	Proposed 617	2959.10	7.06	22.46	4.83	735.74	85.28
Little River	2126	100-Year (2070)	precon survey	2959.10	7.06	22.46	4.83	735.74	85.28
Little River	2021	10-Year (2070)	Proposed 617	1392.00	6.78	15.88	3.65	412.21	63.84
Little River	2021	10-Year (2070)	precon survey	1392.00	6.78	15.88	3.65	412.21	63.84
Little River	2021	50-Year (2070)	Proposed 617	2304.00	6.78	19.94	3.65	698.49	78.47
Little River	2021	50-Year (2070)	precon survey	2304.00	6.78	19.94	3.65	698.49	78.47
Little River	2021	100-Year (2070)	Proposed 617	2959.10	6.78	22.50	3.63	917.56	92.73
Little River	2021	100-Year (2070)	precon survey	2959.10	6.78	22.50	3.63	917.56	92.73
Little River	1922	10-Year (2070)	Proposed 617	1392.00	7.24	15.51	5.42	272.44	44.54
Little River	1922	10-Year (2070)	precon survey	1392.00	7.24	15.51	5.42	272.44	44.54
Little River	1922	50-Year (2070)	Proposed 617	2304.00	7.24	19.63	5.30	483.05	58.60
Little River	1922	50-Year (2070)	precon survey	2304.00	7.24	19.63	5.30	483.05	58.60
Little River	1922	100-Year (2070)	Proposed 617	2959.10	7.24	22.22	5.21	645.82	67.21
Little River	1922	100-Year (2070)	precon survey	2959.10	7.24	22.22	5.21	645.82	67.21
Little River	1825	10-Year (2070)	Proposed 617	1392.00	6.34	15.55	4.23	353.62	46.68
Little River	1825	10-Year (2070)	precon survey	1392.00	6.34	15.55	4.23	353.62	46.68
Little River	1825	50-Year (2070)	Proposed 617	2304.00	6.34	19.65	4.52	569.86	59.07
Little River	1825	50-Year (2070)	precon survey	2304.00	6.34	19.65	4.52	569.86	59.07
Little River	1825	100-Year (2070)	Proposed 617	2959.10	6.34	22.24	4.58	733.50	66.92
Little River	1825	100-Year (2070)	precon survey	2959.10	6.34	22.24	4.58	733.50	66.92
Little River	1775 FEMA Section A	10-Year (2070)	Proposed 617	1392.00	5.20	15.51	4.21	330.56	42.01
Little River	1775 FEMA Section A	10-Year (2070)	precon survey	1392.00	5.20	15.51	4.21	330.56	42.01
Little River	1775 FEMA Section A	50-Year (2070)	Proposed 617	2304.00	5.20	19.54	4.86	473.72	44.95
Little River	1775 FEMA Section A	50-Year (2070)	precon survey	2304.00	5.20	19.54	4.86	473.72	44.95
Little River	1775 FEMA Section A	100-Year (2070)	Proposed 617	2959.10	5.20	22.04	5.26	562.97	46.79
Little River	1775 FEMA Section A	100-Year (2070)	precon survey	2959.10	5.20	22.04	5.26	562.97	46.79
Little River	1750			Bridge					
Little River	0010	10-Year (2070)	Proposed 617	1392.00	-3.30	5.51	6.11	228.27	1259.36
Little River	0010	10-Year (2070)	precon survey	1392.00	-3.30	5.51	6.11	228.27	1259.37
Little River	0010	50-Year (2070)	Proposed 617	2304.00	-3.30	2.30	18.68	123.60	614.57
Little River	0010	50-Year (2070)	precon survey	2304.00	-3.30	2.30	18.68	123.60	614.57
Little River	0010	100-Year (2070)	Proposed 617	2959.10	-3.30	2.86	20.89	141.91	727.37
Little River	0010	100-Year (2070)	precon survey	2959.10	-3.30	2.86	20.89	141.91	727.37
Little River	0	10-Year (2070)	Proposed 617	1392.00	-3.30	5.80	0.40	5615.63	1402.57
Little River	0	10-Year (2070)	precon survey	1392.00	-3.30	5.80	0.40	5615.63	1402.57
Little River	0	50-Year (2070)	Proposed 617	2304.00	-3.30	5.80	0.66	5615.63	1402.57
Little River	0	50-Year (2070)	precon survey	2304.00	-3.30	5.80	0.66	5615.63	1402.57

HEC-RAS River: Little River Reach: Little River (Continued)

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Vel Chnl	Flow Area	Top Width
				(cfs)	(ft)	(ft)	(ft/s)	(sq ft)	(ft)
Little River	0	100-Year (2070)	Proposed 617	2959.10	-3.30	5.80	0.85	5615.63	1402.57
Little River	0	100-Year (2070)	precon survey	2959.10	-3.30	5.80	0.85	5615.63	1402.57

STRUCTURES INSPECTION FIELD REPORT

ROUTINE ARCH INSPECTION

2-DIST	B.I.N.	BR. DEPT. NO.
04	30F	H-12-011

CITY/TOWN	8.-STRUCTURE NO.	11-Kilo. POINT	41-STATUS	90-ROUTINE INSP. DATE
HAVERHILL	H12011-30F-DOT-NBI	031.690	A:OPEN	JUL 22, 2020

07-FACILITY CARRIED	MEMORIAL NAME/LOCAL NAME	27-YR BUILT	106-YR REBUILT	YR REHAB'D (NON 106)
ST 97 WINTER ST	RICHARD J. WINMILL ALL V	1887	0000	0000

06-FEATURES INTERSECTED	26-FUNCTIONAL CLASS	DIST. BRIDGE INSPECTION ENGINEER J. Dideo
WATER LITTLE RIVER	Urban Minor Arterial	

43-STRUCTURE TYPE	22-OWNER	21-MAINTAINER	TEAM LEADER A. Labib
811 : Masonry Arch - Deck	State Highway Agency	State Highway Agency	

107-DECK TYPE	WEATHER	TEMP. (air)	TEAM MEMBERS
N : Not applicable	Clear	25°C	R. JONES

ITEM 58 — DECK: N

		DEF
1. Wearing Surface	5	S-A
2. Deck Condition	N	-
3. Spandrel Fill	H	-
4. Curbs	5	M-P
5. Median	N	-
6. Sidewalks	6	S-A
7. Parapets	N	-
8. Railing	6	M-P
9. Anti Missile Fence	N	-
10 Drainage System	N	-
11 Lighting Standards	N	-
12 Utilities	6	M-P
13 Deck Joints	N	-
14	N	-
15	N	-
16	N	-

CURB REVEAL (In millimeters)	N	S
	75	75

APPROACHES

		DEF
a. Appr. Pavement Condition	5	S-A
b. Appr. Roadway Settlement	6	M-P
c. Appr. Sidewalk Settlement	7	-
d.	N	-

OVERHEAD SIGNS (Attached to bridge) (Y/N): N

		DEF
a. Condition of Welds	N	-
b. Condition of Bolts	N	-
c. Condition of Signs	N	-

ITEM 59 — SUPERSTRUCTURE: 6

		DEF
1. Arch/Arch Ring	6	M-P
2. Keystone Area	6	M-P
3. Stringers	N	-
4. Floorbeams	N	-
5. Spandrel Walls	6	M-P
6. Spring Lines	7	-
7. Diaphragms/Cross Frames	N	-
8. Conn Plt's, Gussets & Angles	N	-
9. Pin & Hangers	N	-
10 Masonry Joints	6	M-P
11 Rivets & Bolts	N	-
12 Welds	N	-
13 Deformation/Flattening	7	-
14 Member Alignment	7	-
15 Paint/Coating	N	-
16 Gunite Encasing	5	M-P

Year Painted	N

COLLISION DAMAGE: *Please explain*
None (X) Minor ( ) Moderate ( ) Severe ( )

LOAD DEFLECTION: *Please explain*
None (X) Minor ( ) Moderate ( ) Severe ( )

LOAD VIBRATION: *Please explain*
None (X) Minor ( ) Moderate ( ) Severe ( )

Any Fracture Critical Member: **(Y/N): N**

Any Cracks: **(Y/N): N**

ITEM 60 — SUBSTRUCTURE: 6

	Dive	Cur		DEF
1. Abutments			6	
a. Pedestals	N	N		-
b. Bridge Seats	N	N		-
c. Backwalls	N	N		-
d. Breastwalls	6	H		-
e. Wingwalls	N	5		S-A
f. Slope Paving/Rip-Rap	N	N		-
g. Pointing	6	H		-
h. Footings	H	H		-
i. Piles	N	N		-
j. Scour	7	H		-
k. Settlement	7	7		-
l.	N	N		-
m.	N	N		-
2. Piers or Bents			N	
a. Pedestals	N	N		-
b. Caps	N	N		-
c. Columns	N	N		-
d. Stems/Webs/Pierwalls	N	N		-
e. Pointing	N	N		-
f. Footing	N	N		-
g. Piles	N	N		-
h. Scour	N	N		-
i. Settlement	N	N		-
j.	N	N		-
k.	N	N		-
3. Pile Bents			N	
a. Pile Caps	N	N		-
b. Piles	N	N		-
c. Diagonal Bracing	N	N		-
d. Horizontal Bracing	N	N		-
e. Fasteners	N	N		-

UNDERMINING (Y/N) If YES please explain: **N**

COLLISION DAMAGE:
None (X) Minor ( ) Moderate ( ) Severe ( )

I-60 (Dive Report): **6** ***I-60 (This Report):*** **6**

93B-U/W (DIVE) Insp **08/01/2017**

X=UNKNOWN N=NOT APPLICABLE H=HIDDEN/INACCESSIBLE R=REMOVED

CITY/TOWN	B.I.N.	BR. DEPT. NO.	8.-STRUCTURE NO.	INSPECTION DATE
HAVERHILL	30F	H-12-011	H12011-30F-DOT-NBI	JUL 22, 2020

ITEM 61 — CHANNEL & CHANNEL PROTECTION — 6

	Dive	Cur	DEF
1.Channel Scour	7	H	-
2.Embankment Erosion	6	6	M-P
3.Debris	7	6	M-P
4.Vegetation	7	7	-
5.Utilities	X	N	-
6.Rip-Rap/Slope Protection	6	6	M-P
7.Aggradation	7	5	S-A
8.Fender System	N	N	-

STREAM FLOW VELOCITY:
Tidal ( ) High ( ) Moderate ( ) Low (X) None ( )

ITEM 61 (Dive Report): 6 *ITEM 61 (This Report):* 6

93b-U/W INSP. DATE: 08/01/2017

ITEM 36 — *TRAFFIC SAFETY*

	36	COND	DEF
A. Bridge Railing	0	6	M-P
B. Transitions	0	7	-
C. Approach Guardrail	0	7	S-A
D. Approach Guardrail Ends	0	N	-

WEIGHT POSTING

Not Applicable X

	H	3	3S2	Single
Actual Posting	N	N	N	N
Recommended Posting	N	N	N	N

Waived Date: 00/00/0000 EJDMT Date: 00/00/0000

Signs In Place (Y=Yes,N=No, NR=NotRequired) Legibility/ Visibility	At bridge E	At bridge W	Other Advance E	Other Advance W

CLEARANCE POSTING

Not X

	N ft	N in	S ft	S in	meter
Actual Field Measurement		0		0	
Posted Clearance		0		0	

Signs In Place (Y=Yes,N=No, NR=Not Required) Legibility/ Visibility	At bridge N	At bridge S	Advance N	Advance S

ACCESSIBILITY (Y/N/P)

	Needed	Used
Lift Bucket	N	N
Ladder	N	N
Boat	P	N
Waders	Y	Y
Inspector 50	N	N
Rigging	N	N
Staging	N	N
Traffic Control	N	N
RR Flagger	N	N
Police	N	N
Other:		
	N	N

TOTAL HOURS 24

PLANS (Y/N): Y

(V.C.R.) (Y/N): N

TAPE#:

List of field tests performed:

RATING

Rating Report (Y/N): Y

Date: 03/01/2015

Inspection data at time of existing rating

I 58: - I 59: 6 I 60: 6 Date : 07/08/2014

Recommend for Rating or Rerating (Y/N): N

If YES please give priority: HIGH ( ) MEDIUM ( ) LOW ( )

REASON:

CONDITION RATING GUIDE (For Items 58, 59, 60 and 61)

	CODE	CONDITION	DEFECTS
	N	NOT APPLICABLE	
G	9	EXCELLENT	Excellent condition.
G	8	VERY GOOD	No problem noted.
G	7	GOOD	Some minor problems.
F	6	SATISFACTORY	Structural elements show some minor deterioration.
F	5	FAIR	All primary structural elements are sound but may have minor section loss, cracking, spalling or scour.
P	4	POOR	Advanced section loss, deterioration, spalling or scour.
P	3	SERIOUS	Loss of section, deterioration, spalling or scour have seriously affected primary structural components. Local failures are possible. Fatigue cracks in steel or shear cracks in concrete may be present.
C	2	CRITICAL	Advanced deterioration of primary structural elements. Fatigue cracks in steel or shear cracks in concrete may be present or scour may have removed substructure support. Unless closely monitored it may be necessary to close the bridge until corrective action is taken.
C	1	"IMMINENT" FAILURE	Major deterioration or section loss present in critical structural components or obvious vertical or horizontal movement affecting structure stablility. Bridge is closed to traffic but corrective action may put it back in light service.
	0	FAILED	Out of service - beyond corrective action.

DEFICIENCY REPORTING GUIDE

DEFICIENCY: A defect in a structure that requires corrective action.

CATEGORIES OF DEFICIENCIES:

M= Minor Deficiency - Deficiencies which are minor in nature, generally do not impact the structural integrity of the bridge and could easily be repaired. Examples include but are not limited to: Spalled concrete, Minor pot holes, Minor corrosion of steel, Minor scouring, Clogged drainage, etc.

S= Severe/Major Deficiency - Deficiencies which are more extensive in nature and need more planning and effort to repair. Examples include but are not limited to: Moderate to major deterioration in concrete, Exposed and corroded rebars, Considerable settlement, Considerable scouring or undermining, Moderate to extensive corrosion to structural steel with measurable loss of section, etc.

C-S= Critical Structural Deficiency - A deficiency in a structural element of a bridge that poses an extreme unsafe condition due to the failure or imminent failure of the element which will affect the structural integrity of the bridge.

C-H= Critical Hazard Deficiency - A deficiency in a component or element of a bridge that poses an extreme hazard or unsafe condition to the public, but does not impair the structural integrity of the bridge. Examples include but are not limited to: Loose concrete hanging down over traffic or pedestrians, A hole in a sidewalk that may cause injuries to pedestrians, Missing section of bridge railing, etc.

URGENCY OF REPAIR:

I = Immediate- [Inspector(s) immediately contact District Bridge Inspection Engineer (DBIE) to report the Deficiency and to receive further instruction from him/her].

A = ASAP- [Action/Repair should be initiated by District Maintenance Engineer or the Responsible Party (if not a State owned bridge) upon receipt of the Inspection Report].

P = Prioritize- [Shall be prioritized by District Maintenance Engineer or the Responsible Party (if not a State owned bridge) and repairs made when funds and/or manpower is available].

CITY/TOWN	B.I.N.	BR. DEPT. NO.	8.-STRUCTURE NO.	INSPECTION DATE
HAVERHILL	**30F**	**H-12-011**	**H12011-30F-DOT-NBI**	**JUL 22, 2020**

REMARKS

BRIDGE ORIENTATION
The single span carries ST 97/Winter Street over the Little River, which flows from north to south. The abutments and approaches are labeled as West and East.

GENERAL REMARKS
The bridge is a stone masonry arch supported by stone masonry abutments with a gunite coating throughout the underside of the arch.

There is a dam that controls the water flow approximately 50 feet north of the bridge.

There is an abandoned mill raceway arch culvert located on the east side of the bridge which is not part of the main structure and is not included in this inspection report.

District 4 Bridge Section was contacted regarding a loose fence in the southeast approach corner, which does not appear to be part of the bridge design plans. See Item 36c - Approach Guardrail.

ITEM 58 - DECK

Item 58.1 - Wearing Surface
Both travel lanes have moderate cracking, up to 1" wide, and deteriorating pavement with depression areas throughout. **See photos 1-3.**

The westbound lane has several potholes and depression areas along the edge of a bituminous patch adjacent to the north curb, which extends into the west approach roadway. **See photos 2 & 3.**

Item 58.4 - Curbs
Both curbs and wheel guards have areas of moderate cracking and spalling along the full length, up to 3" deep, with exposed rebar. **See photos 4 & 5.**

Both curbs and wheel guards have several areas that show signs of minor settlement.

The north curb has vertical misalignment between sections at the west end, full height x 1" misalignment.

Item 58.6 - Sidewalks
Both sidewalks have vegetation and debris along both edges. **See photo 5.**

Both sidewalks have random transverse hairline cracks.

The north sidewalk has a piece of rebar sticking out at the west end adjacent to the wheel guard.

Item 58.8 - Railing
Both bridge rails have areas of paint peeling, minor rust, and random damaged vertical pickets. **See photo 6.**

Both bridge rails have random vertical hairline cracks and areas of minor delamination throughout the concrete bases.

The north rail base has minor spalling along the top edge at the east end, 6' wide x up to 2" high x 1" deep.

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HAVERHILL	**30F**	**H-12-011**	**H12011-30F-DOT-NBI**	**JUL 22, 2020**

REMARKS

Item 58.12 - Utilities
At the south elevation, all steel support brackets have areas of minor rust.

The water main pipe has areas of rust throughout.

APPROACHES

Approaches a - Appr. Pavement Condition
Both approach roadways have areas of moderate cracking, up to 1/2" wide, and deteriorating pavement throughout.

The west approach has several potholes along the edge of a bituminous patch adjacent to the south curb.

The east approach has several potholes along the edge of a bituminous patch extending from the wearing surface of the main structure adjacent to the north curb. **See photo 2.**

Approaches b - Appr. Roadway Settlement
The east approach has a settlement area adjacent to the catch basin and the north curb, up to 3” settlement.

ITEM 59 - SUPERSTRUCTURE

Item 59.1 - Arch/Arch Ring
The arch underside has hairline cracking, efflorescence, dampness, and signs of leakage throughout the gunite encasement of the masonry arch. **See photo 7.**

At 10' from the south edge, the gunite encasement has failed along the full length of the arch exposing void areas between the masonry stones. **See photos 8 & 9.**

Near mid-length, there is a void area adjacent to the west abutment for a drainage pipe.

At both elevations, the masonry joint between the arch and spandrel walls is missing mortar and chinking stones creating void areas, which area filled with vegetation at several locations.

Item 59.2 - Keystone Area
See Item 59.1 - Arch/Arch Ring.

Item 59.5 - Spandrel Walls
Both spandrel walls have void areas filled with vegetation due to missing mortar.

Item 59.10 - Masonry Joints
See Item 59.1 - Arch/Arch Ring.

Item 59.16 - Gunite Encasing
See Item 59.1 - Arch/Arch Ring.

ITEM 60 - SUBSTRUCTURE

Item 60.1 - Abutments
Item 60.1.d - Breastwalls
For underwater details, refer to the Routine Underwater Inspection Report dated 08/01/2017.

CITY/TOWN	B.I.N.	BR. DEPT. NO.	8.-STRUCTURE NO.	INSPECTION DATE
HAVERHILL	**30F**	**H-12-011**	**H12011-30F-DOT-NBI**	**JUL 22, 2020**

REMARKS

Item 60.1.e - Wingwalls
All four wingwalls/retaining walls have numerous void areas, displaced blocks, and missing chinking stones. **See photos 10 & 11.**

The northwest wingwall has a misaligned concrete cap with the arch, up to 1' gap. The filler material behind the cap is eroding. **See photo 12.**

Item 60.1.g - Pointing
For underwater details, refer to the Routine Underwater Inspection Report dated 08/01/2017.

Item 60.1.h - Footings
For underwater details, refer to the Routine Underwater Inspection Report dated 08/01/2017.

Item 60.1.j - Scour
For underwater details, refer to the Routine Underwater Inspection Report dated 08/01/2017.

ITEM 61 - CHANNEL AND CHANNEL PROTECTION

Item 61.1 - Channel Scour
For underwater details, refer to the Routine Underwater Inspection Report dated 08/01/2017.

Item 61.2 - Embankment Erosion
The southwest embankment has washout areas and areas of undercutting. **See photo 13.**

For underwater details, refer to the Routine Underwater Inspection Report dated 08/01/2017.

Item 61.3 - Debris
There is random minor debris throughout the upstream and downstream of the channel.

Item 61.6 - Rip-Rap/Slope Protection
There are several loose stones displaced from the southwest retaining wall.

For underwater details, refer to the Routine Underwater Inspection Report dated 08/01/2017.

Item 61.7 - Aggradation
There is moderate aggradation across the full width of the channel in the downstream end. **See photos 14-16.**

The upstream of the channel has an area of moderate aggradation adjacent to the northeast retaining wall. **See photo 17.**

For underwater details, refer to the Routine Underwater Inspection Report dated 08/01/2017.

TRAFFIC SAFETY

Item 36a - Bridge Railing
Both bridge rails consist of Type H railing. See Item 58.8 - Railing.

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HAVERHILL	**30F**	**H-12-011**	**H12011-30F-DOT-NBI**	**JUL 22, 2020**

REMARKS

Item 36b - Transitions

The northwest corner has a w-beam panel mounted on steel posts and spacers, not tied to the bridge rail end posts.

There are no transition rails at the remaining corners.

Item 36c - Approach Guardrail

The northwest corner has a w-beam panel mounted on steel posts and spacers.

There are no approach rails at the remaining corners.

The southeast corner has a loose fence, which does not appear to be part of the bridge design plans. The District 4 Bridge Section was contacted regarding the matter. **See photo 18.**

Item 36d - Approach Guardrail Ends

There are no approach rail ends.

Photo Log

Photo 1 : Eastbound travel lane, typical cracking throughout wearing surface.
Photo 2 : Westbound travel lane, patched area extending into the west approach with deteriorating pavement along the edges.
Photo 3 : Westbound travel lane, patched area extending into the west approach with deteriorating pavement along the edges.
Photo 4 : Typical spalling throughout both wheel guards; view of south wheel guard.
Photo 5 : South sidewalk, typical vegetation and debris along the edges.
Photo 6 : South rail, typical paint flaking, minor rust, and random damaged vertical picket.
Photo 7 : Typical arch underside; cracking, efflorescence, and signs of leakage throughout.
Photo 8 : Gunite encasement failure and void area at 10' from the south edge.
Photo 9 : Gunite encasement failure and void area at 10' from the south edge.
Photo 10 : Southwest wingwall, loose and displaced stones.
Photo 11 : Southeast retaining wall, void areas throughout.
Photo 12 : Northwest wingwall, concrete cap misalignment and eroding material.
Photo 13 : Southwest embankment, typical area of undercutting.
Photo 14 : Downstream aggradation.
Photo 15 : Downstream aggradation.
Photo 16 : South elevation, typical aggradation throughout the downstream.
Photo 17 : Upstream aggradation adjacent to the northeast corner.
Photo 18 : Southeast approach area, loose fence.

CITY/TOWN	B.I.N.	BR. DEPT. NO.	8.-STRUCTURE NO.	INSPECTION DATE
HAVERHILL	30F	H-12-011	H12011-30F-DOT-NBI	JUL 22, 2020

PHOTOS

Photo 1: Eastbound travel lane, typical cracking throughout wearing surface.

Photo 2: Westbound travel lane, patched area extending into the west approach with deteriorating pavement along the edges.

CITY/TOWN	B.I.N.	BR. DEPT. NO.	8.-STRUCTURE NO.	INSPECTION DATE
HAVERHILL	**30F**	**H-12-011**	**H12011-30F-DOT-NBI**	**JUL 22, 2020**

PHOTOS

Photo 3: **Westbound travel lane, patched area extending into the west approach with deteriorating pavement along the edges.**

Photo 4: **Typical spalling throughout both wheel guards; view of south wheel guard.**

CITY/TOWN	B.I.N.	BR. DEPT. NO.	8.-STRUCTURE NO.	INSPECTION DATE
HAVERHILL	30F	H-12-011	H12011-30F-DOT-NBI	JUL 22, 2020

PHOTOS

Photo 5: South sidewalk, typical vegetation and debris along the edges.

Photo 6: South rail, typical paint flaking, minor rust, and random damaged vertical picket.

CITY/TOWN	B.I.N.	BR. DEPT. NO.	8.-STRUCTURE NO.	INSPECTION DATE
HAVERHILL	**30F**	**H-12-011**	**H12011-30F-DOT-NBI**	**JUL 22, 2020**

PHOTOS

Photo 7: **Typical arch underside; cracking, efflorescence, and signs of leakage throughout.**

Photo 8: **Gunite encasement failure and void area at 10' from the south edge.**

CITY/TOWN	B.I.N.	BR. DEPT. NO.	8.-STRUCTURE NO.	INSPECTION DATE
HAVERHILL	**30F**	**H-12-011**	**H12011-30F-DOT-NBI**	**JUL 22, 2020**

PHOTOS

Photo 9: Gunite encasement failure and void area at 10' from the south edge.

Photo 10: Southwest wingwall, loose and displaced stones.

CITY/TOWN	B.I.N.	BR. DEPT. NO.	8.-STRUCTURE NO.	INSPECTION DATE
HAVERHILL	**30F**	**H-12-011**	**H12011-30F-DOT-NBI**	**JUL 22, 2020**

PHOTOS

Photo 11: Southeast retaining wall, void areas throughout.

Photo 12: Northwest wingwall, concrete cap misalignment and eroding material.

CITY/TOWN	B.I.N.	BR. DEPT. NO.	8.-STRUCTURE NO.	INSPECTION DATE
HAVERHILL	30F	H-12-011	H12011-30F-DOT-NBI	JUL 22, 2020

PHOTOS

Photo 13: Southwest embankment, typical area of undercutting.

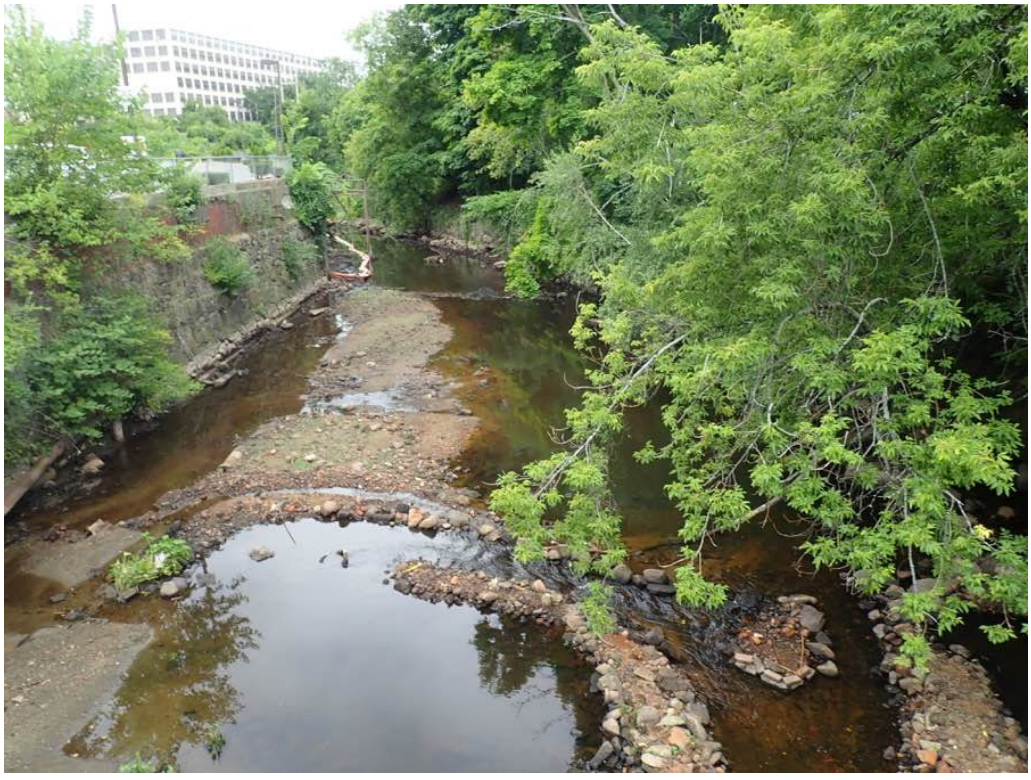


Photo 14: Downstream aggradation.

CITY/TOWN	B.I.N.	BR. DEPT. NO.	8.-STRUCTURE NO.	INSPECTION DATE
HAVERHILL	**30F**	**H-12-011**	**H12011-30F-DOT-NBI**	**JUL 22, 2020**

PHOTOS

Photo 15: Downstream aggradation.

Photo 16: South elevation, typical aggradation throughout the downstream.

CITY/TOWN	B.I.N.	BR. DEPT. NO.	8.-STRUCTURE NO.	INSPECTION DATE
HAVERHILL	30F	H-12-011	H12011-30F-DOT-NBI	JUL 22, 2020

PHOTOS

Photo 17: Upstream aggradation adjacent to the northeast corner.

Photo 18: Southeast approach area, loose fence.

2-DIST	B.I.N.
04	30F

UNDERWATER OPERATIONS TEAM
ROUTINE UNDERWATER INSPECTION REPORT

BR. DEPT. NO.: H-12-011

CITY/TOWN	8-STRUCTURE NO.	LEVEL OF INSPECTION	93B-DATE INSPECTED
HAVERHILL	H12011-30F-DOT-NBI	II	AUG 11, 2020

07-FACILITY CARRIED	ACCESS TO BRIDGE	UNDERWATER OPERATIONS ENGINEER
ST 97 WINTER ST	EMBANKMENT	RANDI E. BONICA

06-FEATURES INTERSECTED	DEPTH	VISIBILITY	TEAM LEADER (DIVE MASTER)	*Report submitted by:*
WATER LITTLE RIVER	1.5 m	1 m	WILLIAM J. COLLERAN	

BOTTOM CONDITION	CURRENT	TEAM MEMBERS
COBBLES, SAND & BOULDERS	SLIGHT	B. FITZGERALD, G. BROZ, R. E. BONICA, Z. GIKAS

ITEM 60 *SUBSTRUCTURE* — 6

		DEF
1. Abutments	6	
a. Pedestals	N	-
b. Bridge Seats	N	-
c. Backwalls	N	-
d. Breastwalls	6	-
e. Wingwalls	N	-
f. Slope Paving/Rip-Rap	N	-
g. Pointing	6	M-P
h. Footings	N	-
i. Piles	N	-
j. Scour	7	-
k. Settlement	7	-
l.	N	-
2. Piers or Bents	N	
a. Pedestals	N	-
b. Caps	N	-
c. Columns	N	-
d. Stems/Webs/Pierwalls	N	-
e. Pointing	N	-
f. Footing	N	-
g. Piles	N	-
h. Scour	N	-
i. Settlement	N	-
j.	N	-
k.	N	-
3. Pile Bents	N	
a. Pile Caps	N	-
b. Piles	N	-
c. Diagonal Bracing	N	-
d. Horizontal Bracing	N	-
e. Fasteners	N	-
UNDERMINING (Y/N)		N

ITEM 61 *CHANNEL & CHANNEL PROTECTION* — 6

		DEF
1. Channel Scour	7	-
2. Embankment Erosion	6	-
3. Debris	7	-
4. Vegetation	7	-
5. Utilities	N	-
6. Rip-Rap/Slope Protection	6	-
7. Aggradation	7	-
8. Fender System	N	-
a. Piles	N	-
b. Diagonal Bracing	N	-
c. Horizontal Bracing	N	-
d. Wales	N	-
e. Fasteners	N	-
f. Ladders	N	-
9.	N	-

ITEM 59 *SUPERSTRUCTURE*

		DEF
1. Arch/Arch Ring	7	-
6. Spring Lines	7	-
	N	-

ITEM 62 *CULVERTS* — N

		DEF
1. Roof	N	-
2. Floor	N	-
3. Walls	N	-
4. Headwall	N	-
5. Wingwall	N	-
6. Pipe	N	-
7. Protective Coating	N	-
8. Embankment	N	-
9. Wearing Surface	N	-
10. Railing	N	-
11. Sidewalks	N	-
12. Utilities	N	-
13. Member Alignment	N	-
14. Deformation	N	-
15. Scour	N	-
16. Settlement	N	-
17.	N	-
18.	N	-
UNDERMINING (Y/N)		N

DEFICIENCY REPORTING GUIDE

DEFICIENCY: A defect in a structure that requires corrective action.

CATEGORIES OF DEFICIENCIES:

M= Minor Deficiency- - Deficiencies which are minor in nature, generally do not impact the structural integrity of the bridge and could easily be repaired. Examples include but are not limited to: Spalled concrete, Minor scouring, etc.

S= Severe/Major Deficiency- Deficiencies which are more extensive in nature and need more planning and effort to repair. Examples include but are not limited to: Moderate to major deterioration in concrete, Exposed and corroding rebars, Deteriorated timber piles, Considerable settlement, Considerable scouring or undermining, etc.

C-S= Critical Structural Deficiency- A deficiency in a structural element of a bridge that poses an extreme unsafe condition due to the failure or imminent failure of the element which will affect the structural integrity of the bridge.

C-H= Critical Hazard Deficiency- A deficiency in a component or element of a bridge that poses an extreme hazard or unsafe condition to the public, but does not impair the structural integrity of the bridge. Examples include but are not limited to: Any part of piles or fender system which are projecting outward and may become a safety hazard for the navigational traffic, etc.

URGENCY OF REPAIR:

I=Immediate- [Inspector(s) immediately contact District Bridge Inspection Engineer (DBIE) to report the Deficiency and to receive further instruction from him/her.]

A=ASAP- [Action/Repair should be initiated by District Maintenance Engineer or the responsible party (if not a State owned bridge) upon receipt of the Inspection Report.]

P=Prioritize- [Shall be prioritized by District Maintenance Engineer or the Responsible Party (if not a State owned bridge) and repairs made when funds and/or manpower is available.]

X=UNKNOWN **N=NOT APPLICABLE** **H=HIDDEN/INACCESSIBLE** **R=REMOVED**

CITY/TOWN	B.I.N.	BR. DEPT. NO.	8.-STRUCTURE NO.	INSPECTION DATE
HAVERHILL	**30F**	**H-12-011**	**H12011-30F-DOT-NBI**	**AUG 11, 2020**

REMARKS

GENERAL REMARKS

This bridge consists of two granite arches. The arch on the left side of the channel (facing downstream) has little flow and does not require an underwater inspection. This arch does not have a Bridge Number. The span width is 14'. There is 13' between the arches. The upstream end of the left arch is under a building. The arch on the right side has a 30' span width and is constructed of granite blocks with sprayed gunite throughout the intrados. The Structure Inventory and Analysis Report says that the bridge is a single span structure.

1) Orientation - Abutments are labeled left and right when facing downstream.
2) Sta 10+00 is at the downstream end, Sta 10+65 is the upstream end.
3) There is a dam 50' upstream of the bridge.

ITEM 59 - SUPERSTRUCTURE

Item 59.1 - Arch/Arch Ring

There is a maximum joint penetration of 2.5' in the sections of the arch that are below the waterline. There is some cracking along granite joints and loss of gunite in the intrados, toward the downstream end. The gunite stops 1.5' below the waterline.

Left Abutment:

At Sta 10+33 there is a formed opening at the waterline measuring 2.6' Long and 2.0' High. There is a 1/8" wide crack in the block below the opening.

Right Abutment:

At Sta 10+08 there is a formed opening above the springline measuring 2.2' Long and 1.6' High.

ITEM 60 - SUBSTRUCTURE

Item 60.1 - Abutments

Item 60.1.d - Breastwalls

Left Abutment:

At Sta 10+54 there is a void 1.6' below the springline measuring 4.6' Long, 0.8' High and 2.3' Penetration.

Item 60.1.g - Pointing

Right Abutment:

The maximum joint penetration is 2.5'.

Left Abutment:

The maximum joint penetration is 2.0'.

Item 60.1.i - Piles

The abutments are not pile supported according to available plans.

ITEM 61 - CHANNEL AND CHANNEL PROTECTION

Item 61.2 - Embankment Erosion

At the downstream right corner of the bridge there is a partially collapsed retaining wall with some slope erosion and minor undercutting of trees.

CITY/TOWN	B.I.N.	BR. DEPT. NO.	8.-STRUCTURE NO.	INSPECTION DATE
HAVERHILL	**30F**	**H-12-011**	**H12011-30F-DOT-NBI**	**AUG 11, 2020**

REMARKS

Item 61.4 - Vegetation

There is some small vegetation growing in the joints at the upstream and downstream ends of the bridge.

Item 61.6 - Rip-Rap/Slope Protection

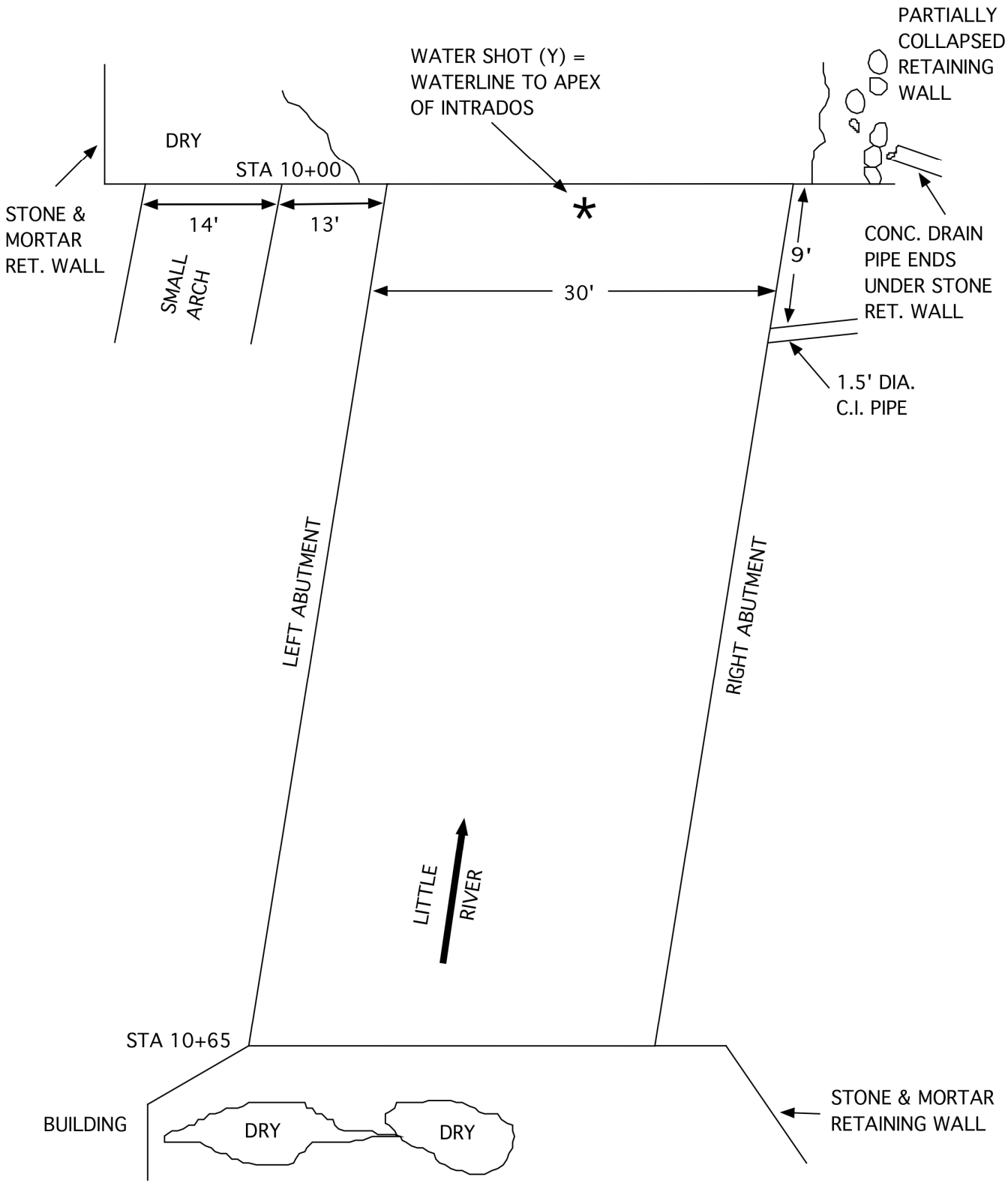
At the downstream right corner of the bridge there is a partially collapsed retaining wall with some slope erosion.

Sketch / Chart Log

Sketch 1 : PLAN VIEW - NOT TO SCALE
Chart 1 : SCOUR MONITORING CHART AT UPSTREAM END (STA 10+65)

CITY/TOWN	B.I.N.	BR. DEPT. NO.	8.-STRUCTURE NO.	INSPECTION DATE
HAVERHILL	**30F**	**H-12-011**	**H12011-30F-DOT-NBI**	**AUG 11, 2020**

SKETCHES



Sketch 1: PLAN VIEW - NOT TO SCALE

CITY/TOWN	B.I.N.	BR. DEPT. NO.	8.-STRUCTURE NO.	INSPECTION DATE
HAVERHILL	**30F**	**H-12-011**	**H12011-30F-DOT-NBI**	**AUG 11, 2020**

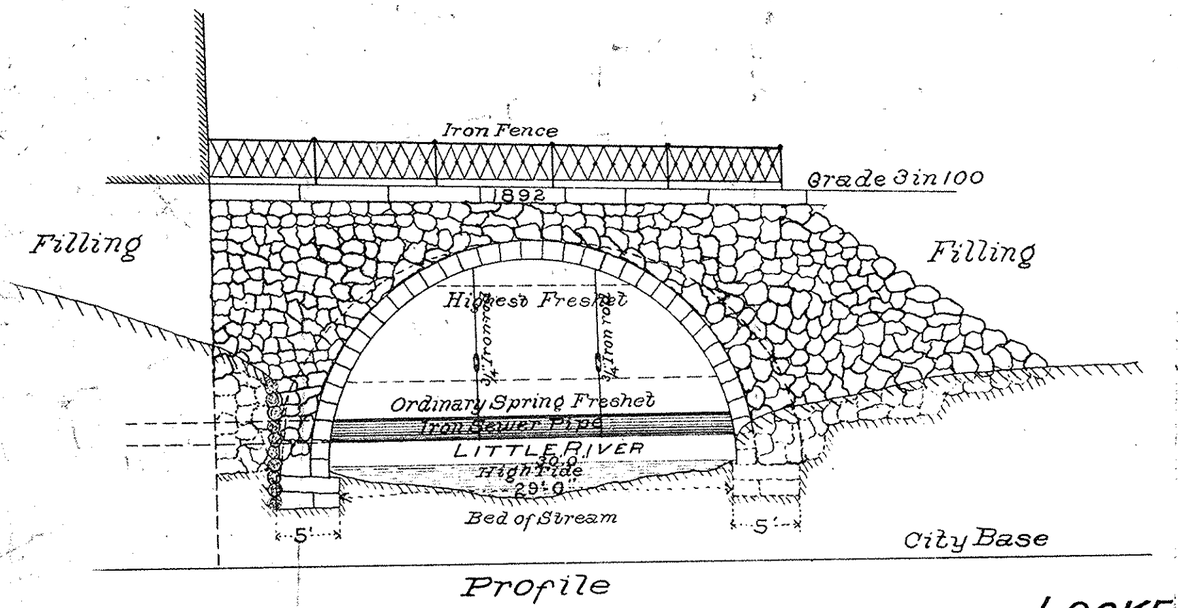
CHARTS

	6/22/90	8/12/93	8/14/96	7/30/99	8/6/02	8/31/05	8/7/08	8/11/11	7/29/14
LEFT ABUTMENT	3.0'	3.4'	3.1'	3.5'	3.3'	3.7'	3.5'	2.5'	3.2'
C/L SPAN	3.5'	3.4'	3.5'	4.9'	4.9'	4.9'	5.0'	4.8'	5.2'
RIGHT ABUTMENT	1.8'	1.8'	1.4'	2.3'	2.0'	2.1'	2.4'	1.9'	2.1'
Y	10.3'	10.3'	10.2'	10.2'	10.2'	10.0'	8.2'	9.6'	9.4'
CORRECTION FACTOR	-	-	-0.1'	-0.1'	-0.1'	-0.3'	-2.1'	-0.7'	-0.9'

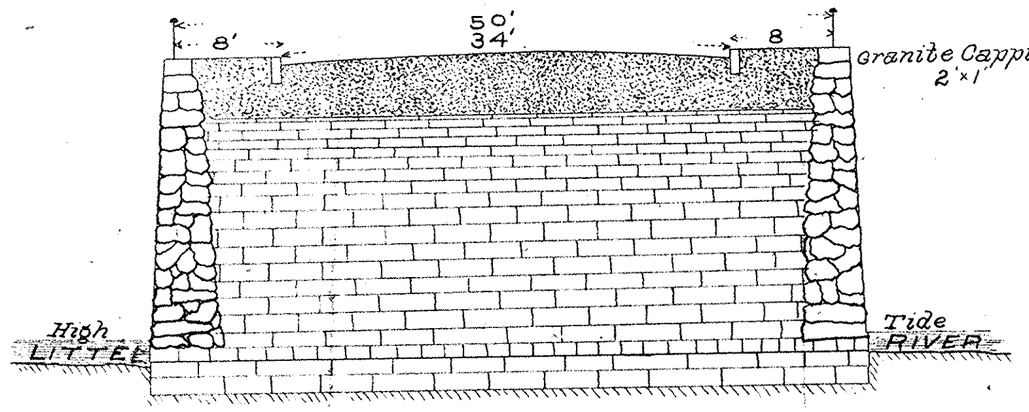
	8/1/17	8/11/20							
LEFT ABUTMENT	3.0'	3.4'							
C/L SPAN	5.2'	5.3'							
RIGHT ABUTMENT	2.4'	2.3'							
Y	9.9'	10.3'							
CORRECTION FACTOR	-0.4'	-							

NOTES:
1. WATER SHOT (Y) = WATERLINE TO APEX OF INTRADOS AT DOWNSTREAM END.
2. SOUNDINGS ADJUSTED TO 6/22/90 WATERLINE WITH CORRECTION FACTOR.
3. STA 10+00 IS AT THE DOWNSTREAM END.

Chart 1: SCOUR MONITORING CHART AT UPSTREAM END (STA 10+65)



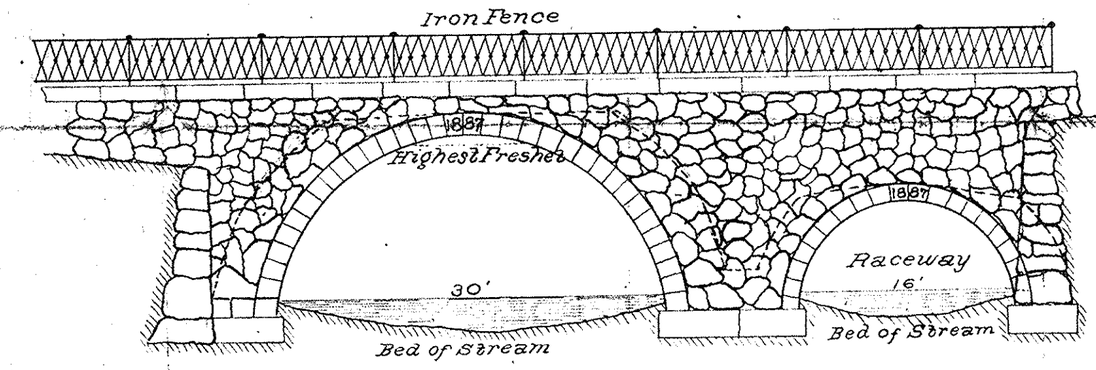
Profile



Cross Section

LOCKE ST. BRIDGE

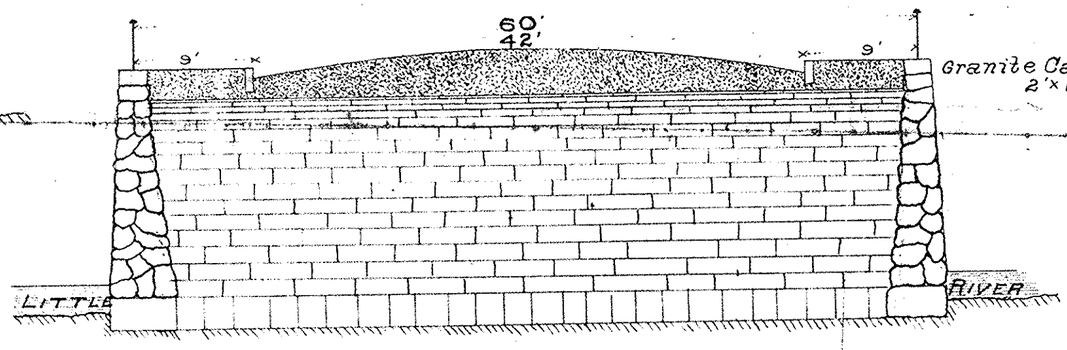
Cost $5475



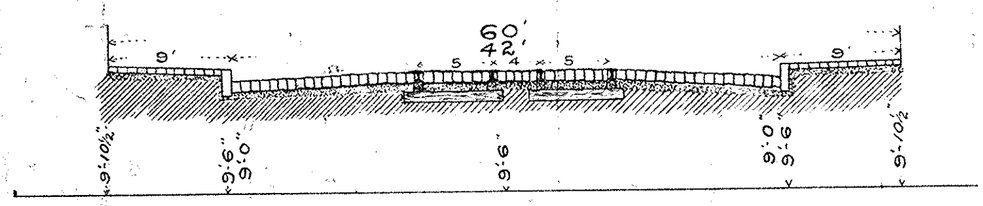
Profile

WINTER ST. BRIDGE

Cost $8950

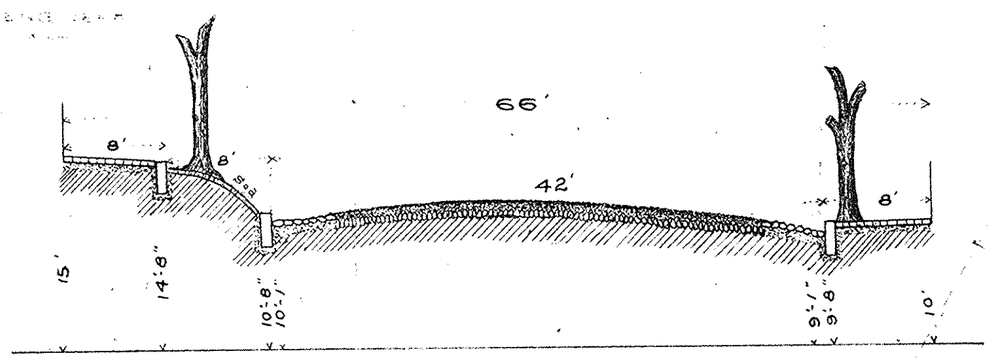


Cross Section



Cross Section of
RIVER ST.

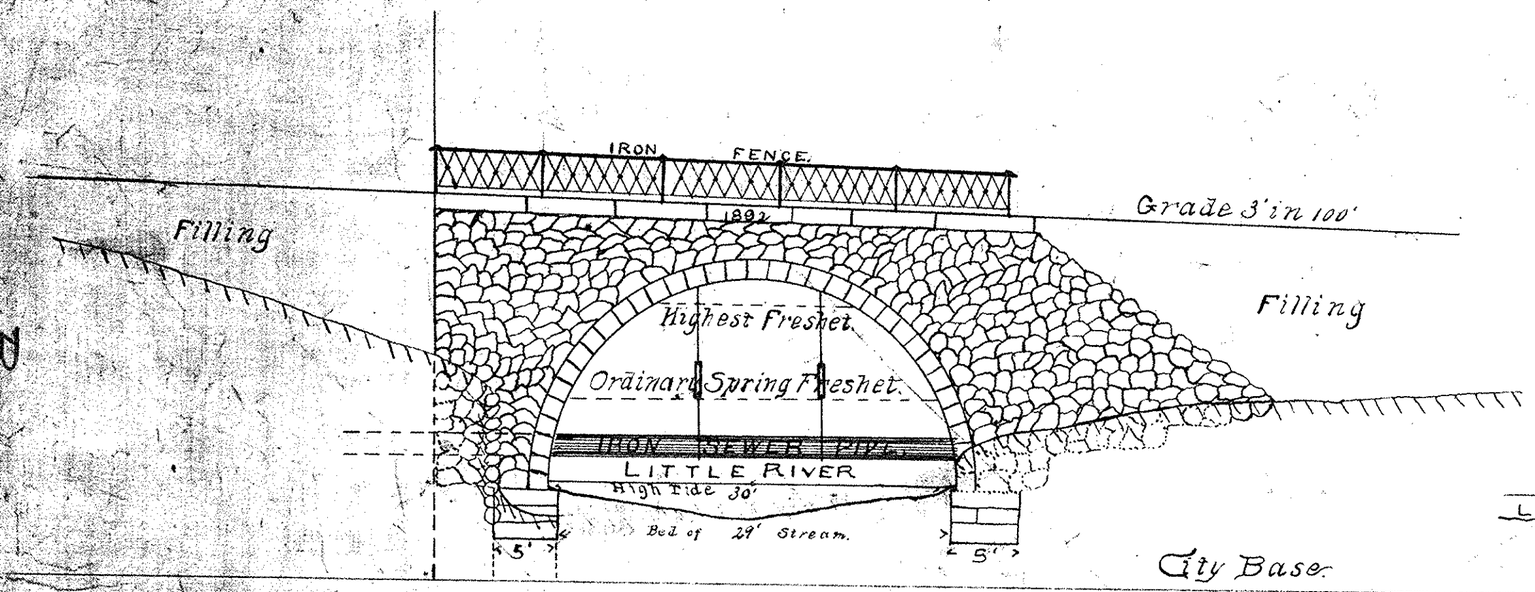
Scales 10 Ft = 1 Inch.



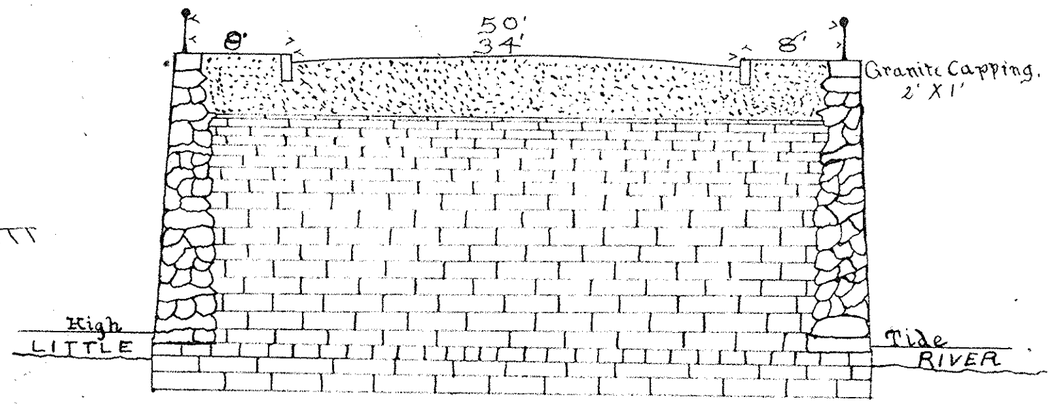
Cross Section of
SUMMER ST.

H 12-11

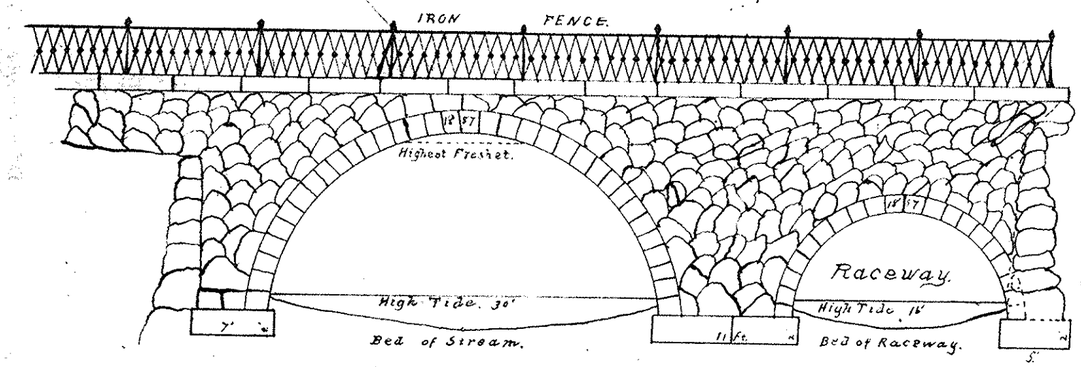
SEC. PLAN



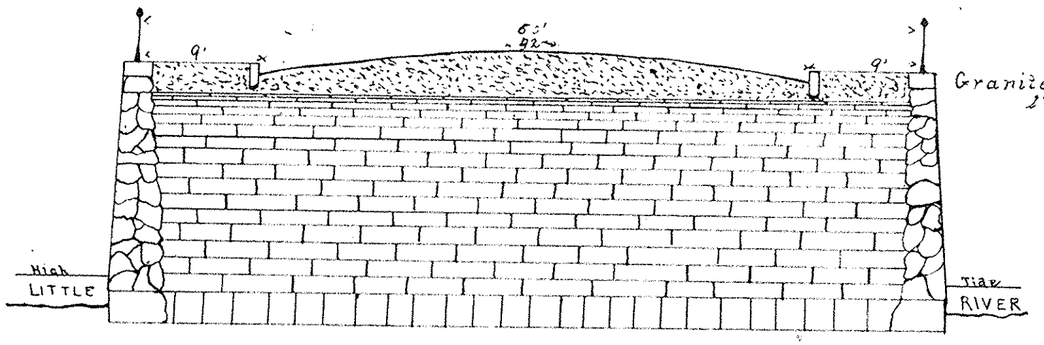
Profile of
Locke Street Bridge.



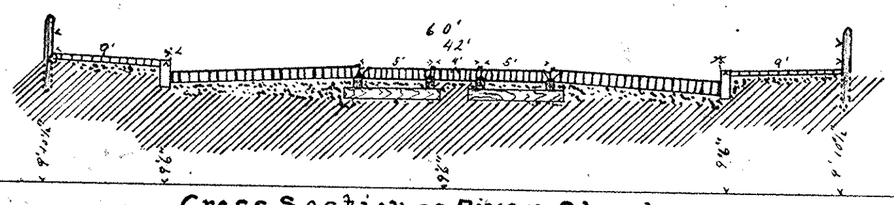
Cross Section of St. at Bridge.



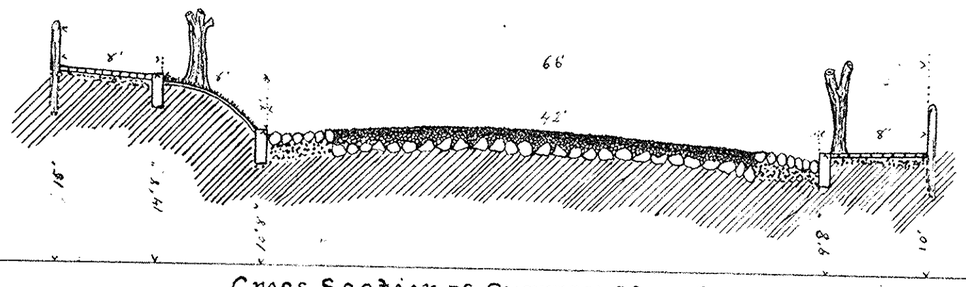
Profile of Winter Street Bridge.



Cross Section of St. at Bridge.



Cross Section of River Street.

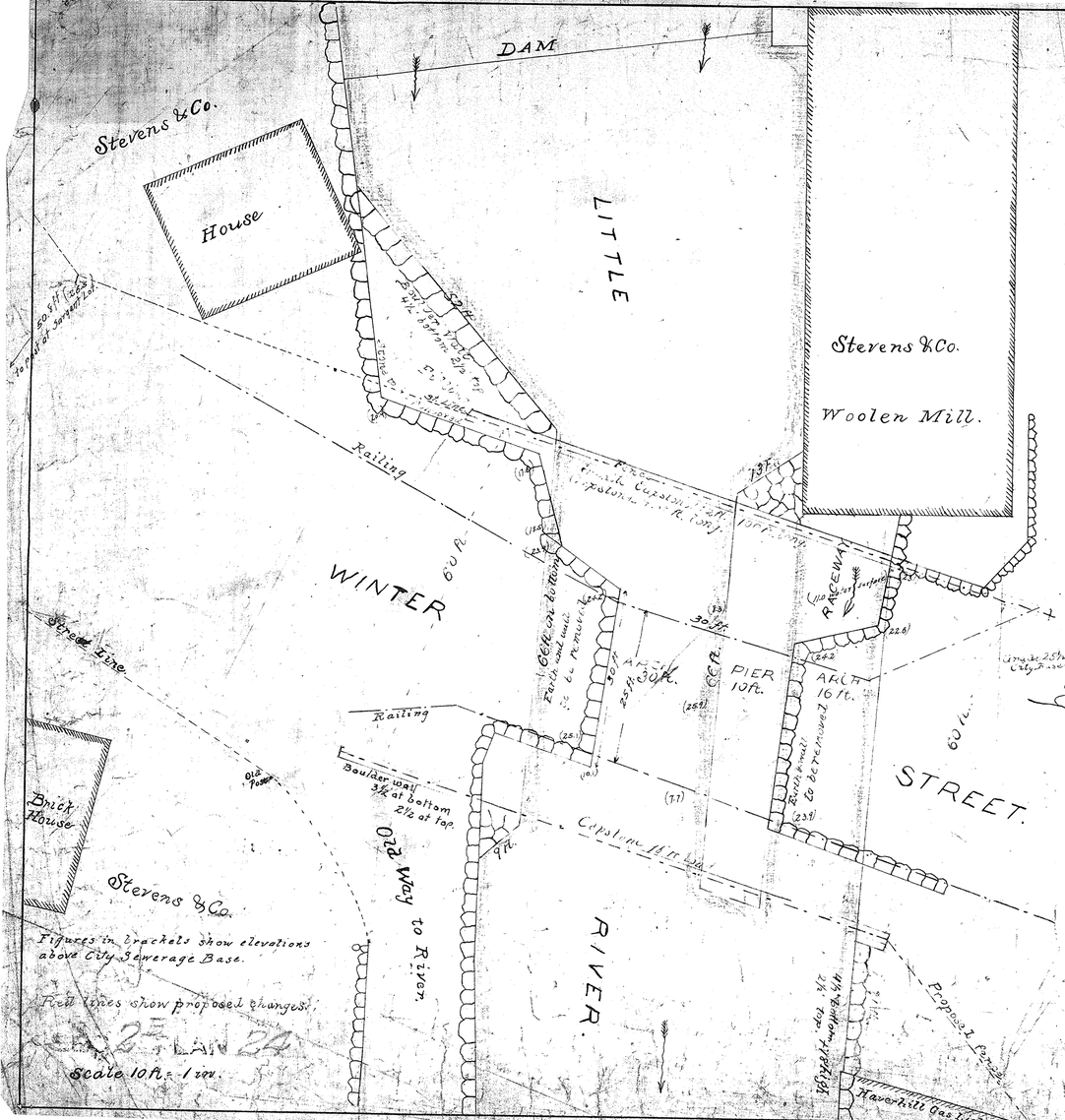


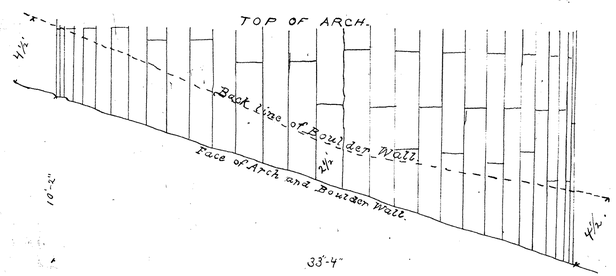
Cross Section of Summer Street.

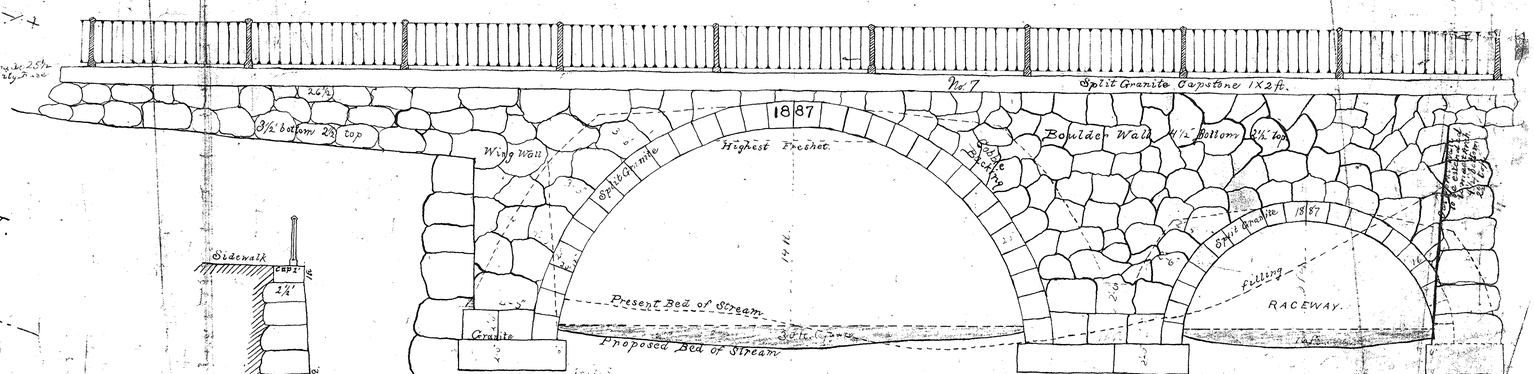
H 12-11

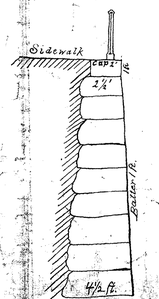
PLAN
OF PROPOSED
WINTER ST. BRIDGE
Haverhill, Mass.
June, 1887.
Copied Sept. 1893.
John T. Desmond, City Engr.

OFFICE OF CITY ENGINEER
HAVERHILL, MASS.







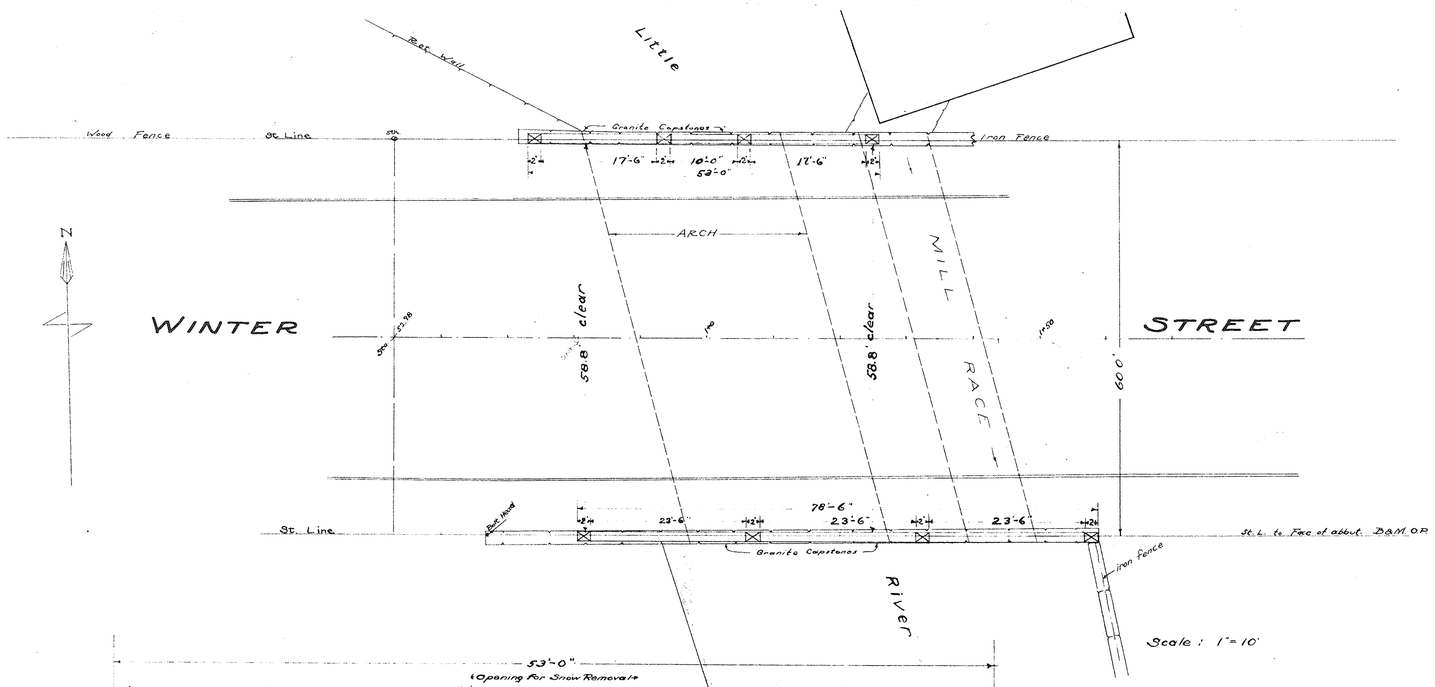


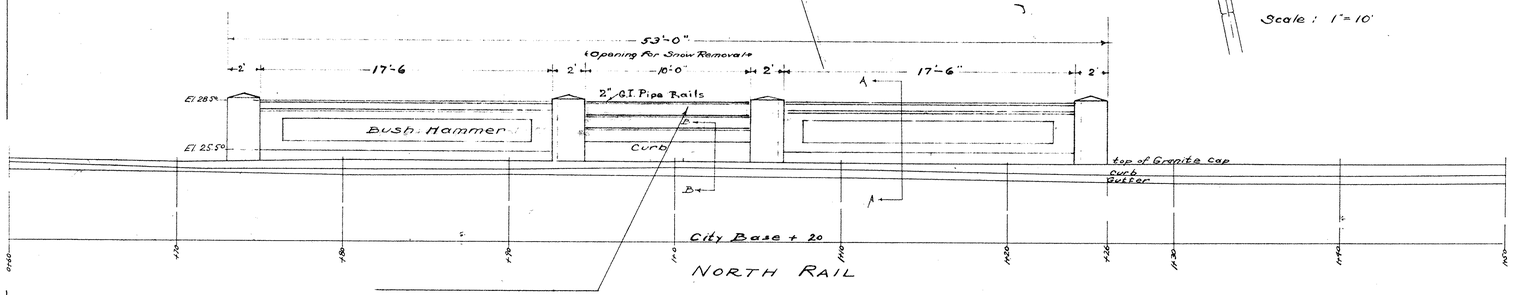
Section of Boulder Wall.

SOUTH ELEVATION. Scale ¼" = 1ft.

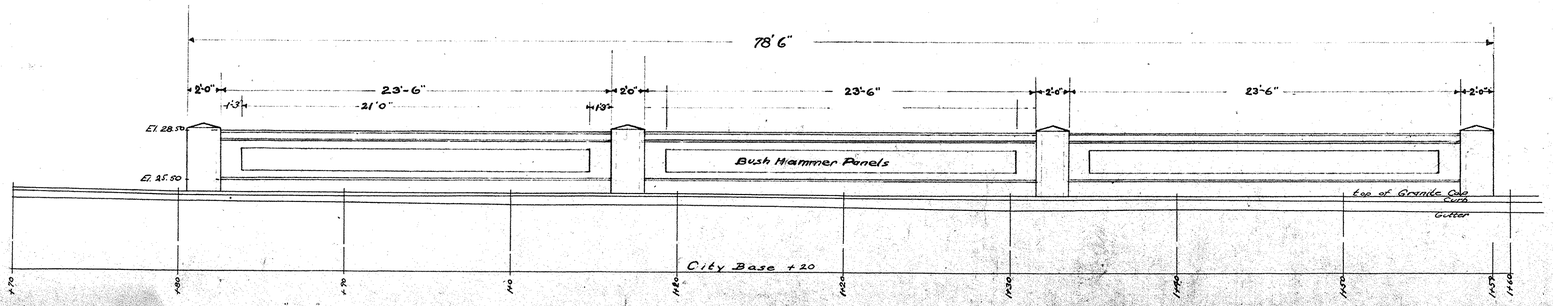
H 12-11

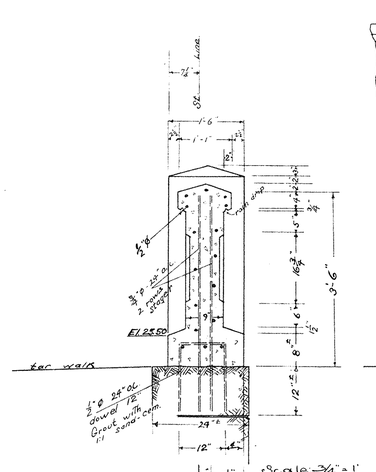
228



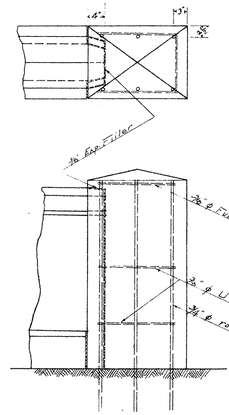


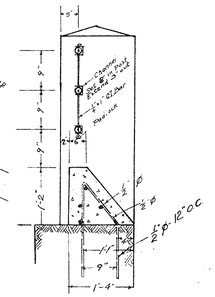
Scale : 1"= 4'





SECTION A-A





SECTION B-B

PROPOSED BRIDGE RAIL
WINTER STREET BRIDGE
HAVERHILL, MASS.

Louis C. Lawton City Eng. Oct 1935

Scales as Shown

ESTIMATED QUANTITIES

Concrete base	117.5'	= 4.9 C.Y.
Posts	8 @ .444	= 3.6 C.Y.
Rail	107.5'	
		TOTAL ~~17~~ 8.5 C.Y.
Steel Reinforcment		2280 lbs.
Iron Grill Fence Removal		134/67 Ft.
Present Tar Walk Removal		132 S.F.

Size	Desc.	L	No.	Wt.
½ ø	Stir.	3'-10"	53	204#
⅝ ø	Str.	24'-6"	49	1132
⅝ ø	Str.	18'-5"	32	576
¾ ø	Str.	7'-11"	4	40'
¾ ø	[20	5'-8"	8	45'
¾ ø	[20	4'-6"	6	27'
¾ ø	[20	3'-11"	9	35'
				2079 · 668 = 1392
¾" ø	Str.	4'-3"	183	455
¾" ø	Str.	4'-9"	98	228
				683, 1502, 1025#

Total Wt of Steel 2917#

Drill in Granite 12" x 1¼" = 276 lbs.

Expansion Filler to be aproved by Engineer in ch.

No Conc. shall be puured when temp. is below 40° F.

H12-11

1197

SEC 2 PLAN

Sediment Sampling Report Compilation

Little River Dam Removal

Haverhill, MA

February, 2024

1550 Main Street, Suite 400
Springfield, MA 01103

20170390.U40

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Sediment Sampling Report Compilation
Little River Dam Removal, Haverhill, MA

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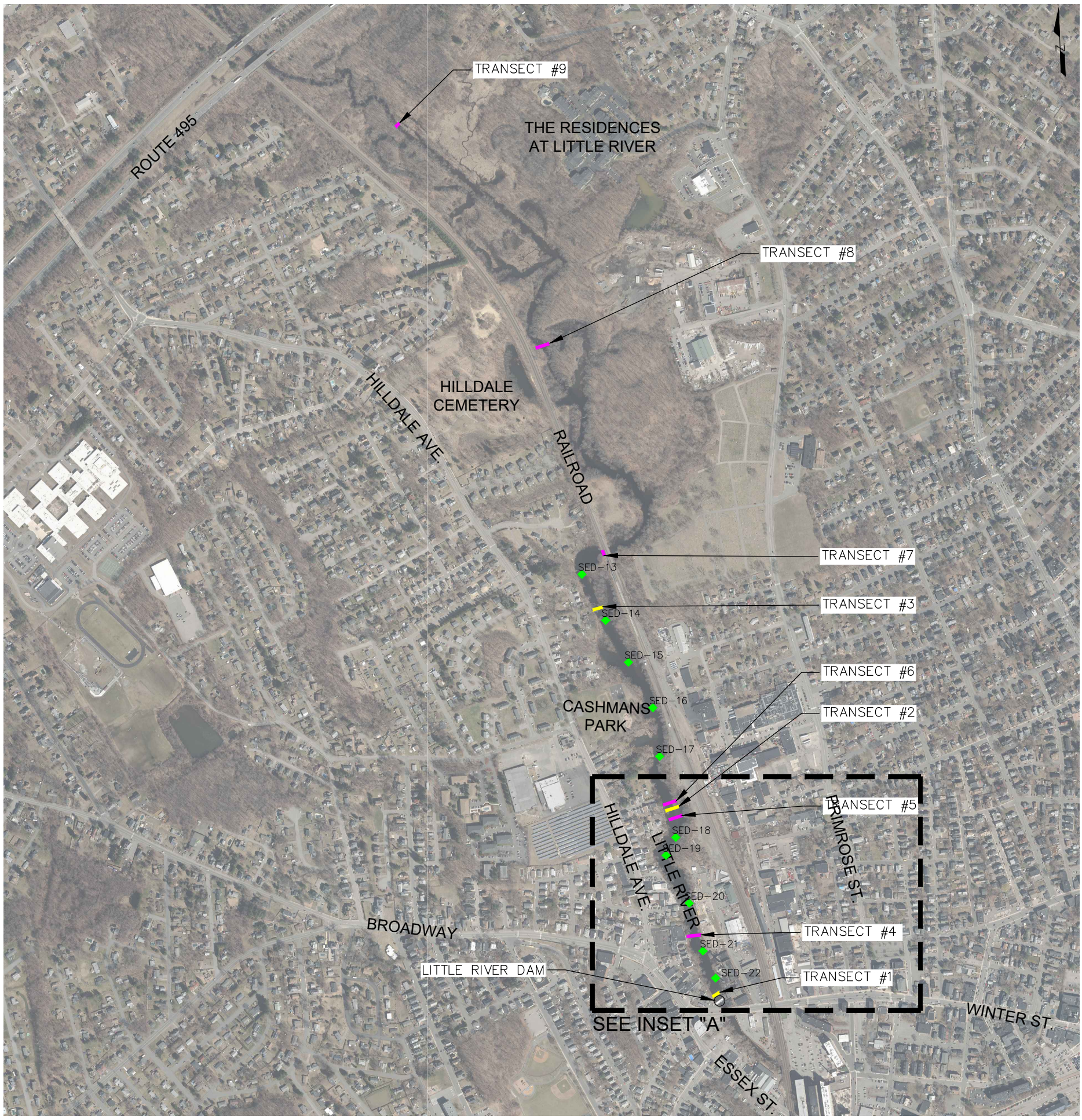
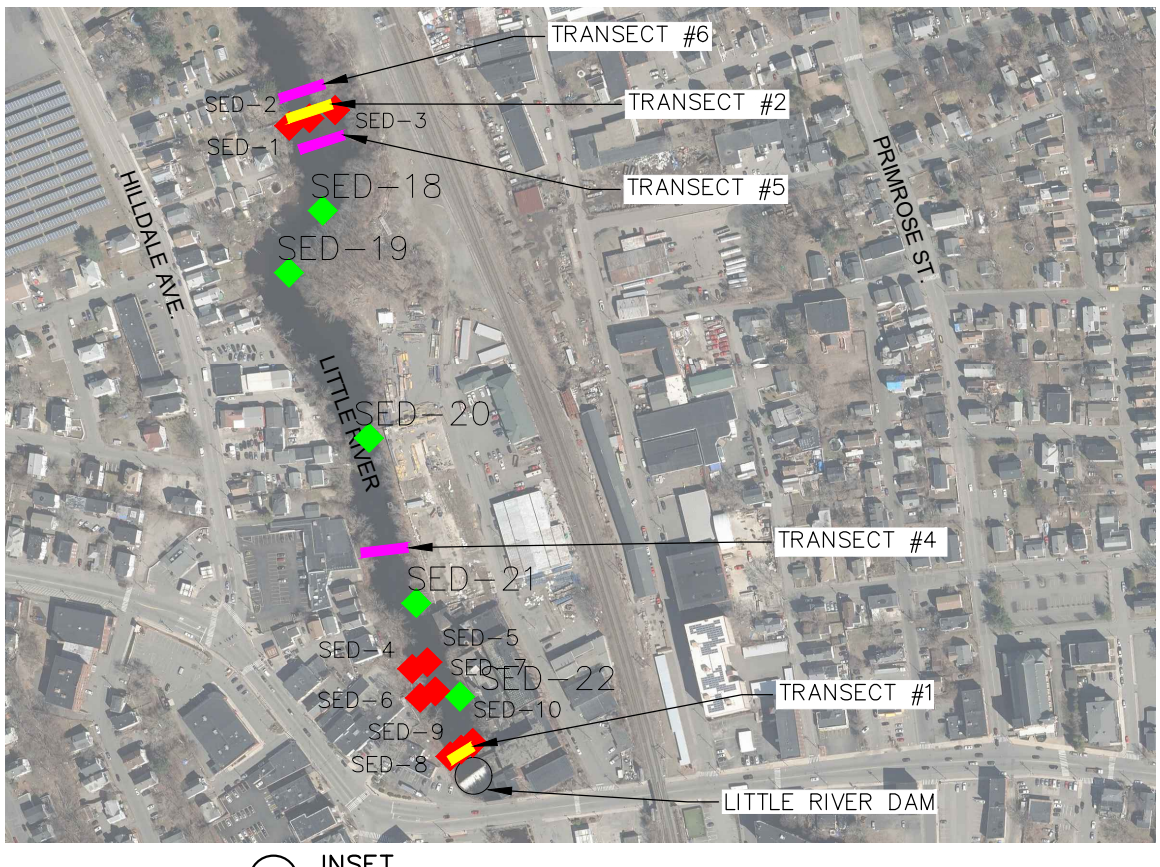
1 Figure 1
2 Figure 2
3 Report Compilation





A INSET
SCALE: 1"= 400'

MAP REFERENCE

THIS MAP WAS PREPARED FROM USGS COLOR ORTHO IMAGERY (2019).

SOURCE: OFFICE OF GEOGRAPHIC AND ENVIRONMENTAL INFORMATION (MASSGIS), COMMONWEALTH OF MASSACHUSETTS EXECUTIVE OFFICE OF ENVIRONMENTAL AFFAIRS.

LEGEND

SED-1 — SEDIMENT SAMPLE (SEPT 2021)

SED-13 — SEDIMENT SAMPLE (JUNE 2022)

TRANSECT (SEPT 2021)

TRANSECT (NOV 2020)

SCALE:	
HORZ.: 1"= 800'	
VERT.:	
DATUM:	
HORZ.:	
VERT.:	
0 400 800	
GRAPHIC SCALE	

FUSS&O'NEILL
1550 MAIN STREET, SUITE 400
SPRINGFIELD, MA 01103
413.452.0445
www.fando.com

CITY OF HAVERHILL

SITE PLAN

LITTLE RIVER IMPOUNDMENT

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: MARCH 2023

FIGURE 1

File: J:\DWG\P2017\0390\U30\Environmental\20170390.U30_STP - 2022-07-01 update.dwg Layout: FIG 2_OVERALL Plotted: 2023-03-02 12:04 PM Saved: 2023-03-02 12:04 PM User: Cotis
MS VIEW: LAYER STATE:
PC3: DWG TO PDF.PC3 STB/CTB: FO HALF.STB

MAP REFERENCE

THIS MAP WAS PREPARED FROM USGS COLOR ORTHO IMAGERY (2019)

SOURCE: OFFICE OF GEOGRAPHIC AND ENVIRONMENTAL INFORMATION (MASSGIS), COMMONWEALTH OF MASSACHUSETTS EXECUTIVE OFFICE OF ENVIRONMENTAL AFFAIRS

LEGEND

SED-1 — SEDIMENT SAMPLE (SEPT 2021)

SED-13 — SEDIMENT SAMPLE (JUNE 2022)

TRANSECT (SEPT 2021)

TRANSECT (NOV 2020)

SCALE:
HORZ.: 1" = 500'
VERT.:
DATUM:
HORZ.:
VERT.:
0 250 500
GRAPHIC SCALE

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CITY OF HAVERHILL

SITE PLAN

LITTLE RIVER DAM

HAVERHILL MASSACHUSETTS

PROJ. No.: 20170390.U30
DATE: MARCH 2023

FIGURE 2

File Path: J:\DWG\P20170390U30\Environmental\20170390.U30_STP - 2022-07-01 update.dwg Layout: NORTHERN PORTION Plotted: Thu, March 02, 2023 - 11:31 AM User: colis
Plotter: DWG TO PDF.PC3 CTB File: FO.STB
MS VIEW: LAYER STATE:

2 Chemical Analysis of Sediment

2.1 Comparison to MCP Reportable Criteria for Soils RCS-1

Sediment located within a waterbody or waterway is not regulated under the Massachusetts Contingency Plan (MCP), however, if sediment is removed from the waterbody or waterway and relocated to an upland area, it would be considered soil, and would therefore be regulated under the Massachusetts Contingency Plan (MCP, 310 CMR 40.0000). Although the RCS-1 reporting criteria does not apply to sediment, for comparison purposes the analytical data collected during all phases of sediment sampling conducted for this project were compared against their corresponding RCS-1 reporting criteria. The RCS-1 is the most stringent reporting criteria for soils under the MCP and applies to soils at or within 500 feet of a residential dwelling, a residential-zone property, a school, playground, recreational area or park, or within the geographic boundaries of a groundwater resource area categorized as RCGW-1. Due to the location of the project area within an urban center, and due to the commercial/industrial land use along the banks of the impoundment, the analytical data were also compared to the MassDEP published "Background Levels of Polycyclic Aromatic Hydrocarbons and Metals in Soil[1]".

No constituents in the sediment sample collected within the Merrimack River upstream of the confluence with the Little River exceeded the RCS-1. Sediment samples collected upstream of the project area did not contain any analyzed constituents that exceeded their applicable RCS-1 criteria, and overall, sediment quality conditions within the project area generally displayed lower concentrations of contaminants compared to downstream in the Merrimack River below the Little River confluence. Benzo(a)pyrene levels downstream in the Merrimack River were measured at 65 mg/kg, compared to an RCS-1 value of 2, whereas levels within the project area where exceedances were detected were substantially lower, ranging from 2.0mg/kg to 4.4 mg/kg. Similarly, for phenanthrene, levels downstream in the Merrimack River were measured at 330mg/kg compared to an RCS-1 value of 10mg/kg, whereas levels within the project area where exceedances were detected were substantially lower, ranging from 13mg/kg to 25mg/kg. For 2-Methylnapthalene, levels downstream in the Merrimack River were measured at 240mg/kg compared to an RCS-1 value of 0.7mg/kg, whereas levels within the project area where exceedances were detected were substantially lower, at 5.4mg/kg. Finally, for C11-C12 Aromatics levels downstream in the Merrimack River were measured at 3,000mg/kg compared to an RCS-1 value of 1,000mg/kg, whereas levels within the project area where exceedances were detected were substantially lower, at 1,600mg/kg.

Table 2-1, below, includes a list of samples which exceeded the RCS-1 criteria, the specific constituent(s) at each sample which exceeded the RCS-1 criteria, the analytical result for each constituent, and the corresponding constituent-specific RCS-1 criteria. Refer to *Figure 1* and *Figure 2* for the locations of sediment samples. Laboratory analytical reports are being submitted concurrent to this application.

[1] https://www.mass.gov/doc/technical-update-background-levels-of-polycyclic-aromatic-hydrocarbons-and-metals-in-soil-0/download

Table 2-1
Summary of Constituents Exceeding the RCS-1

Sediment Sample Location, Constituent(s)	Sample Result (mg/kg)	RCS-1 (mg/kg)
Transect #1	Within Project Area	
Lead	220	200
C11-C12 Aromatics	1,600	1,000
Transect #2	Within Project Area	
Aroclor-1260[2C]	4.2	1
Benzo(a)pyrene	2.6	2
Transect #5	Within Project Area	
Benzo(a)pyrene	2.3	2
Transect #6	Within Project Area	
Lead	260	200
Benzo(a)pyrene	2.8	2
2-Methylnapthalene	5.4	0.7
Transect #7	Within Project Area	
Benzo(a)pyrene	2.0	2
Phenanthrene	25	10
SED-2	Within Project Area	
Lead	600	200
SED-3	Within Project Area	
Arsenic	41	20
Lead	240	200
SED-4	Within Project Area	
Lead	320	200
SED-6	Within Project Area	
Lead	200	200

Table 2-1
Summary of Constituents Exceeding the RCS-1

Sediment Sample Location, Constituent(s)	Sample Result (mg/kg)	RCS-1 (mg/kg)
SED-18	Within Project Area	
Lead	220	200
Benzo(a)pyrene	3.3	2
SED-19	Within Project Area	
Lead	660	200
Benzo(a)pyrene	4.4	2
Phenanthrene	13	10
SED-20	Within Project Area	
Lead	130	200
Benzo(a)pyrene	3.7	2
SED-12, Below Confluence	Downstream, Merrimack River	
Naphthalene	77	4
Acenaphthene	120	4
Acenaphthylene	21	1
Benzo(a)anthracene	85	7
Benzo(a)pyrene	65	2
Benzo(b)fluoranthene	59	7
Chrysene	100	70
Dibenz(a,h)anthracene	7.9	0.7
Indeno(1,2,3-cd)pyrene	25	7
2-Methylnaphthalene	240	0.7
Naphthalene	140	4
Phenanthrene	330	10
C11-C12 Aromatics	3000	1,000

Average sediment concentrations were calculated based on the location of sample collection. Table 2-2 below summarizes the average concentrations on analyzed constituents. When a sample was reported as non-detect (ND), half of the Reporting Limit (RL) was used as the sample result to calculate the average concentration. Sample size for averages varies depending on the location. The average concentration for transects and grab samples in the project area were reported in the online WW26 application.

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Table 2-2
Averages of Constituents by Sampling Location

	Transects in Project Area	Grab Samples in Project Area (SED)	Upstream Transect(s)	Downstream Grab Sample	Merrimack – Grab Sample Downstream of Confluence	Merrimack- Grab Sample of Upstream Confluence
Arsenic (ppm)	10.4	11.3	4.9	7.8	8.9	6.6
Cadmium (ppm)	0.6	0.3	0.3	0.6	1.0	0.2
Chromium (ppm)	32.7	18.7	18.0	30.5	44.0	17.0
Copper (ppm)	28.0	11.3	9.9	29.6	53.0	6.1
EPH (ppm)	1024.6	164.3	63.3	1699.0	3380.0	18.0
Lead (ppm)	104.7	159.4	18.5	71.0	130.0	12.0
Mercury (ppm)	0.1	0.1	0.0	0.1	0.3	0.0
Nickel (ppm)	19.6	11.6	12.1	14.1	21.0	7.1
PAHs (ppm)	40.9	22.5	2.3	885.8	1768.9	2.7
PCBs (ppm)	0.7	0.2	0.1	0.1	0.1	0.0
Volatile solids (VOC)	15.9	NA	0.0	44.5	89.0	0.0
Water (%)	70.2	42.4	29.8	7.9	10.3	5.5
Zinc (ppm)	118.0	74.5	45.5	67.5	100.0	35.0

Samples are broken down as follows:

- In Project Area: Transects 1 through 5, Grab Samples SED 1 through 10, SED 13 through 22
- Upstream of Project Area: Transects 8 through 9
- Downstream of Project Area: Grab Samples SED 12 (below confluence), SED-11 (above confluence)
-

Table 2-3 through *Table 2-6* include a summary of all sample results from Transect #1 through Transect #9, grab samples SED-1 through SED-13, and the sampling locations above and below the confluence of the Merrimack River.

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Table 2-3
Summary of 2020 Sediment Analytical Data

Environmental Site Assessment
Little River Dam Removal
Haverhilll, Massachusetts
November 17, 2020

	Sample Type	Composite, Little River (in project area)			MCP Reportable Criteria		MassDEP Background Guidance[2]
	Sample Location	Transect #1	Transect #2	Transect #3	RCS-1	RCS-2	
	Sample Number	1117-02	1117-03	1117-04			
	Sample Depth (fbg)	9-10	3-10	3-10			
	Headspace (ppmv)	0.0	5.2	0.0			
	Sample Date	11/17/2020	11/17/2020	11/17/2020			
Total Metals (USEPA Methods 6010/7471)							
Arsenic	mg/kg	15	6.3	7.9	20	20	20
Barium	mg/kg	99	32	97	1000	3000	50
Cadmium	mg/kg	1.1	0.46	ND<0.71	70	100	3
Chromium	mg/kg	34	17	35	100	200	40
Copper	mg/kg	40	19	13	1000	10000	200
Lead	mg/kg	**220**[1]	84	33	200	600	600
Mercury	mg/kg	0.29	0.037	0.068	20	30	1
Nickel	mg/kg	21	10	22	600	1000	30
Selenium	mg/kg	ND<7.7	ND<4.5	ND<7.1	400	700	1
Silver	mg/kg	ND<0.77	ND<0.45	ND<0.71	100	200	5
Zinc	mf/kg	230	96	77	1000	3000	300
Leachable Lead (USEPA Method 1311/6010)	mg/l	0.15[4]	NA	NA	---	---	---
PCBs (USEPA Method 8082A)							
Aroclor-1260[2C]	mg/kg	ND<0.18	**4.2**	ND<0.17	1	4	---
Total PCBs	mg/kg	ND<0.18	4.2	ND<0.17	---	---	---
VOCs (USEPA Method 8260C)							
Ethylbenzene	mg/kg	ND<0.16	0.86	ND<0.0033	40	1000	---
Isopropylbenzene (Cumene)	mg/kg	ND<0.16	3.8	ND<0.0033	1000	10000	---
p-Isopropyltoluene (p-Cymene)	mg/kg	ND<0.16	0.88	ND<0.0033	100	1000	---
Naphthalene	mg/kg	ND<0.33	56	ND<0.0067	4	20	---
n-Propylbenzene	mg/kg	ND<0.16	2.6	ND<0.0033	100	1000	---
1,2,4 - Trimethylbenzene	mg/kg	ND<0.16	28	ND<0.0033	1000	10000	---
Total VOCs	mg/kg	ND<Various	92.14	ND<Various	---	---	---
PAHs (USEPA Method 8270D-E)							
Acenaphthene	mg/kg	ND<0.39	0.23	ND<0.37	4	3000	2
Acenaphthylene	mg/kg	ND<0.39	0.43	ND<0.37	1	10	1
Anthracene	mg/kg	0.49	0.93	ND<0.37	1000	3000	4
Benzo(a)anthracene	mg/kg	1.4	2.6	ND<0.37	7	40	9
Benzo(a)pyrene	mg/kg	1.6	**2.6**	ND<0.37	2	7	7
Benzo(b)fluoranthene	mg/kg	2.1	3.2	0.43	7	40	8
Benzo(g,h,i)perylene	mg/kg	0.96	1.5	ND<0.37	1000	3000	3
Benzo(k)fluoranthene	mg/kg	0.79	1.1	ND<0.37	70	400	4
Chrysene	mg/kg	1.7	2.8	ND<0.37	70	400	7
Dibenz(a,h)anthracene	mg/kg	ND<0.39	0.37	ND<0.37	0.7	4	1
Fluoranthene	mg/kg	3.8	6.1	0.68	1000	3000	10
Fluorene	mg/kg	ND<0.39	0.59	ND<0.37	1000	3000	2
Indeno(1,2,3-cd)pyrene	mg/kg	1.1	1.7	ND<0.37	7	40	3
Naphthalene	mg/kg	0.39	0.57	ND<0.37	4	20	1
Phenanthrene	mg/kg	2.0	4.7	ND<0.37	10	1000	20
Pyrene	mg/kg	2.8	5.2	0.57	1000	3000	20
Total PAHs	mg/kg	19.13	34.62	1.68	---	---	---
EPH (MassDEP Method EPH rev 2.1)							
C9-C18 Aliphatics	mg/kg	86	31	95	1000	3000	---
C19-C36 Aliphatics	mg/kg	46	580	860	3000	5000	---
C11-C12 Aromatics	mg/kg	**1,600**	300	320	1000	3000	---
Acenaphthene	mg/kg	~~80~~	~~0.39~~	~~0.39~~	4	3000	2
Acenaphthylene	mg/kg	~~28~~	~~0.24~~	ND<0.22	1	10	1
Anthracene	mg/kg	~~16~~	~~0.48~~	~~0.49~~	1000	3000	4
Benzo(a)anthracene	mg/kg	~~12~~	~~1.1~~	~~1.5~~	7	40	9
Benzo(a)pyrene	mg/kg	~~7.0~~	~~1.2~~	~~1.7~~	2	7	7
Benzo(b)fluoranthene	mg/kg	~~8.2~~	~~2.4~~	~~3.7~~	7	40	8
Benzo(g,h,i)perylene	mg/kg	~~2.7~~	~~0.97~~	~~1.6~~	1000	3000	3
Benzo(k)fluoranthene	mg/kg	~~2.7~~	~~0.82~~	~~1.2~~	70	400	4
Chrysene	mg/kg	~~11~~	~~2.8~~	~~4.2~~	70	400	7
Dibenz(a,h)anthracene	mg/kg	~~0.98~~	~~0.24~~	ND<0.22	0.7	4	1
Fluoranthene	mg/kg	~~43~~	~~3.6~~	~~5.8~~	1000	3000	10
Fluorene	mg/kg	~~68~~	~~0.41~~	~~0.38~~	1000	3000	2
Indeno(1,2,3-cd)pyrene	mg/kg	~~3.0~~	~~1.1~~	~~1.5~~	7	40	3
2-Methylnaphthalene	mg/kg	~~270~~	~~0.41~~	~~0.26~~	0.7	80	1
Naphthalene	mg/kg	~~380~~	~~0.55~~	ND<0.22	4	20	1
Phenathrene	mg/kg	~~150~~	~~2.5~~	~~3.3~~	10	1000	20
Pyrene	mg/kg	~~48~~	~~3.6~~	~~5.7~~	1000	3000	20
Herbicides (USEPA Method 8151A)							
MCPA [1]	mg/kg	ND<29	ND<17	ND<27	100	1,000	---
MCPP [1]	mg/kg	ND<29	ND<17	ND<27	---	---	---
Pesticides (USEPA Method 8081B)							
Various	mg/kg	ND<Various	ND<Various	ND<Various	---	---	---
Total Organic Carbon (USEPA Method 9060A)	%	6.0	1.1	3.9	---	---	---

Notes:
Notes:

Created By: SMD
Checked By: MK

MassDEP: Massachusetts Department of Environmental Protection
T: Transect
EPH: Extractable Petroleum Hydrocarbon
PAH: Polycyclic Aromatic Hydrocarbon
PCB: Polychlorinated Biphenyl
TCLP: Toxic Characteristic Leaching Procedure
VOC: Volatile Organic Compound
SVOC: Semivolatile Organic Compound
ppmv: parts per million by volume
fbg: feet below grade
mg/l: milligrams per liter
mg/kg: milligrams per kilogram
NA: Not analyzed

---: Criteria not defined in applicable regulations
ND<X: Not detected above the lab reporting limits shown.
Shaded and bolded red values exceed the RCS-1 and RCS-2 MCP Reportable Criteria
Bolded red values exceed the RCS-1 MCP Reportable Criteria
Only analytes at concentrations greater than the reporting limits are listed.
[1]: TCLP testing should be performed for metals when the total concentration in sediments are above the theoretical levels at which TCLP criteria may be met or exceeded. Specifically, for lead (Pb) levels greater than 100 mg/kg.
[2]: Parameters required by 314 CMR 9.00 in accordance wuth the approved sampling plan
[3]: 2002 MassDEP Technical Update for *Background Levels of Polycyclic Aromatic Hydrocarbons and Metals in Soil*
[4]: USEPA Regulations for Toxicity set a Regulatory Level of 5.0 mg/L TCLP Lead
[5]: Per MassDEP guidance, 8270D data used for PAH characterization instead of MassEPH Target Compounds

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Table 2-4
Summary of Sediment Analytical Data and Objectives - Breadth Sampling Program

Suplemental Environmental Site Assessment
Little River Dam Removal
Haverhilll, Massachusetts
September 8 and 9, 2021

	Sample Type	Composite, Little River (in project area)				Composite, Little River (upstream)		MCP Reportable Criteria		MassDEP Background Guidance[2]
	Sample Location	Transect #4	Transect #5	Transect #6	Transect #7	Transect #8	Transect #9			
	Sample Number	0907-04	0907-03	0907-02	0907-05	0908-07	0908-08			
	Sample Depth (fbg)	4-14.1	2.5-8.9	3.1-12	5.2-13.4	1.0-5.9	1.0-4.5	RCS-1	RCS-2	
	Headspace (ppmv)	0.2	1.0	34.4	5.2	0	0.7			
	Sample Date	9/7/2021	9/7/2021	9/7/2021	9/7/2021	9/8/2021	9/8/2021			
Total Metals (USEPA Methods 6010/7471)										
Arsenic	mg/kg	5.8	7.5	23	7.4	7.5	ND<4.7	20	20	20
Cadmium	mg/kg	ND<0.51	0.54	1.4	ND<0.52	ND<0.57	ND<0.47	70	100	3
Chromium	mg/kg	25	27	52	39	24	12	100	200	40
Copper	mg/kg	13	25	63	23	14	5.7	1,000	10,000	200
Lead	mg/kg	32	87	**260**	17	26	11	200	600	600
Mercury	mg/kg	0.072	0.093	0.22	ND<0.043	ND<0.044	ND<0.038	20	30	1
Nickel	mg/kg	15	15	29	25	17	7.2	600	1000	30
Zinc	mg/kg	42	93	210	78	60	31	1000	3000	300
Leachable Lead (USEPA Method 1311/6010)	mg/l	NA	NA	1.3	NA	NA	NA	---	---	---
PCBs (USEPA Method 8082A)										
Aroclor-1254	mg/kg	ND<0.13	0.13	0.33	ND<0.12	ND<0.14	ND<0.12	1	4	---
Total PCBs	mg/kg	ND<0.13	0.13	0.33	ND<0.12	ND<0.14	ND<0.12	---	---	---
VOCs (USEPA Method 8260C)										
n-Butylbenzene	mg/kg	ND<0.0023	0.14	1.1	ND<0.0020	ND<0.0026	ND<0.0017	---	---	---
sec-Butylbenzene	mg/kg	ND<0.0023	ND<0.086	0.46	ND<0.0020	ND<0.0026	ND<0.0017	---	---	---
Isopropylbenzene (Cumene)	mg/kg	ND<0.0023	0.28	0.38	ND<0.0020	ND<0.0026	ND<0.0017	1000	10000	---
p-Isopropyltoluene (p-Cymene)	mg/kg	ND<0.0023	ND<0.086	0.82	ND<0.0020	ND<0.0026	ND<0.0017	100	1000	---
Naphthalene	mg/kg	ND<0.0046	0.93	3.7	ND<0.0040	ND<0.0052	ND<0.0034	4	20	---
n-Propylbenzene	mg/kg	ND<0.0023	0.089	0.24	ND<0.0020	ND<0.0026	ND<0.0017	100	1000	---
1,2,4 - Trimethylbenzene	mg/kg	ND<0.0023	2.7	4.6	ND<0.0020	ND<0.0026	ND<0.0017	1000	10000	---
1,3,5 - Trimethylbenzene	mg/kg	ND<0.0023	0.12	2.2	ND<0.0020	ND<0.0026	ND<0.0017	10	100	---
m+p Xylene	mg/kg	ND<0.0093	ND<0.17	0.32	ND<0.0080	ND<0.010	ND<0.0068	100	100	---
Total VOCs	mg/kg	ND<0.0093	4.259	13.82	ND<0.0080	ND<0.010	ND<0.0068	---	---	---
PAHs (USEPA Method 8270D-E)										
Acenaphthene	mg/kg	ND<0.27	0.31	0.83	ND<0.26	ND<0.30	ND<0.25	4	3000	2
Acenaphthylene	mg/kg	ND<0.27	ND<0.26	0.45	ND<0.26	ND<0.30	ND<0.25	1	10	1
Anthracene	mg/kg	ND<0.27	0.85	0.96	2.3	ND<0.30	ND<0.25	1000	3000	4
Benzo(a)anthracene	mg/kg	0.55	2.4	2.9	6.2	ND<0.30	ND<0.25	7	40	9
Benzo(a)pyrene	mg/kg	0.62	**2.3**	**2.8**	**2.0**	ND<0.30	ND<0.25	2	7	7
Benzo(b)fluoranthene	mg/kg	0.81	2.7	3.5	4.7	ND<0.30	ND<0.25	7	40	8
Benzo(g,h,i)perylene	mg/kg	0.50	1.7	2.5	0.80	ND<0.30	ND<0.25	1000	3000	3
Benzo(k)fluoranthene	mg/kg	0.30	1.1	1.4	1.9	ND<0.30	ND<0.25	70	400	4
Chrysene	mg/kg	0.69	2.7	3.5	*8.5*	ND<0.30	ND<0.25	70	400	7
Dibenz(a,h)anthracene	mg/kg	ND<0.27	0.43	0.52	ND<0.26	ND<0.30	ND<0.25	0.7	4	1
Fluoranthene	mg/kg	1.2	5.3	7.0	*49*	ND<0.30	ND<0.25	1000	3000	10
Fluorene	mg/kg	ND<0.27	0.55	1.4	0.64	ND<0.30	ND<0.25	1000	3000	2
Indeno(1,2,3-cd)pyrene	mg/kg	0.51	1.7	2.5	1.0	ND<0.30	ND<0.25	7	40	3
2-Methylnaphthalene	mg/kg	ND<0.27	ND<0.26	***5.4***	ND<0.26	ND<0.30	ND<0.25	0.7	80	1
Naphthalene	mg/kg	ND<0.27	0.33	*3.2*	ND<0.26	ND<0.30	ND<0.25	4	20	1
Phenanthrene	mg/kg	0.82	4.2	6.8	***25***	ND<0.30	ND<0.25	10	1000	20
Pyrene	mg/kg	1.4	5.8	7.7	31	ND<0.30	ND<0.25	1000	3000	20
Total PAHs	mg/kg	7.4	32.37	53.36	133.04	ND<0.30	ND<0.25	---	---	---
EPH (MassDEP Method EPH rev 2.1)[5]										
C9-C18 Aliphatics	mg/kg	24	55	630	ND<16	ND<17	ND<14	1000	3000	---
C19-C36 Aliphatics	mg/kg	96	260	390	92	31	30	3000	5000	---
C11-C12 Aromatics	mg/kg	65	190	1,400	44	33	17	1000	3000	---
Acenaphthene	mg/kg	~~ND<0.16~~	~~0.4~~	~~1.2~~	~~ND<0.16~~	~~ND<0.17~~	~~ND<0.14~~	1000	3000	2
Acenaphthylene	mg/kg	~~ND<0.16~~	~~0.27~~	~~0.67~~	~~ND<0.16~~	~~ND<0.17~~	~~ND<0.14~~	10	10	1
Anthracene	mg/kg	~~0.21~~	~~0.70~~	~~2.7~~	~~ND<0.16~~	~~ND<0.17~~	~~ND<0.14~~	1000	3000	4
Benzo(a)anthracene	mg/kg	~~0.90~~	~~3.2~~	~~5.1~~	~~2.2~~	~~2.8~~	~~0.42~~	7	40	9
Benzo(a)pyrene	mg/kg	~~1.7~~	~~3.7~~	~~7.2~~	~~2.2~~	~~1.9~~	~~1.1~~	2	7	7
Benzo(b)fluoranthene	mg/kg	~~1.2~~	~~3.2~~	~~6.5~~	~~0.42~~	~~0.42~~	~~ND<0.14~~	7	40	8
Benzo(g,h,i)perylene	mg/kg	~~0.90~~	~~1.5~~	~~2.9~~	~~ND<0.16~~	~~ND<0.17~~	~~ND<0.14~~	1000	3000	3
Benzo(k)fluoranthene	mg/kg	~~0.44~~	~~1.2~~	~~2.3~~	~~ND<0.16~~	~~ND<0.17~~	~~ND<0.14~~	70	400	4
Chrysene	mg/kg	~~1.9~~	~~3.0~~	~~5.0~~	~~1.4~~	~~1.7~~	~~0.4~~	70	400	7
Dibenz(a,h)anthracene	mg/kg	~~ND<0.16~~	~~0.39~~	~~0.77~~	~~ND<0.16~~	~~ND<0.17~~	~~ND<0.14~~	0.7	4	1
Fluoranthene	mg/kg	~~1.8~~	~~5.6~~	~~13~~	~~0.94~~	~~0.66~~	~~0.51~~	1000	3000	10
Fluorene	mg/kg	~~ND<0.16~~	~~0.49~~	~~0.6~~	~~ND<0.16~~	~~ND<0.17~~	~~ND<0.14~~	1000	3000	2
Indeno(1,2,3-cd)pyrene	mg/kg	~~0.69~~	~~1.2~~	~~2.4~~	~~ND<0.16~~	~~ND<0.17~~	~~ND<0.14~~	7	40	3
2-Methylnaphthalene	mg/kg	~~ND<0.16~~	~~0.17~~	~~0.8~~	~~ND<0.16~~	~~ND<0.17~~	~~ND<0.14~~	300	500	1
Naphthalene	mg/kg	~~0.19~~	~~0.44~~	~~1.1~~	~~ND<0.16~~	~~ND<0.17~~	~~ND<0.14~~	500	1000	1
Phenathrene	mg/kg	~~1.1~~	~~3.5~~	~~15~~	~~0.40~~	~~0.34~~	~~0.23~~	500	1000	20
Pyrene	mg/kg	~~1.8~~	~~5.6~~	~~14~~	~~0.84~~	~~0.66~~	~~0.42~~	1000	3000	20
Herbicides (USEPA Method 8151A)										
Various	mg/kg	ND<Various	ND<Various	ND<Various	ND<Various	ND<Various	ND<Various	Varies	Varies	Varies
Pesticides (USEPA Method 8081B)										
Various	mg/kg	ND<Various	ND<Various	ND<Various	ND<Various	ND<Various	ND<Various	---	---	---
Total Organic Carbon (USEPA Method 9060A)	mg/kg	14,000	29,000	66,000	43,000	20,000	91,000	---	---	---

Created By: SMD
Checked By: MK

Notes:
MassDEP: Massachusetts Department of Environmental Protection
T: Transect
EPH: Extractable Petroleum Hydrocarbon
PAH: Polycyclic Aromatic Hydrocarbon
PCB: Polychlorinated Biphenyl
TCLP: Toxic Characteristic Leaching Procedure
VOC: Volatile Organic Compound
SVOC: Semivolatile Organic Compound
ppmv: parts per million by volume
fbg: feet below grade
mg/l: milligrams per liter
mg/kg: milligrams per kilogram
NA: Not analyzed

---: Criteria not defined in applicable regulations
ND<X: Not detected above the lab reporting limits shown.
Shaded and bolded red values exceed the RCS-1 and RCS-2 MCP Reportable Criteria
Bolded red values exceed the RCS-1 MCP Reportable Criteria
Only analytes at concentrations greater than the reporting limits are listed.
[1]: TCLP testing should be performed for metals when the total concentration in sediments are above the theoretical levels at which TCLP criteria may be met or exceeded. Specifically, for lead (Pb) levels
[2]: Parameters required by 314 CMR 9.00 in accordance wuth the approved sampling plan
[3]: 2002 MassDEP Technical Update for *Background Levels of Polycyclic Aromatic Hydrocarbons and Metals in Soil*
[4]: USEPA Regulations for Toxicity set a Regulatory Level of 5.0 mg/L TCLP Lead
[5]: Per MassDEP guidance, 8270D data used for PAH characterization instead of MassEPH Target Compounds

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Table 2-5
Summary of Sediment Analytical Data and Objectives - Detail Phase

Environmental Site Assessment
Little River Dam Removal
Haverhilll, Massachusetts
November 17, 2021

	Sample Type	Grab, Little River (in project area)										MCP Reportable Criteria		
	Sample Location	SED-1	SED-2	SED-3	SED-4	SED-5	SED-6	SED-7	SED-8	SED-9	SED-10	RCS-1	RCS-2	MassDEP Background Guidance[2]
	Sample Number	0917-01	0917-03	0917-02	0917-05	0917-06	0917-07	0917-04	0917-10	0917-09	0917-08			
	Sample Depth (fbg)	0-2	0-2	0-2.5	0-2	0-2	0-2	0-2	0-1.6	0-1.0	0-0.9			
	Headspace (ppmv)	1.5	0.6	2.5	0.0	0.1	0.2	0.0	0.1	1.0	0.0			
	Sample Date	9/17/2021	9/17/2021	9/17/2021	9/17/2021	9/17/2021	9/17/2021	9/17/2021	9/17/2021	9/17/2021	9/17/2021			
Total Metals (USEPA Methods 6010/7471)														
Arsenic	mg/kg	12	13	**41**	16	ND<4.3	13	14	14	11	12	20	20	20
Cadmium	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	70	100	3
Chromium	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	100	200	40
Copper	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1,000	10,000	200
Lead	mg/kg	150	**600**	**240**	**320**	3.0	**200**	79	160	160	160	200	600	600
Mercury	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	20	30	1
Nickel	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	600	1000	30
Zinc	mf/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1000	3000	300
PCBs (USEPA Method 8082A)														
Aroclor-1254	mg/kg	0.20	0.23	ND<0.19	0.20	ND<0.11	ND<0.14	ND<0.15	ND<0.16	ND<0.14	ND<0.19	1	4	---
Total PCBs	mg/kg	0.20	0.23	ND<0.19	0.20	ND<0.11	ND<0.14	ND<0.15	ND<0.16	ND<0.14	ND<0.19	---	---	---
PAHs (USEPA Method 8270D-E)														
Acenaphthene	mg/kg	NA	NA	NA	ND<0.41	ND<0.23	ND<0.30	ND<0.32	ND<0.34	0.37	*3.2*	4	3000	2
Acenaphthylene	mg/kg	NA	NA	NA	ND<0.41	ND<0.23	ND<0.30	ND<0.32	ND<0.34	ND<0.29	ND<0.40	1	10	1
Anthracene	mg/kg	NA	NA	NA	ND<0.41	ND<0.23	ND<0.30	ND<0.32	ND<0.34	1.5	3.8	1000	3000	4
Benzo(a)anthracene	mg/kg	NA	NA	NA	1.2	ND<0.23	1.0	1.0	1.2	2.9	6.5	7	40	9
Benzo(a)pyrene	mg/kg	NA	NA	NA	1.4	ND<0.23	1.2	1.2	1.2	2.8	5.3	2	7	7
Benzo(b)fluoranthene	mg/kg	NA	NA	NA	2.0	ND<0.23	1.6	1.5	1.6	3.3	5.8	7	40	8
Benzo(g,h,i)perylene	mg/kg	NA	NA	NA	0.84	ND<0.23	0.89	0.65	0.57	1.8	*3.3*	1000	3000	3
Benzo(k)fluoranthene	mg/kg	NA	NA	NA	0.77	ND<0.23	0.66	0.58	0.52	1.2	2.2	70	400	4
Chrysene	mg/kg	NA	NA	NA	1.5	ND<0.23	1.3	1.1	1.3	2.9	*7.2*	70	400	7
Dibenz(a,h)anthracene	mg/kg	NA	NA	NA	ND<0.41	ND<0.23	ND<0.30	ND<0.32	ND<0.34	0.43	0.73	0.7	4	1
Fluoranthene	mg/kg	NA	NA	NA	2.6	ND<0.23	2.2	2.3	2.4	5.9	*12*	1000	3000	10
Fluorene	mg/kg	NA	NA	NA	ND<0.41	ND<0.23	ND<0.30	ND<0.32	ND<0.34	0.59	*2.7*	1000	3000	2
Indeno(1,2,3-cd)pyrene	mg/kg	NA	NA	NA	0.87	ND<0.23	0.91	0.82	0.71	1.9	*3.3*	7	40	3
2-Methylnaphthalene		NA	NA	NA	ND<0.41	ND<0.23	ND<0.30	ND<0.32	ND<0.34	ND<0.29	*1.3*	0.7	80	1
Naphthalene	mg/kg	NA	NA	NA	ND<0.41	ND<0.23	ND<0.30	ND<0.32	0.89	ND<0.29	*1.7*	4	20	1
Phenanthrene	mg/kg	NA	NA	NA	1.4	ND<0.23	1.6	1.2	0.95	5.2	*21*	10	1000	20
Pyrene	mg/kg	NA	NA	NA	2.4	ND<0.23	2.1	2.0	2.3	5.8	19	1000	3000	20
Total PAHs	mg/kg	NA	NA	NA	14.98	ND<0.23	13.46	12.35	13.64	36.59	99.03	---	---	---
EPH Fractions (MassDEP Method EPH rev 2.1)														
C9-C18 Aliphatics	mg/kg	NA	NA	NA	99	ND<14	49	24	29	51	34	1000	3000	---
C19-C36 Aliphatics	mg/kg	NA	NA	NA	640	ND<14	190	150	280	190	400	3000	5000	---
C11-C12 Aromatics	mg/kg	NA	NA	NA	320	ND<14	150	98	200	100	260	1000	3000	---

Created By: SMD
Checked By: MK

Notes:
MassDEP: Massachusetts Department of Environmental Protection
T: Transect
EPH: Extractable Petroleum Hydrocarbon
PAH: Polycyclic Aromatic Hydrocarbon
PCB: Polychlorinated Biphenyl
TCLP: Toxic Characteristic Leaching Procedure
VOC: Volatile Organic Compound
SVOC: Semivolatile Organic Compound
ppmv: parts per million by volume
fbg: feet below grade
mg/l: milligrams per liter
mg/kg: milligrams per kilogram
NA: Not analyzed

---: Criteria not defined in applicable regulations
ND<X: Not detected above the lab reporting limits shown.
Shaded and bolded red values exceed the RCS-1 and RCS-2 MCP Reportable Criteria
Bolded red values exceed the RCS-1 MCP Reportable Criteria
Only analytes at concentrations greater than the reporting limits are listed.
[1]: TCLP testing should be performed for metals when the total concentration in sediments are above the theoretical levels at which TCLP criteria may be met or exceeded. Specifically, for lead (Pb)
[2]: Parameters required by 314 CMR 9.00 in accordance wuth the approved sampling plan
[3]: 2002 MassDEP Technical Update for *Background Levels of Polycyclic Aromatic Hydrocarbons and Metals in Soil*
[4]: USEPA Regulations for Toxicity set a Regulatory Level of 5.0 mg/L TCLP Lead
[5]: Per MassDEP guidance, 8270D data used for PAH characterization instead of MassEPH Target Compounds

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Table 2-6
Summary of Sediment Analytical Data and Objectives - Supplemental Phase

Little River Dam Removal
Haverhilll, Massachusetts
June 8, 2022

	Sample Type	Grab, Little River (in project area)										Grab, Merrimack River (downstream)		MCP Reportable Criteria		MassDEP Background Guidance[2]
	Sample Location	SED-18	SED-19	SED-20	SED-21	SED-22	SED-17	SED-16	SED-15	SED-14	SED-13	Below Confluence	Above Confluence			
	Sample Number	1708220608-01	1708220608-02	1708220608-03	1708220608-04	1708220608-05	1708220608-06	1708220608-07	1708220608-08	1708220608-09	1708220608-10	1708220608-11	1708220608-12			
	Sample Depth (fbg)	3.2 - 4.4	10.9 - 12.3	9.8 - 12.0	5.8 - 7.0	6.9 - 7.5	5.9 - 7.4	6.0 - 6.6	8.7 - 9.0	8.3 - 8.7	3.4 - 6.1	10.1 - 10.6	10.0 - 10.7	RCS-1	RCS-2	
	Headspace (ppmv)	0.1	0.1	0.8	0.3	0	4.6	0.5	0.1	0.0	0.2	25.5	0.0			
	Sample Date	6/8/2022	6/8/2022	6/8/2022	6/8/2022	6/8/2022	6/8/2022	6/8/2022	6/8/2022	6/8/2022	6/8/2022	6/8/2022	6/8/2022			
Total Metals (USEPA Methods 6010/7471)																
Arsenic	mg/kg	15	7.5	12	ND<(5.4)	10	ND<(4.3)	ND<(6.0)	5.5	8.4	11	8.9	6.6	20	20	20
Cadmium	mg/kg	0.91	ND<(0.45)	ND<(0.50)	ND<(0.54)	ND<(0.55)	ND<(0.43)	ND<(0.60)	ND<(0.53)	ND<(0.47)	ND<(0.70)	0.98	ND<(0.40)	70	100	3
Chromium	mg/kg	31	9.3	25	16	20	6.8	9.8	17	23	29	44	17	100	200	40
Copper	mg/kg	35	11	23	4.2	5.6	ND (0.86)	2.6	7	8.2	16	53	6.1	1,000	10,000	200
Lead	mg/kg	**220**	**660**	**130**	4.1	6.7	1.5	2.4	11	12	68	130	12	200	600	600
Mercury	mg/kg	0.21	ND<(0.035)	0.060	ND<(0.043)	ND<(0.040)	ND<(0.035)	ND<(0.047)	0.047	ND<(0.037)	0.12	0.26	ND<(0.031)	20	30	1
Nickel	mg/kg	19	6.5	15	9.8	12	3.3	6	11	14	19	21	7.1	600	1000	30
Zinc	mg/kg	220	130	130	23	31	7.7	14	37	42	110	100	35	1000	3000	300
TCLP Metals (USEPA Methods 1311/6010)																
Nickel	mg/l	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.064	ND<(0.010)	---	---	---
Zinc	mg/l	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.91	ND<(0.50)	---	---	---
Lead	mg/l	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2.3	ND<(0.10)	---	---	---
PCBs (USEPA Method 8082A)																
Total PCBs	mg/kg	0.25	0.33	0.37	NA	NA	NA	NA	NA	NA	NA	ND<(0.11)	ND<(0.096)	---	---	---
VOCs (USEPA Method 8260D)																
n-Butylbenzene	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.9	ND<(0.0015)	---	---	---
sec-Butylbenzene	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND<(1.2)	ND<(0.0015)	---	---	---
Isopropylbenzene (Cumene)	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND<(1.2)	ND<(0.0015)	1000	10000	---
p-Isopropyltoluene (p-Cymene)	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.4	ND<(0.0015)	100	1000	---
Naphthalene	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**77**	ND<(0.0029)	4	20	---
n-Propylbenzene	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND<(1.2)	ND<(0.0015)	100	1000	---
1,2,4 - Trimethylbenzene	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	4.3	ND<(0.0015)	1000	10000	---
1,3,5 - Trimethylbenzene	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.4	ND<(0.0015)	10	100	---
Total VOCs	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	86	ND<(0.0029)	---	---	---
PAHs (USEPA Method 8270D-E)																
Acenaphthene	mg/kg	ND<(0.45)	0.94	0.42	ND<(0.29)	ND<(0.28)	ND<(0.23)	ND<(0.31)	ND<(0.27)	ND<(0.25)	ND<(0.38)	**120**	ND (0.20)	4	3000	2
Acenaphthylene	mg/kg	0.58	0.84	0.81	ND<(0.29)	ND<(0.28)	ND<(0.23)	ND<(0.31)	ND<(0.27)	ND<(0.25)	ND<(0.38)	**21**	ND (0.20)	1	10	1
Anthracene	mg/kg	0.75	2.8	1	ND<(0.29)	ND<(0.28)	ND<(0.23)	ND<(0.31)	ND<(0.27)	ND<(0.25)	ND<(0.38)	78	ND (0.20)	1000	3000	4
Benzo(a)anthracene	mg/kg	3.2	5.1	3.5	ND<(0.29)	ND<(0.28)	ND<(0.23)	ND<(0.31)	ND<(0.27)	ND<(0.25)	0.49	**85**	ND (0.20)	7	40	9
Benzo(a)pyrene	mg/kg	**3.3**	**4.4**	**3.7**	ND<(0.29)	ND<(0.28)	ND<(0.23)	ND<(0.31)	ND<(0.27)	ND<(0.25)	0.45	**65**	ND (0.20)	2	7	7
Benzo(b)fluoranthene	mg/kg	4.4	5.5	5.2	ND<(0.29)	ND<(0.28)	ND<(0.23)	ND<(0.31)	ND<(0.27)	ND<(0.25)	0.66	**59**	0.21	7	40	8
Benzo(g,h,i)perylene	mg/kg	1.60	2.4	2.2	ND<(0.29)	ND<(0.28)	ND<(0.23)	ND<(0.31)	ND<(0.27)	ND<(0.25)	ND<(0.38)	29	ND (0.20)	1000	3000	3
Benzo(k)fluoranthene	mg/kg	1.70	1.9	1.9	ND<(0.29)	ND<(0.28)	ND<(0.23)	ND<(0.31)	ND<(0.27)	ND<(0.25)	ND<(0.38)	17	ND (0.20)	70	400	4
Chrysene	mg/kg	3.3	5.1	4.5	ND<(0.29)	ND<(0.28)	ND<(0.23)	ND<(0.31)	ND<(0.27)	ND<(0.25)	0.59	**100**	ND (0.20)	70	400	7
Dibenz(a,h)anthracene	mg/kg	0.47	0.65	0.62	ND<(0.29)	ND<(0.28)	ND<(0.23)	ND<(0.31)	ND<(0.27)	ND<(0.25)	ND<(0.38)	**7.9**	ND (0.20)	0.7	4	1
Fluoranthene	mg/kg	7.4	13	8.5	ND<(0.29)	ND<(0.28)	ND<(0.23)	ND<(0.31)	ND<(0.27)	ND<(0.25)	1.2	150	0.46	1000	3000	10
Fluorene	mg/kg	ND<(0.45)	1.5	0.83	ND<(0.29)	ND<(0.28)	ND<(0.23)	ND<(0.31)	ND<(0.27)	ND<(0.25)	ND<(0.38)	82	ND (0.20)	1000	3000	2
Indeno(1,2,3-cd)pyrene	mg/kg	1.8	2.5	2.4	ND<(0.29)	ND<(0.28)	ND<(0.23)	ND<(0.31)	ND<(0.27)	ND<(0.25)	ND<(0.38)	**25**	ND (0.20)	7	40	3
2-Methylnaphthalene	mg/kg	ND<(0.45)	0.63	0.42	ND<(0.29)	ND<(0.28)	ND<(0.23)	ND<(0.31)	ND<(0.27)	ND<(0.25)	ND<(0.38)	**240**	ND (0.20)	0.7	80	1
Naphthalene	mg/kg	ND<(0.45)	1.4	0.73	ND<(0.29)	ND<(0.28)	ND<(0.23)	ND<(0.31)	ND<(0.27)	ND<(0.25)	ND<(0.38)	**140**	ND (0.20)	4	20	1
Phenanthrene	mg/kg	3.3	**13**	5.9	ND<(0.29)	ND<(0.28)	ND<(0.23)	ND<(0.31)	ND<(0.27)	ND<(0.25)	0.53	**330**	0.37	10	1000	20
Pyrene	mg/kg	7	13	7.8	ND<(0.29)	ND<(0.28)	ND<(0.23)	ND<(0.31)	ND<(0.27)	ND<(0.25)	1	220	0.36	1000	3000	20
Total PAHs	mg/kg	38.8	74.66	50.43	ND<(0.29)	ND<(0.28)	ND<(0.23)	ND<(0.31)	ND<(0.27)	ND<(0.25)	4.92	1768.9	1.4	---	---	---
EPH (MassDEP Method EPH rev 2.1)																
C9-C18 Aliphatics	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	210	ND<(12)	1000	3000	---
C19-C36 Aliphatics	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	170	ND<(12)	3000	5000	---
C11-C12 Aromatics	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**3000**	ND<(12)	1000	3000	---
Total Organic Carbon (USEPA Method 9060A)	mg/kg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	60,000	690	---	---	---

Notes:
MassDEP: Massachusetts Department of Environmental Protection
USEPA: United States Environmental Protection Agency
T: Transect
EPH: Extractable Petroleum Hydrocarbon
PAH: Polycyclic Aromatic Hydrocarbon
PCB: Polychlorinated Biphenyl
TCLP: Toxic Characteristic Leaching Procedure
VOC: Volatile Organic Compound
SVOC: Semivolatile Organic Compound
ppmv: parts per million by volume
fbg: feet below grade
mg/l: milligrams per liter
mg/kg: milligrams per kilogram

---: Criteria not defined in applicable regulations
NA: Not analyzed
ND<X: Not detected above the lab reporting limits shown.
Shaded and bolded red values exceed the RCS-1 and RCS-2 MCP Reportable Criteria
Bolded red values exceed the RCS-1 MCP Reportable Criteria
Only analytes at concentrations greater than the reporting limits are listed.
[1]: TCLP testing should be performed for metals when the total concentration in sediments are above the theoretical levels at which TCLP criteria may be met or exceeded.
[2]: Parameters required by 314 CMR 9.00 in accordance wuth the approved sampling plan
[3]: Interim Policy COMM-94-007: Dredged Sediment Reuse or Disposal *Table 1*
[4]: USEPA Regulations for Toxicity set a Regulatory Level of 5.0 mg/L TCLP Lead
[5]: PEC = Probably Effect Concentration, MacDonald et. al, 2000
[6]: 2002 MassDEP Technical Update for Background Levels of Polycyclic Aromatic Hydrocarbons and Metals in Soil

2.2 Comparison to MACLs and Consensus Based-PECs for Sediment

For additional risk-based and disposal-based analysis, sediment analytical data were also compared to the Consensus-Based Probable Effects Concentrations (PECs), per DD MacDonald et. al.[2] The data were further compared to MassDEP's Maximum Allowable Contaminant Levels (MACLs) for sediment reuse at lined Massachusetts landfills.[3] While not regulatory criteria, the PECs are "intended to identify contaminant concentrations above which harmful effects on sediment-dwelling organisms were expected to occur frequently"[4].

2.2.1 November 17, 2020, Sampling

The following is a summary of the sediment conditions based on the November 17, 2020, sampling event (note that a detection above a laboratory reporting limit does not necessarily indicate the exceedance of applicable regulatory criteria, which are discussed later in this section):

- A total of eight (8) metals (arsenic, barium, chromium, copper, lead, mercury, nickel, and zinc) were detected above the laboratory reporting limits in each of the three sediment composite samples. Additionally, cadmium was detected above laboratory reporting limits in the composite samples collected from Transect #1 and Transect #2. None of the results exceeded applicable sediment standards for reuse at lined landfills.
- The result for total lead in Transect #1 was 220 mg/kg. Therefore, pursuant to Section 1.2 of EPA Method 1311 and the 20 times rule, the sample was submitted for TCLP analysis. The "20-times rule" instructs that if the result for a total metal analyte (220 mg/kg lead in Transect #1) exceeds 20 times the regulatory TCLP level for that metal (5.0 mg/l for lead), then the sample should be submitted for TCLP analysis for that metal. TCLP was detected above the laboratory reporting limit in the composite sample collected from Transect #1 with a result of 0.15 mg/l. This result is below the USEPA criteria for solid waste that exhibits the characteristics of toxicity (5.0 mg/l) and would therefore not have to be handled as a hazardous waste pursuant to 40 CFR 261.24.
- Total PCBs were detected above laboratory reporting limits in one composite sample collected from Transect #2 at a concentration of 4.2 mg/kg. PCBs were not detected above laboratory reporting limits in samples collected from Transect #1 and Transect #3.
- PAHs were detected above laboratory reporting limits in all three transect composite samples (Transect #1, Transect #2, and Transect #3). The highest total PAHs were reported in the composite sample collected from Transect #2 with a result of 34.62 mg/kg.

[2] MacDonald et al., *Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems*, 2000.

[3] MassDEP, 1994. *Interim Policy #COMM-94-007, Interim Policy for Sampling, Analysis, Handling and Tracking Requirements for Dredged Sediment Reused or Disposed at Massachusetts Permitted Landfills.*

[4] MacDonald et al., *Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems*, 2000.

- EPH Ranges were detected in all three transect composite samples above laboratory reporting limits. The maximum total EPHs (summation of C9-C18 aliphatics, C19-C36 aliphatics, and C11-C22 aromatics) were collected from Transect #1 with a result of 1,732 mg/kg.
- Target PAH Analytes were detected above laboratory reporting limits via the MassDEP EPH Method Rev 2.1 in all three transect composite samples at levels greatly exceeding the results of PAHs via method 8270 D-E. When utilizing the MassDEP EPH Method Rev 2.1 there can often be positive interference from hydrocarbons and/or non-hydrocarbons not associated with EPH in Target PAH Analytes; therefore, it is recommended that Method 8270 D-E be employed to resolve any uncertainty regarding these identifications[5]. Therefore, for the purposes of this assessment, the PAH results from Method 8270 D-E were used for sediment characterization.
- Six VOCs (ethylbenzene, isopropylbenzene, p-isopropyltoluene, naphthalene, n-propylbenzene, and 1,2,4-trimethylbenzene) were detected above laboratory reporting limits in the sediment composite sample taken from one transect location (Transect #2). VOCs were below laboratory detection limits in samples from Transect #1 and Transect #2.
- TOC content was detected above laboratory reporting limits in all three sediment composite samples with the highest content of 6 percent collected from Transect #1.
- Herbicides and pesticides were not detected above laboratory reporting limits in the three sediment composite samples.
- All results for the Trip Blank collected were below the laboratory detection limits.
- Sieve analysis indicated Transect #1 was a brown silty sand, Transect #2 was a brown poorly graded sand with silt and gravel, and Transect #3 was a brown silty sand.

The following summarizes the exceedances when compared to the applicable sediment standards:

- The total Lead concentration of 220 mg/kg collected from Transect #1 exceeded the PEC.
- The total PCB concentration of 4.2 mg/kg collected from Transect #2 exceeded the PEC and MACL for sediment reuse at lined landfills.
- The total VOC concentrations collected at Transect #2 (92.14 mg/kg) exceeded the MACL for sediment reuse at lined landfills.
- Phenanthrene and pyrene collected from Transect #1 exceeded the PEC.
- Anthracene, fluorene, naphthalene, phenanthrene, pyrene, and total PAHs collected from Transect #2 exceeded their respective PEC.
- All other analytical data was below applicable PECs and MACLs.

All other analytical data was below applicable PECs and MACLs.

[5] WSC-CAM Section IV B, March 1, 2020 Rev. 2, *Quality Control Requirements and Performance Standards for the Analysis of EPH in Support of Response Actions under the MCP*

2.2.2 September 7 and 8, 2021, Sampling

The following is a summary of the sediment conditions based on the September 7 and 8, 2021, sampling event (note that a detection above a laboratory reporting limit does not necessarily indicate the exceedance of applicable regulatory criteria, which are discussed later in this section):

- A total of six (6) metals (arsenic, chromium, copper, lead, nickel, and zinc) were detected above the laboratory reporting limits in each of the six sediment composite samples. Cadmium and mercury were detected above laboratory reporting limits in the composite samples collected from Transect #5 and Transect #6. Additionally, mercury was detected above laboratory reporting limits in the composite sample collected from Transect #4.
    - The total lead concentration in Transect #6 was 260 mg/kg. The sample was analyzed for leachable lead via TCLP extraction. Leachable lead was detected at a concentration of 1.3 mg/l, less than the USEPA characteristic of toxicity (5.0 mg/l). Therefore, this material does not exhibit a characteristic of lead toxicity requiring hazardous waste management pursuant to 40 CFR 261.24.
- Total PCBs were detected above laboratory reporting limits in composite samples collected from Transects #5 and #6 at concentrations of 0.13 mg/kg and 0.33 mg/kg, respectively. PCBs were not detected above laboratory reporting limits in the remaining samples.
- PAHs were detected above laboratory reporting limits in four transect composite samples (Transect #4, Transect #5, Transect #6, and Transect #7) using USEPA Method 8270 and in all six transects by MassDEP EPH method. The highest aggregate PAHs concentration was reported in the composite sample collected from Transect #7 with a result of 133.04 mg/kg.
- EPH Ranges, specifically including C19-C36 aliphatic and C11-C12 aromatic hydrocarbons, were detected in all six transect composite samples above laboratory reporting limits. C9-C18 aliphatic hydrocarbons were detected in three samples, from Transects #4, #5 and #6. The maximum aggregate EPH concentration was reported in the sample from Transect #6, at a total concentration of 2,420 mg/kg.
- Nine VOCs, generally associated with petroleum, were detected above laboratory reporting limits in the sediment composite sample taken from one transect location (Transect #6). Six of the nine listed VOCs above were also detected above laboratory reporting limits in the composite sample taken from Transect #5. No VOCs were detected in the samples from Transects #4, #7, #8, or #9.
- TOC content was detected above laboratory reporting limits in all six sediment composite samples, ranging from 14,000 (1.4% by weight) to 91,000 mg/kg (9.1% by weight).
- Herbicides and pesticides were not detected above laboratory reporting limits in the six sediment composite samples.
- All results for the Trip Blank collected were below the laboratory detection limits.
- Sieve analysis indicated Transect #4 was grey clay and the other transects (Transect #5, Transect #6, Transect #7, Transect #8, and Transect #9) was grey clayey sand.

The following is a summary of exceedances compared to the applicable MACLs:

- The total VOC concentrations collected at Transect #6 (13.82 mg/kg) exceeded the MACL for sediment reuse at lined landfills.
- Total PAH concentration of 133.04 mg/kg collected at Transect #7 exceeded the MACL.

The following is a summary of exceedances compared to the applicable PECs:

- The total Lead concentration of 260 mg/kg collected from Transect #6 exceeded the PEC.
- The total PCB concentration detected at Transect #5 and Transect #6 exceeded the PEC.
- The concentrations of multiple PAHs, including anthracene, fluorene, phenanthrene, and pyrene in samples from Transects #5, #6, and #7 exceeded the respective PECs. The aggregate PAH concentration of 133.04 mg/kg in the sample from Transect #7 exceeded the MACL.
- The concentration of naphthalene detected in Transect #6 exceeded the PEC.
- EPH compounds anthracene, benzo(a)anthracene, benzo(a)pyrene, chrysene, fluoranthene, fluorene, naphthalene, phenanthrene, and pyrene from Transect #4 – Transect #8 exceeded their respective PEC.

All other analytical data was below applicable PECs and MACLs.

2.2.3 September 17, 2021, Sampling

The following is a summary of the sediment conditions based on the September 17, 2021, sampling event (note that a detection above a laboratory reporting limit does not necessarily indicate the exceedance of applicable regulatory criteria, which are discussed later in this section):

- Lead was detected above the laboratory reporting limits in each of the ten individual sediment composite samples. The concentrations the ten samples ranged from 3 to 600 mg/kg. Arsenic was detected above the laboratory limits for all individual sediment composite samples except for the SED-5 sample location.
- Total PCBs were detected above laboratory reporting limits in samples collected from SED-1, SED-2, and SED-4 at a concentration of 0.20 mg/kg, 0.23 mg/kg, and 0.20 mg/kg, respectfully. PCBs were not detected above laboratory reporting limits in the remaining seven sample locations.
- A total of 16 PAH compounds were detected above laboratory reporting limits in six sample locations (SED-4, SED-6, SED-7, SED-8, SED-9, and SED-10). The highest total PAHs were reported in the composite sample collected from SED-10 with a result of 99.03 mg/kg.
- EPH fractions were detected in six sample locations above laboratory reporting limits. The maximum total EPH (summation of C9-C18 aliphatics, C19-C36 aliphatics, and C11-C22 aromatics) was 1,059 mg/kg in sediment sample SED-4.
- Sieve analysis indicated SED-5 was dark brown clayey sand and SED-6 was dark brown clay. The moisture content for SED-5 and SED-6 was 28.7% and 56.0%, respectively.

The following summarizes the exceedances when compared to the applicable MACLs:

- The total arsenic concentration of sample location SED-3 (41 mg/kg) exceeded the MACL (40 mg/kg).

- The aggregate PAH concentration in sediment sample SED-10 (99.03 mg/kg) was effectively equal to the MACL (100 mg/kg).

The following summarizes the exceedances when compared to the applicable PECs:

- The total lead concentrations in eight of the ten sample locations (SED-1, SED-2, SED-3, SED-4, SED-6, SED-8, SED-9, and SED-10) ranged from 150 to 600 mg/kg, which exceeded the PEC of 128 mg/kg.
- The total arsenic concentration of sample location SED-3 (41 mg/kg) exceeded the PEC (33 mg/kg).
- Anthracene, fluorene, 2-methylnaphthalene, naphthalene, phenanthrene, and/or pyrene collected from SED-4, SED-6, SED-7, SED-8, SED-9, and SED-10 exceeded their respective PECs. In addition, naphthalene detected in Transect #6 exceeded the PEC. Total PAH concentrations of SED-9 (36.59 mg/kg) and SED-10 (99.03 mg/kg) exceeded the PEC.

All other analytical data was below applicable PECs and MACLs.

2.2.4 June 8, 2022, Sampling

The following is a summary of the sediment conditions based on the June 8, 2022, sampling event, during which samples were collected from the Little River and the Merrimack River (note that a detection above a laboratory reporting limit does not necessarily indicate the exceedance of applicable regulatory criteria, which are discussed later in this section):

Little River:

- A total of four (4) metals (chromium, lead, nickel, and zinc) were detected above the laboratory reporting limits in each of the ten sediment samples. Arsenic was detected above laboratory reporting limits in the samples from SED-13, SED-14, SED-15, SED-18, SED-19, SED-20, and SED-22. Cadmium was detected above laboratory reporting limits in the sample from SED-18. Copper was detected above laboratory reporting limits in the sample from all samples except for SED-17. Mercury was detected above laboratory reporting limits in the samples collected from SED-13, SED-18, and SED-20.
- Total PCBs were detected above laboratory reporting limits in samples collected from SED-18, SED-19, and SED-20 at concentrations of 0.25 mg/kg, 0.33 mg/kg, and 0.37 mg/kg, respectively. The other samples were not analyzed for PCBs.
- PAHs were detected above laboratory reporting limits by USEPA Method 8270 in four composite samples from the Little River (SED-13, SED-18, SED-19, SED-20). The highest aggregate PAHs concentration was reported in the sample collected from SED-19 with a result of 74.66 mg/kg.

Merrimack River:

- A total of six (6) metals (arsenic, chromium, copper, lead, nickel, and zinc) were detected above the laboratory reporting limits in both of the sediment samples, collected from above the

confluence and below the confluence of the Little River with the Merrimack River. Cadmium and Mercury were detected above laboratory reporting limits in the samples from below the confluence.

  - TCLP analysis for nickel, lead, and zinc was performed on both samples. Leachable metals were not detected above the confluence. Below the confluence, leachable lead was detected at a concentration of 0.91 mg/l, less than the USEPA characteristic of toxicity (5.0 mg/l). Therefore, this material does not exhibit a characteristic of lead toxicity requiring hazardous waste management pursuant to 40 CFR 261.24. Leachable nickel and zinc were detected below the confluence; however, those metals are not regulated by 40 CFR 261.24.

- Total PCBs were not detected above laboratory reporting limits in samples collected from above and below the confluence.
- PAHs were detected above laboratory reporting limits by USEPA Method 8270 above and below the confluence. The aggregate PAH concentration above the confluence was 1.4 mg/kg. The aggregate PAH concentration below the confluence was 1768.9 mg/kg. Multiple PAHs detected in the sample from below the confluence exceeded RCS-1 and/or RCS-2 MCP Reportable criteria; Acenaphthene, chrysene, and phenanthrene exceeded the RCS-1 reportable concentrations, and acenaphthylene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, 2-methylnaphthalene, and phenanthrene exceeded RCS-2 reportable concentrations.
- No VOCs were detected above laboratory reporting limits in the sediment sample taken above the confluence. Five VOCs (n-butylbenzene, p-isopropyltoluene, naphthalene, 1,2,4-trimethylbenzene, and 1,3,5- trimethylbenzene) were detected above laboratory reporting limits in the sediment sample taken from below the confluence. Naphthalene was detected above the RCS-2 criteria.
- TOC content was detected above the confluence at a concentration of 690 mg/kg and was detected below the confluence at a concentration of 60,000 mg/kg.
- All results for the Trip Blank collected were below the laboratory detection limits.
- Sieve analysis indicated the sample from above the confluence was dark olive-brown poorly graded sand with gravel and that the sample from below the confluence was olive-brown well-graded gravel with sand.

The following summarizes the exceedances when compared to the applicable MACLs:

- The total VOC concentration below the confluence of the Little River and the Merrimack River (86 mg/kg) exceeded the MACL (10 mg/kg)
- The total PAH concentration below the confluence (1768.9 mg/kg) exceeded the MACL (100 mg/kg)

The following summarizes the exceedances when compared to the applicable PECs:

- Lead concentrations at SED-18, SED-19, SED-20, and Below the Confluence (220 mg/kg, 660 mg/kg, 130 mg/kg, and 130 mg/kg, respectively) exceeded the PEC (128 mg/kg).
- Anthracene concentrations at SED-19, SED-20, and Below the Confluence (2.8 mg/kg, 1 mg/kg, and 78 mg/kg, respectively) exceeded the PEC (0.845 mg/kg).

- Fluorine concentrations at SED-19, SED-20, and Below the Confluence (1.5 mg/kg, 0.83 mg/kg, and 82 mg/kg, respectively) exceeded the PEC (0.536 mg/kg).
- Phenanthrene concentrations at SED-18, SED-19, SED-20, and Below the Confluence (3.3 mg/kg, 13 mg/kg, 5.9 mg/kg, and 330 mg/kg, respectively) exceeded the PEC (1.17 mg/kg).
- Pyrene concentrations at SED-18, SED-19, SED-20, and Below the Confluence (7 mg/kg, 13 mg/kg, 7.8 mg/kg, and 220 mg/kg, respectively) exceeded the PEC (1.52 mg/kg).
- Total PAHs concentrations at SED-18, SED-19, SED-20, and Below the Confluence (38.8 mg/kg, 74.66 mg/kg, 50.43 mg/kg, and 1768.9 mg/kg, respectively) exceeded the PEC (23 mg/kg).

All other analytical data was below applicable PECs and MACLs.

2.3 Sediment Quality Conclusions

- As indicated during the 2020 sediment sampling activities, a delineated PCB condition in sediment from the vicinity of Transect #2 will trigger ex-situ management of sediment.
- For dam removal, it is currently estimated that approximately 5,000 cubic yards of sediment will be removed from the river and sent for off-site disposal in order to re-establish the main river channel. It is assumed that approximately 1,000 cubic yards of that material (the PCB-impacted sediment from the vicinity of Transect #2) will have to be disposed of as regulated waste. The balance (4,000 cubic yards) can be disposed of in lined landfills within the State.
- Based on the current information, the majority of the accumulated sediment in the impoundment does not represent a hazard to humans or the aquatic environment. With the approval of permitting agencies, it is proposed that non-hazardous sediments be allowed to redistribute naturally downstream or be reused within the impoundment area to reconstruct the channel banks.
- Analytical data from samples collected downstream of the confluence of the Merrimack River and Little River generally show existing impacts within the Merrimack River (the receiving waterway for the Little River) to be worse than the impacts observed within the dam removal project area. Observed contaminant levels within the Merrimack River, downstream of its confluence with the Little River, are generally higher than those observed for the same contaminant within the project area. Downstream redistribution of sediment, as proposed, is therefore not expected to have a substantive increase in impacts on the already degraded downstream condition.

2.4 Sediment Laboratory Analysis

Sediment samples were analyzed for chemical parameters by Con-Test Analytical Laboratory (Con-Test, now Pace Analytical). Refer to the attached laboratory analysis reports.

con-test® ANALYTICAL LABORATORY
39 Spruce Street * East Longmeadow, MA 01028 * FAX 413/525-6405 * TEL. 413/525-2332

December 2, 2020

Dan Lafrance
Fuss & O'Neill EnviroScience, LLC - MA
108 Myrtle St,
Quincy, MA 02171

Project Location: Haverhill, MA
Client Job Number:
Project Number: 20170390.U20
Laboratory Work Order Number: 20K0857

Enclosed are results of analyses for samples received by the laboratory on November 17, 2020. If you have any questions concerning this report, please feel free to contact me.

Sincerely,

Jessica L. Hoffman
Project Manager

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39 Spruce Street * East Longmeadow, MA 01028 * FAX 413/525-6405 * TEL. 413/525-2332

Fuss & O'Neill EnviroScience, LLC - MA
108 Myrtle St,
Quincy, MA 02171
ATTN: Dan Lafrance

REPORT DATE: 12/2/2020

PURCHASE ORDER NUMBER:

PROJECT NUMBER: 20170390.U20

ANALYTICAL SUMMARY

WORK ORDER NUMBER: 20K0857

The results of analyses performed on the following samples submitted to the CON-TEST Analytical Laboratory are found in this report.

PROJECT LOCATION: Haverhill, MA

FIELD SAMPLE #	LAB ID:	MATRIX	SAMPLE DESCRIPTION	TEST	SUB LAB
1543201117-01	20K0857-01	Trip Blank Soil		SW-846 8260C-D	
1543201117-02	20K0857-02	Sediment		MADEP EPH rev 2.1	
				SM 2540G	
				SW 846 9060A	
				SW-846 6010D	
				SW-846 7471B	
				SW-846 8081B	
				SW-846 8082A	
				SW-846 8151A	
				SW-846 8260C-D	
				SW-846 8270D-E	
1543201117-03	20K0857-03	Sediment		MADEP EPH rev 2.1	
				SM 2540G	
				SW 846 9060A	
				SW-846 6010D	
				SW-846 7471B	
				SW-846 8081B	
				SW-846 8082A	
				SW-846 8151A	
				SW-846 8260C-D	
				SW-846 8270D-E	
1543201117-04	20K0857-04	Sediment		MADEP EPH rev 2.1	
				SM 2540G	
				SW 846 9060A	
				SW-846 6010D	
				SW-846 7471B	
				SW-846 8081B	
				SW-846 8082A	
				SW-846 8151A	
				SW-846 8260C-D	
				SW-846 8270D-E	

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CASE NARRATIVE SUMMARY

All reported results are within defined laboratory quality control objectives unless listed below or otherwise qualified in this report.

REVISED REPORT 12/2/2020 Client asked to have total Nickel added to samples 2-4

REVISON: 11/30/2020 Client asked to have Copper and Zinc added to samples 2-4

For method 8270E, only PAHs were requested and reported.

For method 8151 samples were derivatized on 11/23/20.

For method 8151 sample analysis bracketed by LCS to monitor esterification. All recoveries in the bracketing LCS met method criteria.

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SW 846 9060A

Qualifications:

Z-01

Sample results were outside of the curve and could not be analyzed within the curve due to method's physical limitations. Results are estimated.

Analyte & Samples(s) Qualified:

Total Organic Carbon

20K0857-02[1543201117-02]

SW-846 8081B

Qualifications:

DL-03

Elevated reporting limit due to matrix interference.

Analyte & Samples(s) Qualified:

20K0857-02[1543201117-02], 20K0857-03[1543201117-03], 20K0857-04[1543201117-04]

SW-846 8082A

Qualifications:

O-32

A dilution was performed as part of the standard analytical procedure.

Analyte & Samples(s) Qualified:

20K0857-02[1543201117-02], 20K0857-04[1543201117-04]

SW-846 8151A

Qualifications:

DL-03

Elevated reporting limit due to matrix interference.

Analyte & Samples(s) Qualified:

20K0857-02[1543201117-02], 20K0857-03[1543201117-03], 20K0857-04[1543201117-04]

S-02

The surrogate recovery for this sample cannot be accurately quantified due to interference from coeluting organic compounds present in the sample extract.

Analyte & Samples(s) Qualified:

2,4-Dichlorophenylacetic acid [2C]

20K0857-02[1543201117-02], 20K0857-03[1543201117-03], 20K0857-04[1543201117-04]

SW-846 8260C-D

Qualifications:

L-04

Laboratory fortified blank/laboratory control sample recovery and duplicate recovery are outside of control limits. Reported value for this compound is likely to be biased on the low side.

Analyte & Samples(s) Qualified:

2,2-Dichloropropane

20K0857-02[1543201117-02], 20K0857-03[1543201117-03], B271147-BLK1, B271147-BS1, B271147-BSD1

RL-05

Elevated reporting limit due to high concentration of target compounds. MA CAM reporting limit not met.

Analyte & Samples(s) Qualified:

20K0857-03[1543201117-03]

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RL-07

Elevated reporting limit based on lowest point in calibration.
MA CAM reporting limit not met.

Analyte & Samples(s) Qualified:

Bromomethane
20K0857-02[1543201117-02]

Carbon Disulfide
20K0857-02[1543201117-02]

Methylene Chloride
20K0857-02[1543201117-02]

V-05

Continuing calibration verification (CCV) did not meet method specifications and was biased on the low side for this compound.

Analyte & Samples(s) Qualified:

2,2-Dichloropropane
20K0857-02[1543201117-02], 20K0857-03[1543201117-03], B271147-BLK1, B271147-BS1, B271147-BSD1, S054618-CCV1

Chloromethane
20K0857-02[1543201117-02], 20K0857-03[1543201117-03], B271147-BLK1, B271147-BS1, B271147-BSD1, S054618-CCV1

V-16

Response factor is less than method specified minimum acceptable value. Reduced precision and accuracy may be associated with reported result.

Analyte & Samples(s) Qualified:

1,4-Dioxane
S054612-CCV1, S054618-CCV1

V-20

Continuing calibration verification (CCV) did not meet method specifications and was biased on the high side. Data validation is not affected since sample result was "not detected" for this compound.

Analyte & Samples(s) Qualified:

Acetone
B271149-BS1, B271149-BSD1, S054612-CCV1

Bromomethane
B271147-BS1, B271147-BSD1, S054618-CCV1

V-34

Initial calibration verification (ICV) did not meet method specifications and was biased on the low side for this compound. Reported result is estimated.

Analyte & Samples(s) Qualified:

Bromomethane
20K0857-01[1543201117-01], 20K0857-02[1543201117-02], 20K0857-03[1543201117-03], 20K0857-04[1543201117-04], B271147-BLK1, B271147-BS1, B271147-BSD1, B271149-BLK1, B271149-BS1, B271149-BSD1, S054612-CCV1, S054618-CCV1

Chloromethane
20K0857-02[1543201117-02], 20K0857-03[1543201117-03], B271147-BLK1, B271147-BS1, B271147-BSD1, S054618-CCV1

The results of analyses reported only relate to samples submitted to the Con-Test Analytical Laboratory for testing.
I certify that the analyses listed above, unless specifically listed as subcontracted, if any, were performed under my direction according to the approved methodologies listed in this document, and that based upon my inquiry of those individuals immediately responsible for obtaining the information, the material contained in this report is, to the best of my knowledge and belief, accurate and complete.

Lisa A. Worthington
Technical Representative

con-test® ANALYTICAL LABORATORY
39 Spruce Street * East Longmeadow, MA 01028 * FAX 413/525-6405 * TEL. 413/525-2332

Project Location: Haverhill, MA | Sample Description: | Work Order: 20K0857

Date Received: 11/17/2020

Field Sample #: 1543201117-01 | Sampled: 11/17/2020 09:24

Sample ID: 20K0857-01

Sample Matrix: Trip Blank Soil

Volatile Organic Compounds by GC/MS

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Acetone	ND	0.10	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
tert-Amyl Methyl Ether (TAME)	ND	0.0010	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
Benzene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
Bromobenzene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
Bromochloromethane	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
Bromodichloromethane	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
Bromoform	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
Bromomethane	ND	0.010	mg/Kg wet	1	V-34	SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
2-Butanone (MEK)	ND	0.040	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
n-Butylbenzene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
sec-Butylbenzene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
tert-Butylbenzene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
tert-Butyl Ethyl Ether (TBEE)	ND	0.0010	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
Carbon Disulfide	ND	0.0060	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
Carbon Tetrachloride	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
Chlorobenzene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
Chlorodibromomethane	ND	0.0010	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
Chloroethane	ND	0.010	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
Chloroform	ND	0.0040	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
Chloromethane	ND	0.010	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
2-Chlorotoluene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
4-Chlorotoluene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
1,2-Dibromo-3-chloropropane (DBCP)	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
1,2-Dibromoethane (EDB)	ND	0.0010	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
Dibromomethane	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
1,2-Dichlorobenzene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
1,3-Dichlorobenzene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
1,4-Dichlorobenzene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
Dichlorodifluoromethane (Freon 12)	ND	0.010	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
1,1-Dichloroethane	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
1,2-Dichloroethane	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
1,1-Dichloroethylene	ND	0.0040	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
cis-1,2-Dichloroethylene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
trans-1,2-Dichloroethylene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
1,2-Dichloropropane	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
1,3-Dichloropropane	ND	0.0010	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
2,2-Dichloropropane	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
1,1-Dichloropropene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
cis-1,3-Dichloropropene	ND	0.0010	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
trans-1,3-Dichloropropene	ND	0.0010	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
Diethyl Ether	ND	0.010	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
Diisopropyl Ether (DIPE)	ND	0.0010	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
1,4-Dioxane	ND	0.10	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
Ethylbenzene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF

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39 Spruce Street * East Longmeadow, MA 01028 * FAX 413/525-6405 * TEL. 413/525-2332

Project Location: Haverhill, MA | Sample Description: | Work Order: 20K0857

Date Received: 11/17/2020

Field Sample #: 1543201117-01 | Sampled: 11/17/2020 09:24

Sample ID: 20K0857-01

Sample Matrix: Trip Blank Soil

Volatile Organic Compounds by GC/MS

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Hexachlorobutadiene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
2-Hexanone (MBK)	ND	0.020	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
Isopropylbenzene (Cumene)	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
p-Isopropyltoluene (p-Cymene)	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
Methyl tert-Butyl Ether (MTBE)	ND	0.0040	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
Methylene Chloride	ND	0.010	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
4-Methyl-2-pentanone (MIBK)	ND	0.020	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
Naphthalene	ND	0.0040	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
n-Propylbenzene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
Styrene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
1,1,1,2-Tetrachloroethane	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
1,1,2,2-Tetrachloroethane	ND	0.0010	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
Tetrachloroethylene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
Tetrahydrofuran	ND	0.010	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
Toluene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
1,2,3-Trichlorobenzene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
1,2,4-Trichlorobenzene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
1,1,1-Trichloroethane	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
1,1,2-Trichloroethane	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
Trichloroethylene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
Trichlorofluoromethane (Freon 11)	ND	0.010	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
1,2,3-Trichloropropane	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
1,2,4-Trimethylbenzene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
1,3,5-Trimethylbenzene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
Vinyl Chloride	ND	0.010	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
m+p Xylene	ND	0.0040	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF
o-Xylene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	11/18/20	11/18/20 10:57	MFF

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
1,2-Dichloroethane-d4	112	70-130		11/18/20 10:57
Toluene-d8	101	70-130		11/18/20 10:57
4-Bromofluorobenzene	100	70-130		11/18/20 10:57

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39 Spruce Street * East Longmeadow, MA 01028 * FAX 413/525-6405 * TEL. 413/525-2332

Project Location: Haverhill, MA | Sample Description: | Work Order: 20K0857

Date Received: 11/17/2020

Field Sample #: 1543201117-02 | Sampled: 11/17/2020 09:50

Sample ID: 20K0857-02

Sample Matrix: Sediment

Volatile Organic Compounds by GC/MS

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Acetone	ND	8.2	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
tert-Amyl Methyl Ether (TAME)	ND	0.082	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
Benzene	ND	0.16	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
Bromobenzene	ND	0.16	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
Bromochloromethane	ND	0.16	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
Bromodichloromethane	ND	0.16	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
Bromoform	ND	0.16	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
Bromomethane	ND	0.82	mg/Kg dry	1	RL-07, V-34	SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
2-Butanone (MEK)	ND	3.3	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
n-Butylbenzene	ND	0.16	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
sec-Butylbenzene	ND	0.16	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
tert-Butylbenzene	ND	0.16	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
tert-Butyl Ethyl Ether (TBEE)	ND	0.082	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
Carbon Disulfide	ND	1.6	mg/Kg dry	1	RL-07	SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
Carbon Tetrachloride	ND	0.16	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
Chlorobenzene	ND	0.16	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
Chlorodibromomethane	ND	0.082	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
Chloroethane	ND	0.33	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
Chloroform	ND	0.33	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
Chloromethane	ND	0.33	mg/Kg dry	1	V-05, V-34	SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
2-Chlorotoluene	ND	0.16	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
4-Chlorotoluene	ND	0.16	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
1,2-Dibromo-3-chloropropane (DBCP)	ND	0.65	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
1,2-Dibromoethane (EDB)	ND	0.082	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
Dibromomethane	ND	0.16	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
1,2-Dichlorobenzene	ND	0.16	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
1,3-Dichlorobenzene	ND	0.16	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
1,4-Dichlorobenzene	ND	0.16	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
Dichlorodifluoromethane (Freon 12)	ND	0.33	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
1,1-Dichloroethane	ND	0.16	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
1,2-Dichloroethane	ND	0.16	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
1,1-Dichloroethylene	ND	0.16	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
cis-1,2-Dichloroethylene	ND	0.16	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
trans-1,2-Dichloroethylene	ND	0.16	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
1,2-Dichloropropane	ND	0.16	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
1,3-Dichloropropane	ND	0.082	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
2,2-Dichloropropane	ND	0.16	mg/Kg dry	1	V-05, L-04	SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
1,1-Dichloropropene	ND	0.33	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
cis-1,3-Dichloropropene	ND	0.082	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
trans-1,3-Dichloropropene	ND	0.082	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
Diethyl Ether	ND	0.33	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
Diisopropyl Ether (DIPE)	ND	0.082	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
1,4-Dioxane	ND	8.2	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
Ethylbenzene	ND	0.16	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD

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39 Spruce Street * East Longmeadow, MA 01028 * FAX 413/525-6405 * TEL. 413/525-2332

Project Location: Haverhill, MA | Sample Description: | Work Order: 20K0857

Date Received: 11/17/2020

Field Sample #: 1543201117-02 | Sampled: 11/17/2020 09:50

Sample ID: 20K0857-02

Sample Matrix: Sediment

Volatile Organic Compounds by GC/MS

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Hexachlorobutadiene	ND	0.16	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
2-Hexanone (MBK)	ND	1.6	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
Isopropylbenzene (Cumene)	ND	0.16	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
p-Isopropyltoluene (p-Cymene)	ND	0.16	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
Methyl tert-Butyl Ether (MTBE)	ND	0.16	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
Methylene Chloride	ND	0.82	mg/Kg dry	1	RL-07	SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
4-Methyl-2-pentanone (MIBK)	ND	1.6	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
Naphthalene	ND	0.33	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
n-Propylbenzene	ND	0.16	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
Styrene	ND	0.16	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
1,1,1,2-Tetrachloroethane	ND	0.16	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
1,1,2,2-Tetrachloroethane	ND	0.082	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
Tetrachloroethylene	ND	0.16	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
Tetrahydrofuran	ND	0.65	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
Toluene	ND	0.16	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
1,2,3-Trichlorobenzene	ND	0.65	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
1,2,4-Trichlorobenzene	ND	0.16	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
1,1,1-Trichloroethane	ND	0.16	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
1,1,2-Trichloroethane	ND	0.16	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
Trichloroethylene	ND	0.16	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
Trichlorofluoromethane (Freon 11)	ND	0.33	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
1,2,3-Trichloropropane	ND	0.33	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
1,2,4-Trimethylbenzene	ND	0.16	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
1,3,5-Trimethylbenzene	ND	0.16	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
Vinyl Chloride	ND	0.33	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
m+p Xylene	ND	0.33	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD
o-Xylene	ND	0.16	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/19/20 4:39	LBD

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
1,2-Dichloroethane-d4	73.1	70-130		11/19/20 4:39
Toluene-d8	93.2	70-130		11/19/20 4:39
4-Bromofluorobenzene	96.8	70-130		11/19/20 4:39

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Project Location: Haverhill, MA | Sample Description: | Work Order: 20K0857

Date Received: 11/17/2020

Field Sample #: 1543201117-02 | Sampled: 11/17/2020 09:50

Sample ID: 20K0857-02

Sample Matrix: Sediment

Semivolatile Organic Compounds by GC/MS

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Acenaphthene	ND	0.39	mg/Kg dry	1		SW-846 8270D-E	11/19/20	11/21/20 17:10	BGL
Acenaphthylene	ND	0.39	mg/Kg dry	1		SW-846 8270D-E	11/19/20	11/21/20 17:10	BGL
Anthracene	0.49	0.39	mg/Kg dry	1		SW-846 8270D-E	11/19/20	11/21/20 17:10	BGL
Benzo(a)anthracene	1.4	0.39	mg/Kg dry	1		SW-846 8270D-E	11/19/20	11/21/20 17:10	BGL
Benzo(a)pyrene	1.6	0.39	mg/Kg dry	1		SW-846 8270D-E	11/19/20	11/21/20 17:10	BGL
Benzo(b)fluoranthene	2.1	0.39	mg/Kg dry	1		SW-846 8270D-E	11/19/20	11/21/20 17:10	BGL
Benzo(g,h,i)perylene	0.96	0.39	mg/Kg dry	1		SW-846 8270D-E	11/19/20	11/21/20 17:10	BGL
Benzo(k)fluoranthene	0.79	0.39	mg/Kg dry	1		SW-846 8270D-E	11/19/20	11/21/20 17:10	BGL
Chrysene	1.7	0.39	mg/Kg dry	1		SW-846 8270D-E	11/19/20	11/21/20 17:10	BGL
Dibenz(a,h)anthracene	ND	0.39	mg/Kg dry	1		SW-846 8270D-E	11/19/20	11/21/20 17:10	BGL
Fluoranthene	3.8	0.39	mg/Kg dry	1		SW-846 8270D-E	11/19/20	11/21/20 17:10	BGL
Fluorene	ND	0.39	mg/Kg dry	1		SW-846 8270D-E	11/19/20	11/21/20 17:10	BGL
Indeno(1,2,3-cd)pyrene	1.1	0.39	mg/Kg dry	1		SW-846 8270D-E	11/19/20	11/21/20 17:10	BGL
2-Methylnaphthalene	ND	0.39	mg/Kg dry	1		SW-846 8270D-E	11/19/20	11/21/20 17:10	BGL
Naphthalene	0.39	0.39	mg/Kg dry	1		SW-846 8270D-E	11/19/20	11/21/20 17:10	BGL
Phenanthrene	2.0	0.39	mg/Kg dry	1		SW-846 8270D-E	11/19/20	11/21/20 17:10	BGL
Pyrene	2.8	0.39	mg/Kg dry	1		SW-846 8270D-E	11/19/20	11/21/20 17:10	BGL

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Nitrobenzene-d5	68.7	30-130		11/21/20 17:10
2-Fluorobiphenyl	73.1	30-130		11/21/20 17:10
p-Terphenyl-d14	76.6	30-130		11/21/20 17:10

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Project Location: Haverhill, MA | Sample Description: | Work Order: 20K0857

Date Received: 11/17/2020

Field Sample #: 1543201117-02 | Sampled: 11/17/2020 09:50

Sample ID: 20K0857-02

Sample Matrix: Sediment

Sample Flags: DL-03

Organochloride Pesticides by GC/ECD

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Aldrin [1]	ND	0.057	mg/Kg dry	5		SW-846 8081B	11/18/20	11/25/20 5:14	PJG
alpha-BHC [1]	ND	0.057	mg/Kg dry	5		SW-846 8081B	11/18/20	11/25/20 5:14	PJG
beta-BHC [1]	ND	0.057	mg/Kg dry	5		SW-846 8081B	11/18/20	11/25/20 5:14	PJG
delta-BHC [1]	ND	0.057	mg/Kg dry	5		SW-846 8081B	11/18/20	11/25/20 5:14	PJG
gamma-BHC (Lindane) [1]	ND	0.023	mg/Kg dry	5		SW-846 8081B	11/18/20	11/25/20 5:14	PJG
Chlordane [1]	ND	0.23	mg/Kg dry	5		SW-846 8081B	11/18/20	11/25/20 5:14	PJG
4,4'-DDD [1]	ND	0.046	mg/Kg dry	5		SW-846 8081B	11/18/20	11/25/20 5:14	PJG
4,4'-DDE [1]	ND	0.046	mg/Kg dry	5		SW-846 8081B	11/18/20	11/25/20 5:14	PJG
4,4'-DDT [1]	ND	0.046	mg/Kg dry	5		SW-846 8081B	11/18/20	11/25/20 5:14	PJG
Dieldrin [1]	ND	0.046	mg/Kg dry	5		SW-846 8081B	11/18/20	11/25/20 5:14	PJG
Endosulfan I [1]	ND	0.057	mg/Kg dry	5		SW-846 8081B	11/18/20	11/25/20 5:14	PJG
Endosulfan II [1]	ND	0.091	mg/Kg dry	5		SW-846 8081B	11/18/20	11/25/20 5:14	PJG
Endosulfan sulfate [1]	ND	0.091	mg/Kg dry	5		SW-846 8081B	11/18/20	11/25/20 5:14	PJG
Endrin [1]	ND	0.091	mg/Kg dry	5		SW-846 8081B	11/18/20	11/25/20 5:14	PJG
Endrin ketone [1]	ND	0.091	mg/Kg dry	5		SW-846 8081B	11/18/20	11/25/20 5:14	PJG
Heptachlor [1]	ND	0.057	mg/Kg dry	5		SW-846 8081B	11/18/20	11/25/20 5:14	PJG
Heptachlor epoxide [1]	ND	0.057	mg/Kg dry	5		SW-846 8081B	11/18/20	11/25/20 5:14	PJG
Hexachlorobenzene [1]	ND	0.068	mg/Kg dry	5		SW-846 8081B	11/18/20	11/25/20 5:14	PJG
Methoxychlor [1]	ND	0.57	mg/Kg dry	5		SW-846 8081B	11/18/20	11/25/20 5:14	PJG

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Decachlorobiphenyl [1]	53.0	30-150		11/25/20 5:14
Decachlorobiphenyl [2]	59.0	30-150		11/25/20 5:14
Tetrachloro-m-xylene [1]	63.8	30-150		11/25/20 5:14
Tetrachloro-m-xylene [2]	61.5	30-150		11/25/20 5:14

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Project Location: Haverhill, MA | Sample Description: | Work Order: 20K0857

Date Received: 11/17/2020

Field Sample #: 1543201117-02 | Sampled: 11/17/2020 09:50

Sample ID: 20K0857-02

Sample Matrix: Sediment

Sample Flags: O-32

Polychlorinated Biphenyls By GC/ECD

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Aroclor-1016 [1]	ND	0.18	mg/Kg dry	4		SW-846 8082A	11/18/20	11/22/20 20:21	JMB
Aroclor-1221 [1]	ND	0.18	mg/Kg dry	4		SW-846 8082A	11/18/20	11/22/20 20:21	JMB
Aroclor-1232 [1]	ND	0.18	mg/Kg dry	4		SW-846 8082A	11/18/20	11/22/20 20:21	JMB
Aroclor-1242 [1]	ND	0.18	mg/Kg dry	4		SW-846 8082A	11/18/20	11/22/20 20:21	JMB
Aroclor-1248 [1]	ND	0.18	mg/Kg dry	4		SW-846 8082A	11/18/20	11/22/20 20:21	JMB
Aroclor-1254 [1]	ND	0.18	mg/Kg dry	4		SW-846 8082A	11/18/20	11/22/20 20:21	JMB
Aroclor-1260 [1]	ND	0.18	mg/Kg dry	4		SW-846 8082A	11/18/20	11/22/20 20:21	JMB
Aroclor-1262 [1]	ND	0.18	mg/Kg dry	4		SW-846 8082A	11/18/20	11/22/20 20:21	JMB
Aroclor-1268 [1]	ND	0.18	mg/Kg dry	4		SW-846 8082A	11/18/20	11/22/20 20:21	JMB

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Decachlorobiphenyl [1]	75.2	30-150		11/22/20 20:21
Decachlorobiphenyl [2]	78.9	30-150		11/22/20 20:21
Tetrachloro-m-xylene [1]	79.2	30-150		11/22/20 20:21
Tetrachloro-m-xylene [2]	81.0	30-150		11/22/20 20:21

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Project Location: Haverhill, MA | Sample Description: | Work Order: 20K0857

Date Received: 11/17/2020

Field Sample #: 1543201117-02 | Sampled: 11/17/2020 09:50

Sample ID: 20K0857-02

Sample Matrix: Sediment

Sample Flags: DL-03

Herbicides by GC/ECD

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
2,4-D [1]	ND	290	µg/kg dry	5		SW-846 8151A	11/20/20	11/23/20 19:53	JMB
2,4-DB [2]	ND	290	µg/kg dry	5		SW-846 8151A	11/20/20	11/23/20 19:53	JMB
2,4,5-TP (Silvex) [1]	ND	29	µg/kg dry	5		SW-846 8151A	11/20/20	11/23/20 19:53	JMB
2,4,5-T [1]	ND	29	µg/kg dry	5		SW-846 8151A	11/20/20	11/23/20 19:53	JMB
Dalalpon [1]	ND	710	µg/kg dry	5		SW-846 8151A	11/20/20	11/23/20 19:53	JMB
Dicamba [1]	ND	29	µg/kg dry	5		SW-846 8151A	11/20/20	11/23/20 19:53	JMB
Dichloroprop [1]	ND	290	µg/kg dry	5		SW-846 8151A	11/20/20	11/23/20 19:53	JMB
Dinoseb [1]	ND	140	µg/kg dry	5		SW-846 8151A	11/20/20	11/23/20 19:53	JMB
MCPA [1]	ND	29000	µg/kg dry	5		SW-846 8151A	11/20/20	11/23/20 19:53	JMB
MCPP [1]	ND	29000	µg/kg dry	5		SW-846 8151A	11/20/20	11/23/20 19:53	JMB

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
2,4-Dichlorophenylacetic acid [1]	113	30-150		11/23/20 19:53
2,4-Dichlorophenylacetic acid [2]	**1110** *	30-150	S-02	11/23/20 19:53

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Project Location: Haverhill, MA | Sample Description: | Work Order: 20K0857

Date Received: 11/17/2020

Field Sample #: 1543201117-02 | Sampled: 11/17/2020 09:50

Sample ID: 20K0857-02

Sample Matrix: Sediment

Petroleum Hydrocarbons Analyses - EPH

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
C9-C18 Aliphatics	86	23	mg/Kg dry	1		MADEP EPH rev 2.1	11/19/20	11/25/20 2:17	RMW
C19-C36 Aliphatics	46	23	mg/Kg dry	1		MADEP EPH rev 2.1	11/19/20	11/25/20 2:17	RMW
Unadjusted C11-C22 Aromatics	2700	230	mg/Kg dry	10		MADEP EPH rev 2.1	11/19/20	11/25/20 12:17	RMW
C11-C22 Aromatics	1600	230	mg/Kg dry	10		MADEP EPH rev 2.1	11/19/20	11/25/20 12:17	RMW
Acenaphthene	80	2.3	mg/Kg dry	10		MADEP EPH rev 2.1	11/19/20	11/25/20 12:17	RMW
Acenaphthylene	28	0.23	mg/Kg dry	1		MADEP EPH rev 2.1	11/19/20	11/25/20 2:17	RMW
Anthracene	16	0.23	mg/Kg dry	1		MADEP EPH rev 2.1	11/19/20	11/25/20 2:17	RMW
Benzo(a)anthracene	12	0.23	mg/Kg dry	1		MADEP EPH rev 2.1	11/19/20	11/25/20 2:17	RMW
Benzo(a)pyrene	7.0	0.23	mg/Kg dry	1		MADEP EPH rev 2.1	11/19/20	11/25/20 2:17	RMW
Benzo(b)fluoranthene	8.2	0.23	mg/Kg dry	1		MADEP EPH rev 2.1	11/19/20	11/25/20 2:17	RMW
Benzo(g,h,i)perylene	2.7	0.23	mg/Kg dry	1		MADEP EPH rev 2.1	11/19/20	11/25/20 2:17	RMW
Benzo(k)fluoranthene	2.7	0.23	mg/Kg dry	1		MADEP EPH rev 2.1	11/19/20	11/25/20 2:17	RMW
Chrysene	11	0.23	mg/Kg dry	1		MADEP EPH rev 2.1	11/19/20	11/25/20 2:17	RMW
Dibenz(a,h)anthracene	0.98	0.23	mg/Kg dry	1		MADEP EPH rev 2.1	11/19/20	11/25/20 2:17	RMW
Fluoranthene	43	0.23	mg/Kg dry	1		MADEP EPH rev 2.1	11/19/20	11/25/20 2:17	RMW
Fluorene	68	2.3	mg/Kg dry	10		MADEP EPH rev 2.1	11/19/20	11/25/20 12:17	RMW
Indeno(1,2,3-cd)pyrene	3.0	0.23	mg/Kg dry	1		MADEP EPH rev 2.1	11/19/20	11/25/20 2:17	RMW
2-Methylnaphthalene	270	2.3	mg/Kg dry	10		MADEP EPH rev 2.1	11/19/20	11/25/20 12:17	RMW
Naphthalene	380	2.3	mg/Kg dry	10		MADEP EPH rev 2.1	11/19/20	11/25/20 12:17	RMW
Phenanthrene	150	2.3	mg/Kg dry	10		MADEP EPH rev 2.1	11/19/20	11/25/20 12:17	RMW
Pyrene	48	2.3	mg/Kg dry	10		MADEP EPH rev 2.1	11/19/20	11/25/20 12:17	RMW

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Chlorooctadecane (COD)	64.1	40-140		11/25/20 2:17
o-Terphenyl (OTP)	120	40-140		11/25/20 2:17
o-Terphenyl (OTP)	109	40-140		11/25/20 12:17
2-Bromonaphthalene	105	40-140		11/25/20 2:17
2-Fluorobiphenyl	96.7	40-140		11/25/20 2:17

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Project Location: Haverhill, MA | Sample Description: | Work Order: 20K0857

Date Received: 11/17/2020

Field Sample #: 1543201117-02 | Sampled: 11/17/2020 09:50

Sample ID: 20K0857-02

Sample Matrix: Sediment

Metals Analyses (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Arsenic	15	7.7	mg/Kg dry	1		SW-846 6010D	11/18/20	11/19/20 20:39	MJH
Barium	99	3.8	mg/Kg dry	1		SW-846 6010D	11/18/20	11/19/20 20:39	MJH
Cadmium	1.1	0.77	mg/Kg dry	1		SW-846 6010D	11/18/20	11/19/20 20:39	MJH
Chromium	34	1.5	mg/Kg dry	1		SW-846 6010D	11/18/20	11/19/20 20:39	MJH
Copper	40	1.5	mg/Kg dry	1		SW-846 6010D	11/18/20	11/19/20 20:39	TBC
Lead	220	1.2	mg/Kg dry	1		SW-846 6010D	11/18/20	11/19/20 20:39	MJH
Mercury	0.29	0.058	mg/Kg dry	1		SW-846 7471B	11/18/20	11/20/20 14:52	CJV
Nickel	21	1.5	mg/Kg dry	1		SW-846 6010D	11/18/20	11/19/20 20:39	MJH
Selenium	ND	7.7	mg/Kg dry	1		SW-846 6010D	11/18/20	11/19/20 20:39	MJH
Silver	ND	0.77	mg/Kg dry	1		SW-846 6010D	11/18/20	11/19/20 20:39	MJH
Zinc	230	1.5	mg/Kg dry	1		SW-846 6010D	11/18/20	11/19/20 20:39	TBC

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Project Location: Haverhill, MA | Sample Description: | Work Order: 20K0857

Date Received: 11/17/2020

Field Sample #: 1543201117-02 | Sampled: 11/17/2020 09:50

Sample ID: 20K0857-02

Sample Matrix: Sediment

Conventional Chemistry Parameters by EPA/APHA/SW-846 Methods (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
% Solids	43.8		% Wt	1		SM 2540G	11/19/20	11/20/20 9:03	RMF
Total Organic Carbon	60000	100	mg/Kg	1	Z-01	SW 846 9060A	11/19/20	11/19/20 20:31	DJM

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Project Location: Haverhill, MA | Sample Description: | Work Order: 20K0857

Date Received: 11/17/2020

Field Sample #: 1543201117-03 | Sampled: 11/17/2020 10:15

Sample ID: 20K0857-03

Sample Matrix: Sediment

Sample Flags: RL-05

Volatile Organic Compounds by GC/MS

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Acetone	ND	38	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
tert-Amyl Methyl Ether (TAME)	ND	0.38	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
Benzene	ND	0.75	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
Bromobenzene	ND	0.75	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
Bromochloromethane	ND	0.75	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
Bromodichloromethane	ND	0.75	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
Bromoform	ND	0.75	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
Bromomethane	ND	3.8	mg/Kg dry	10	V-34	SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
2-Butanone (MEK)	ND	15	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
n-Butylbenzene	ND	0.75	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
sec-Butylbenzene	ND	0.75	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
tert-Butylbenzene	ND	0.75	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
tert-Butyl Ethyl Ether (TBEE)	ND	0.38	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
Carbon Disulfide	ND	7.5	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
Carbon Tetrachloride	ND	0.75	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
Chlorobenzene	ND	0.75	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
Chlorodibromomethane	ND	0.38	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
Chloroethane	ND	1.5	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
Chloroform	ND	1.5	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
Chloromethane	ND	1.5	mg/Kg dry	10	V-05, V-34	SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
2-Chlorotoluene	ND	0.75	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
4-Chlorotoluene	ND	0.75	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
1,2-Dibromo-3-chloropropane (DBCP)	ND	3.0	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
1,2-Dibromoethane (EDB)	ND	0.38	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
Dibromomethane	ND	0.75	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
1,2-Dichlorobenzene	ND	0.75	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
1,3-Dichlorobenzene	ND	0.75	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
1,4-Dichlorobenzene	ND	0.75	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
Dichlorodifluoromethane (Freon 12)	ND	1.5	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
1,1-Dichloroethane	ND	0.75	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
1,2-Dichloroethane	ND	0.75	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
1,1-Dichloroethylene	ND	0.75	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
cis-1,2-Dichloroethylene	ND	0.75	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
trans-1,2-Dichloroethylene	ND	0.75	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
1,2-Dichloropropane	ND	0.75	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
1,3-Dichloropropane	ND	0.38	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
2,2-Dichloropropane	ND	0.75	mg/Kg dry	10	L-04, V-05	SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
1,1-Dichloropropene	ND	1.5	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
cis-1,3-Dichloropropene	ND	0.38	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
trans-1,3-Dichloropropene	ND	0.38	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
Diethyl Ether	ND	1.5	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
Diisopropyl Ether (DIPE)	ND	0.38	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
1,4-Dioxane	ND	38	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
Ethylbenzene	0.86	0.75	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD

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Project Location: Haverhill, MA | Sample Description: | Work Order: 20K0857

Date Received: 11/17/2020

Field Sample #: 1543201117-03 | Sampled: 11/17/2020 10:15

Sample ID: 20K0857-03

Sample Matrix: Sediment

Sample Flags: RL-05

Volatile Organic Compounds by GC/MS

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Hexachlorobutadiene	ND	0.75	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
2-Hexanone (MBK)	ND	7.5	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
Isopropylbenzene (Cumene)	3.8	0.75	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
p-Isopropyltoluene (p-Cymene)	0.88	0.75	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
Methyl tert-Butyl Ether (MTBE)	ND	0.75	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
Methylene Chloride	ND	3.8	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
4-Methyl-2-pentanone (MIBK)	ND	7.5	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
Naphthalene	56	1.5	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
n-Propylbenzene	2.6	0.75	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
Styrene	ND	0.75	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
1,1,1,2-Tetrachloroethane	ND	0.75	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
1,1,2,2-Tetrachloroethane	ND	0.38	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
Tetrachloroethylene	ND	0.75	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
Tetrahydrofuran	ND	3.0	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
Toluene	ND	0.75	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
1,2,3-Trichlorobenzene	ND	3.0	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
1,2,4-Trichlorobenzene	ND	0.75	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
1,1,1-Trichloroethane	ND	0.75	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
1,1,2-Trichloroethane	ND	0.75	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
Trichloroethylene	ND	0.75	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
Trichlorofluoromethane (Freon 11)	ND	1.5	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
1,2,3-Trichloropropane	ND	1.5	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
1,2,4-Trimethylbenzene	28	0.75	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
1,3,5-Trimethylbenzene	ND	0.75	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
Vinyl Chloride	ND	1.5	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
m+p Xylene	ND	1.5	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD
o-Xylene	ND	0.75	mg/Kg dry	10		SW-846 8260C-D	11/18/20	11/19/20 7:23	LBD

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
1,2-Dichloroethane-d4	70.2	70-130		11/19/20 7:23
Toluene-d8	92.8	70-130		11/19/20 7:23
4-Bromofluorobenzene	96.6	70-130		11/19/20 7:23

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Project Location: Haverhill, MA | Sample Description: | Work Order: 20K0857

Date Received: 11/17/2020

Field Sample #: 1543201117-03 | Sampled: 11/17/2020 10:15

Sample ID: 20K0857-03

Sample Matrix: Sediment

Semivolatile Organic Compounds by GC/MS

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Acenaphthene	0.23	0.23	mg/Kg dry	1		SW-846 8270D-E	11/19/20	11/21/20 17:34	BGL
Acenaphthylene	0.43	0.23	mg/Kg dry	1		SW-846 8270D-E	11/19/20	11/21/20 17:34	BGL
Anthracene	0.93	0.23	mg/Kg dry	1		SW-846 8270D-E	11/19/20	11/21/20 17:34	BGL
Benzo(a)anthracene	2.6	0.23	mg/Kg dry	1		SW-846 8270D-E	11/19/20	11/21/20 17:34	BGL
Benzo(a)pyrene	2.6	0.23	mg/Kg dry	1		SW-846 8270D-E	11/19/20	11/21/20 17:34	BGL
Benzo(b)fluoranthene	3.2	0.23	mg/Kg dry	1		SW-846 8270D-E	11/19/20	11/21/20 17:34	BGL
Benzo(g,h,i)perylene	1.5	0.23	mg/Kg dry	1		SW-846 8270D-E	11/19/20	11/21/20 17:34	BGL
Benzo(k)fluoranthene	1.1	0.23	mg/Kg dry	1		SW-846 8270D-E	11/19/20	11/21/20 17:34	BGL
Chrysene	2.8	0.23	mg/Kg dry	1		SW-846 8270D-E	11/19/20	11/21/20 17:34	BGL
Dibenz(a,h)anthracene	0.37	0.23	mg/Kg dry	1		SW-846 8270D-E	11/19/20	11/21/20 17:34	BGL
Fluoranthene	6.1	0.47	mg/Kg dry	2		SW-846 8270D-E	11/19/20	11/23/20 16:23	BGL
Fluorene	0.59	0.23	mg/Kg dry	1		SW-846 8270D-E	11/19/20	11/21/20 17:34	BGL
Indeno(1,2,3-cd)pyrene	1.7	0.23	mg/Kg dry	1		SW-846 8270D-E	11/19/20	11/21/20 17:34	BGL
2-Methylnaphthalene	ND	0.23	mg/Kg dry	1		SW-846 8270D-E	11/19/20	11/21/20 17:34	BGL
Naphthalene	0.57	0.23	mg/Kg dry	1		SW-846 8270D-E	11/19/20	11/21/20 17:34	BGL
Phenanthrene	4.7	0.23	mg/Kg dry	1		SW-846 8270D-E	11/19/20	11/21/20 17:34	BGL
Pyrene	5.2	0.23	mg/Kg dry	1		SW-846 8270D-E	11/19/20	11/21/20 17:34	BGL

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Nitrobenzene-d5	63.0	30-130		11/21/20 17:34
Nitrobenzene-d5	63.4	30-130		11/23/20 16:23
2-Fluorobiphenyl	69.9	30-130		11/21/20 17:34
2-Fluorobiphenyl	68.2	30-130		11/23/20 16:23
p-Terphenyl-d14	70.6	30-130		11/21/20 17:34
p-Terphenyl-d14	70.0	30-130		11/23/20 16:23

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Project Location: Haverhill, MA | Sample Description: | Work Order: 20K0857

Date Received: 11/17/2020

Field Sample #: 1543201117-03 | Sampled: 11/17/2020 10:15

Sample ID: 20K0857-03

Sample Matrix: Sediment

Sample Flags: DL-03

Organochloride Pesticides by GC/ECD

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Aldrin [1]	ND	0.068	mg/Kg dry	10		SW-846 8081B	11/18/20	11/25/20 5:41	PJG
alpha-BHC [1]	ND	0.068	mg/Kg dry	10		SW-846 8081B	11/18/20	11/25/20 5:41	PJG
beta-BHC [1]	ND	0.068	mg/Kg dry	10		SW-846 8081B	11/18/20	11/25/20 5:41	PJG
delta-BHC [1]	ND	0.068	mg/Kg dry	10		SW-846 8081B	11/18/20	11/25/20 5:41	PJG
gamma-BHC (Lindane) [1]	ND	0.027	mg/Kg dry	10		SW-846 8081B	11/18/20	11/25/20 5:41	PJG
Chlordane [1]	ND	0.27	mg/Kg dry	10		SW-846 8081B	11/18/20	11/25/20 5:41	PJG
4,4'-DDD [1]	ND	0.055	mg/Kg dry	10		SW-846 8081B	11/18/20	11/25/20 5:41	PJG
4,4'-DDE [1]	ND	0.055	mg/Kg dry	10		SW-846 8081B	11/18/20	11/25/20 5:41	PJG
4,4'-DDT [1]	ND	0.055	mg/Kg dry	10		SW-846 8081B	11/18/20	11/25/20 5:41	PJG
Dieldrin [1]	ND	0.055	mg/Kg dry	10		SW-846 8081B	11/18/20	11/25/20 5:41	PJG
Endosulfan I [1]	ND	0.068	mg/Kg dry	10		SW-846 8081B	11/18/20	11/25/20 5:41	PJG
Endosulfan II [1]	ND	0.11	mg/Kg dry	10		SW-846 8081B	11/18/20	11/25/20 5:41	PJG
Endosulfan sulfate [1]	ND	0.11	mg/Kg dry	10		SW-846 8081B	11/18/20	11/25/20 5:41	PJG
Endrin [1]	ND	0.11	mg/Kg dry	10		SW-846 8081B	11/18/20	11/25/20 5:41	PJG
Endrin ketone [1]	ND	0.11	mg/Kg dry	10		SW-846 8081B	11/18/20	11/25/20 5:41	PJG
Heptachlor [1]	ND	0.068	mg/Kg dry	10		SW-846 8081B	11/18/20	11/25/20 5:41	PJG
Heptachlor epoxide [1]	ND	0.068	mg/Kg dry	10		SW-846 8081B	11/18/20	11/25/20 5:41	PJG
Hexachlorobenzene [1]	ND	0.082	mg/Kg dry	10		SW-846 8081B	11/18/20	11/25/20 5:41	PJG
Methoxychlor [1]	ND	0.68	mg/Kg dry	10		SW-846 8081B	11/18/20	11/25/20 5:41	PJG

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Decachlorobiphenyl [1]	80.8	30-150		11/25/20 5:41
Decachlorobiphenyl [2]	83.9	30-150		11/25/20 5:41
Tetrachloro-m-xylene [1]	87.0	30-150		11/25/20 5:41
Tetrachloro-m-xylene [2]	80.7	30-150		11/25/20 5:41

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Project Location: Haverhill, MA | Sample Description: | Work Order: 20K0857

Date Received: 11/17/2020

Field Sample #: 1543201117-03 | Sampled: 11/17/2020 10:15

Sample ID: 20K0857-03

Sample Matrix: Sediment

Polychlorinated Biphenyls By GC/ECD

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Aroclor-1016 [1]	ND	0.55	mg/Kg dry	20		SW-846 8082A	11/18/20	11/23/20 4:57	JMB
Aroclor-1221 [1]	ND	0.55	mg/Kg dry	20		SW-846 8082A	11/18/20	11/23/20 4:57	JMB
Aroclor-1232 [1]	ND	0.55	mg/Kg dry	20		SW-846 8082A	11/18/20	11/23/20 4:57	JMB
Aroclor-1242 [1]	ND	0.55	mg/Kg dry	20		SW-846 8082A	11/18/20	11/23/20 4:57	JMB
Aroclor-1248 [1]	ND	0.55	mg/Kg dry	20		SW-846 8082A	11/18/20	11/23/20 4:57	JMB
Aroclor-1254 [1]	ND	0.55	mg/Kg dry	20		SW-846 8082A	11/18/20	11/23/20 4:57	JMB
Aroclor-1260 [2]	4.2	0.55	mg/Kg dry	20		SW-846 8082A	11/18/20	11/23/20 4:57	JMB
Aroclor-1262 [1]	ND	0.55	mg/Kg dry	20		SW-846 8082A	11/18/20	11/23/20 4:57	JMB
Aroclor-1268 [1]	ND	0.55	mg/Kg dry	20		SW-846 8082A	11/18/20	11/23/20 4:57	JMB

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Decachlorobiphenyl [1]	108	30-150		11/23/20 4:57
Decachlorobiphenyl [2]	115	30-150		11/23/20 4:57
Tetrachloro-m-xylene [1]	96.5	30-150		11/23/20 4:57
Tetrachloro-m-xylene [2]	105	30-150		11/23/20 4:57

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Project Location: Haverhill, MA | Sample Description: | Work Order: 20K0857

Date Received: 11/17/2020

Field Sample #: 1543201117-03 | Sampled: 11/17/2020 10:15

Sample ID: 20K0857-03

Sample Matrix: Sediment

Sample Flags: DL-03

Herbicides by GC/ECD

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
2,4-D [1]	ND	170	µg/kg dry	5		SW-846 8151A	11/20/20	11/23/20 20:33	JMB
2,4-DB [2]	ND	170	µg/kg dry	5		SW-846 8151A	11/20/20	11/23/20 20:33	JMB
2,4,5-TP (Silvex) [1]	ND	17	µg/kg dry	5		SW-846 8151A	11/20/20	11/23/20 20:33	JMB
2,4,5-T [1]	ND	17	µg/kg dry	5		SW-846 8151A	11/20/20	11/23/20 20:33	JMB
Dalalpon [1]	ND	430	µg/kg dry	5		SW-846 8151A	11/20/20	11/23/20 20:33	JMB
Dicamba [1]	ND	17	µg/kg dry	5		SW-846 8151A	11/20/20	11/23/20 20:33	JMB
Dichloroprop [1]	ND	170	µg/kg dry	5		SW-846 8151A	11/20/20	11/23/20 20:33	JMB
Dinoseb [1]	ND	86	µg/kg dry	5		SW-846 8151A	11/20/20	11/23/20 20:33	JMB
MCPA [1]	ND	17000	µg/kg dry	5		SW-846 8151A	11/20/20	11/23/20 20:33	JMB
MCPP [1]	ND	17000	µg/kg dry	5		SW-846 8151A	11/20/20	11/23/20 20:33	JMB

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
2,4-Dichlorophenylacetic acid [1]	101	30-150		11/23/20 20:33
2,4-Dichlorophenylacetic acid [2]	**841** *	30-150	S-02	11/23/20 20:33

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Project Location: Haverhill, MA | Sample Description: | Work Order: 20K0857

Date Received: 11/17/2020

Field Sample #: 1543201117-03 | Sampled: 11/17/2020 10:15

Sample ID: 20K0857-03

Sample Matrix: Sediment

Petroleum Hydrocarbons Analyses - EPH

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
C9-C18 Aliphatics	31	14	mg/Kg dry	1		MADEP EPH rev 2.1	11/19/20	11/25/20 2:36	RMW
C19-C36 Aliphatics	580	140	mg/Kg dry	10		MADEP EPH rev 2.1	11/19/20	11/25/20 12:36	RMW
Unadjusted C11-C22 Aromatics	320	14	mg/Kg dry	1		MADEP EPH rev 2.1	11/19/20	11/25/20 2:36	RMW
C11-C22 Aromatics	300	14	mg/Kg dry	1		MADEP EPH rev 2.1	11/19/20	11/25/20 2:36	RMW
Acenaphthene	0.39	0.14	mg/Kg dry	1		MADEP EPH rev 2.1	11/19/20	11/25/20 2:36	RMW
Acenaphthylene	0.24	0.14	mg/Kg dry	1		MADEP EPH rev 2.1	11/19/20	11/25/20 2:36	RMW
Anthracene	0.48	0.14	mg/Kg dry	1		MADEP EPH rev 2.1	11/19/20	11/25/20 2:36	RMW
Benzo(a)anthracene	1.1	0.14	mg/Kg dry	1		MADEP EPH rev 2.1	11/19/20	11/25/20 2:36	RMW
Benzo(a)pyrene	1.2	0.14	mg/Kg dry	1		MADEP EPH rev 2.1	11/19/20	11/25/20 2:36	RMW
Benzo(b)fluoranthene	2.4	0.14	mg/Kg dry	1		MADEP EPH rev 2.1	11/19/20	11/25/20 2:36	RMW
Benzo(g,h,i)perylene	0.97	0.14	mg/Kg dry	1		MADEP EPH rev 2.1	11/19/20	11/25/20 2:36	RMW
Benzo(k)fluoranthene	0.82	0.14	mg/Kg dry	1		MADEP EPH rev 2.1	11/19/20	11/25/20 2:36	RMW
Chrysene	2.8	0.14	mg/Kg dry	1		MADEP EPH rev 2.1	11/19/20	11/25/20 2:36	RMW
Dibenz(a,h)anthracene	0.24	0.14	mg/Kg dry	1		MADEP EPH rev 2.1	11/19/20	11/25/20 2:36	RMW
Fluoranthene	3.6	0.14	mg/Kg dry	1		MADEP EPH rev 2.1	11/19/20	11/25/20 2:36	RMW
Fluorene	0.41	0.14	mg/Kg dry	1		MADEP EPH rev 2.1	11/19/20	11/25/20 2:36	RMW
Indeno(1,2,3-cd)pyrene	1.1	0.14	mg/Kg dry	1		MADEP EPH rev 2.1	11/19/20	11/25/20 2:36	RMW
2-Methylnaphthalene	0.41	0.14	mg/Kg dry	1		MADEP EPH rev 2.1	11/19/20	11/25/20 2:36	RMW
Naphthalene	0.55	0.14	mg/Kg dry	1		MADEP EPH rev 2.1	11/19/20	11/25/20 2:36	RMW
Phenanthrene	2.5	0.14	mg/Kg dry	1		MADEP EPH rev 2.1	11/19/20	11/25/20 2:36	RMW
Pyrene	3.6	0.14	mg/Kg dry	1		MADEP EPH rev 2.1	11/19/20	11/25/20 2:36	RMW

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Chlorooctadecane (COD)	65.3	40-140		11/25/20 2:36
Chlorooctadecane (COD)	60.7	40-140		11/25/20 12:36
o-Terphenyl (OTP)	71.2	40-140		11/25/20 2:36
2-Bromonaphthalene	86.7	40-140		11/25/20 2:36
2-Fluorobiphenyl	95.4	40-140		11/25/20 2:36

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39 Spruce Street * East Longmeadow, MA 01028 * FAX 413/525-6405 * TEL. 413/525-2332

Project Location: Haverhill, MA | Sample Description: | Work Order: 20K0857

Date Received: 11/17/2020

Field Sample #: 1543201117-03 | Sampled: 11/17/2020 10:15

Sample ID: 20K0857-03

Sample Matrix: Sediment

Metals Analyses (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Arsenic	6.3	4.5	mg/Kg dry	1		SW-846 6010D	11/18/20	11/19/20 20:43	MJH
Barium	32	2.3	mg/Kg dry	1		SW-846 6010D	11/18/20	11/19/20 20:43	MJH
Cadmium	0.46	0.45	mg/Kg dry	1		SW-846 6010D	11/18/20	11/19/20 20:43	MJH
Chromium	17	0.90	mg/Kg dry	1		SW-846 6010D	11/18/20	11/19/20 20:43	MJH
Copper	19	0.90	mg/Kg dry	1		SW-846 6010D	11/18/20	11/19/20 20:43	TBC
Lead	84	0.68	mg/Kg dry	1		SW-846 6010D	11/18/20	11/19/20 20:43	MJH
Mercury	0.037	0.034	mg/Kg dry	1		SW-846 7471B	11/18/20	11/20/20 14:54	CJV
Nickel	10	0.90	mg/Kg dry	1		SW-846 6010D	11/18/20	11/19/20 20:43	MJH
Selenium	ND	4.5	mg/Kg dry	1		SW-846 6010D	11/18/20	11/19/20 20:43	MJH
Silver	ND	0.45	mg/Kg dry	1		SW-846 6010D	11/18/20	11/19/20 20:43	MJH
Zinc	96	0.90	mg/Kg dry	1		SW-846 6010D	11/18/20	11/19/20 20:43	TBC

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Project Location: Haverhill, MA | Sample Description: | Work Order: 20K0857

Date Received: 11/17/2020

Field Sample #: 1543201117-03 | Sampled: 11/17/2020 10:15

Sample ID: 20K0857-03

Sample Matrix: Sediment

Conventional Chemistry Parameters by EPA/APHA/SW-846 Methods (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
% Solids	73.0		% Wt	1		SM 2540G	11/19/20	11/20/20 9:03	RMF
Total Organic Carbon	11000	100	mg/Kg	1		SW 846 9060A	11/19/20	11/19/20 21:09	DJM

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Project Location: Haverhill, MA | Sample Description: | Work Order: 20K0857

Date Received: 11/17/2020

Field Sample #: 1543201117-04 | Sampled: 11/17/2020 11:15

Sample ID: 20K0857-04

Sample Matrix: Sediment

Volatile Organic Compounds by GC/MS

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Acetone	ND	0.17	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
tert-Amyl Methyl Ether (TAME)	ND	0.0017	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
Benzene	ND	0.0033	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
Bromobenzene	ND	0.0033	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
Bromochloromethane	ND	0.0033	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
Bromodichloromethane	ND	0.0033	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
Bromoform	ND	0.0033	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
Bromomethane	ND	0.017	mg/Kg dry	1	V-34	SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
2-Butanone (MEK)	ND	0.067	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
n-Butylbenzene	ND	0.0033	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
sec-Butylbenzene	ND	0.0033	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
tert-Butylbenzene	ND	0.0033	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
tert-Butyl Ethyl Ether (TBEE)	ND	0.0017	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
Carbon Disulfide	ND	0.010	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
Carbon Tetrachloride	ND	0.0033	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
Chlorobenzene	ND	0.0033	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
Chlorodibromomethane	ND	0.0017	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
Chloroethane	ND	0.017	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
Chloroform	ND	0.0067	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
Chloromethane	ND	0.017	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
2-Chlorotoluene	ND	0.0033	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
4-Chlorotoluene	ND	0.0033	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
1,2-Dibromo-3-chloropropane (DBCP)	ND	0.0033	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
1,2-Dibromoethane (EDB)	ND	0.0017	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
Dibromomethane	ND	0.0033	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
1,2-Dichlorobenzene	ND	0.0033	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
1,3-Dichlorobenzene	ND	0.0033	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
1,4-Dichlorobenzene	ND	0.0033	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
Dichlorodifluoromethane (Freon 12)	ND	0.017	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
1,1-Dichloroethane	ND	0.0033	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
1,2-Dichloroethane	ND	0.0033	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
1,1-Dichloroethylene	ND	0.0067	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
cis-1,2-Dichloroethylene	ND	0.0033	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
trans-1,2-Dichloroethylene	ND	0.0033	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
1,2-Dichloropropane	ND	0.0033	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
1,3-Dichloropropane	ND	0.0017	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
2,2-Dichloropropane	ND	0.0033	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
1,1-Dichloropropene	ND	0.0033	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
cis-1,3-Dichloropropene	ND	0.0017	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
trans-1,3-Dichloropropene	ND	0.0017	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
Diethyl Ether	ND	0.017	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
Diisopropyl Ether (DIPE)	ND	0.0017	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
1,4-Dioxane	ND	0.17	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
Ethylbenzene	ND	0.0033	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF

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Project Location: Haverhill, MA | Sample Description: | Work Order: 20K0857

Date Received: 11/17/2020

Field Sample #: 1543201117-04 | Sampled: 11/17/2020 11:15

Sample ID: 20K0857-04

Sample Matrix: Sediment

Volatile Organic Compounds by GC/MS

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Hexachlorobutadiene	ND	0.0033	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
2-Hexanone (MBK)	ND	0.033	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
Isopropylbenzene (Cumene)	ND	0.0033	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
p-Isopropyltoluene (p-Cymene)	ND	0.0033	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
Methyl tert-Butyl Ether (MTBE)	ND	0.0067	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
Methylene Chloride	ND	0.017	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
4-Methyl-2-pentanone (MIBK)	ND	0.033	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
Naphthalene	ND	0.0067	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
n-Propylbenzene	ND	0.0033	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
Styrene	ND	0.0033	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
1,1,1,2-Tetrachloroethane	ND	0.0033	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
1,1,2,2-Tetrachloroethane	ND	0.0017	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
Tetrachloroethylene	ND	0.0033	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
Tetrahydrofuran	ND	0.017	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
Toluene	ND	0.0033	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
1,2,3-Trichlorobenzene	ND	0.0033	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
1,2,4-Trichlorobenzene	ND	0.0033	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
1,1,1-Trichloroethane	ND	0.0033	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
1,1,2-Trichloroethane	ND	0.0033	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
Trichloroethylene	ND	0.0033	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
Trichlorofluoromethane (Freon 11)	ND	0.017	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
1,2,3-Trichloropropane	ND	0.0033	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
1,2,4-Trimethylbenzene	ND	0.0033	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
1,3,5-Trimethylbenzene	ND	0.0033	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
Vinyl Chloride	ND	0.017	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
m+p Xylene	ND	0.0067	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF
o-Xylene	ND	0.0033	mg/Kg dry	1		SW-846 8260C-D	11/18/20	11/18/20 11:22	MFF

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
1,2-Dichloroethane-d4	111	70-130		11/18/20 11:22
Toluene-d8	102	70-130		11/18/20 11:22
4-Bromofluorobenzene	99.7	70-130		11/18/20 11:22

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Project Location: Haverhill, MA | Sample Description: | Work Order: 20K0857

Date Received: 11/17/2020

Field Sample #: 1543201117-04 | Sampled: 11/17/2020 11:15

Sample ID: 20K0857-04

Sample Matrix: Sediment

Semivolatile Organic Compounds by GC/MS

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Acenaphthene	ND	0.37	mg/Kg dry	1		SW-846 8270D-E	11/19/20	11/21/20 17:58	BGL
Acenaphthylene	ND	0.37	mg/Kg dry	1		SW-846 8270D-E	11/19/20	11/21/20 17:58	BGL
Anthracene	ND	0.37	mg/Kg dry	1		SW-846 8270D-E	11/19/20	11/21/20 17:58	BGL
Benzo(a)anthracene	ND	0.37	mg/Kg dry	1		SW-846 8270D-E	11/19/20	11/21/20 17:58	BGL
Benzo(a)pyrene	ND	0.37	mg/Kg dry	1		SW-846 8270D-E	11/19/20	11/21/20 17:58	BGL
Benzo(b)fluoranthene	0.43	0.37	mg/Kg dry	1		SW-846 8270D-E	11/19/20	11/21/20 17:58	BGL
Benzo(g,h,i)perylene	ND	0.37	mg/Kg dry	1		SW-846 8270D-E	11/19/20	11/21/20 17:58	BGL
Benzo(k)fluoranthene	ND	0.37	mg/Kg dry	1		SW-846 8270D-E	11/19/20	11/21/20 17:58	BGL
Chrysene	ND	0.37	mg/Kg dry	1		SW-846 8270D-E	11/19/20	11/21/20 17:58	BGL
Dibenz(a,h)anthracene	ND	0.37	mg/Kg dry	1		SW-846 8270D-E	11/19/20	11/21/20 17:58	BGL
Fluoranthene	0.68	0.37	mg/Kg dry	1		SW-846 8270D-E	11/19/20	11/21/20 17:58	BGL
Fluorene	ND	0.37	mg/Kg dry	1		SW-846 8270D-E	11/19/20	11/21/20 17:58	BGL
Indeno(1,2,3-cd)pyrene	ND	0.37	mg/Kg dry	1		SW-846 8270D-E	11/19/20	11/21/20 17:58	BGL
2-Methylnaphthalene	ND	0.37	mg/Kg dry	1		SW-846 8270D-E	11/19/20	11/21/20 17:58	BGL
Naphthalene	ND	0.37	mg/Kg dry	1		SW-846 8270D-E	11/19/20	11/21/20 17:58	BGL
Phenanthrene	ND	0.37	mg/Kg dry	1		SW-846 8270D-E	11/19/20	11/21/20 17:58	BGL
Pyrene	0.57	0.37	mg/Kg dry	1		SW-846 8270D-E	11/19/20	11/21/20 17:58	BGL

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Nitrobenzene-d5	64.8	30-130		11/21/20 17:58
2-Fluorobiphenyl	73.4	30-130		11/21/20 17:58
p-Terphenyl-d14	75.8	30-130		11/21/20 17:58

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Project Location: Haverhill, MA | Sample Description: | Work Order: 20K0857

Date Received: 11/17/2020

Field Sample #: 1543201117-04 | Sampled: 11/17/2020 11:15

Sample ID: 20K0857-04

Sample Matrix: Sediment

Sample Flags: DL-03

Organochloride Pesticides by GC/ECD

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Aldrin [1]	ND	0.054	mg/Kg dry	5		SW-846 8081B	11/18/20	11/25/20 6:08	PJG
alpha-BHC [1]	ND	0.054	mg/Kg dry	5		SW-846 8081B	11/18/20	11/25/20 6:08	PJG
beta-BHC [1]	ND	0.054	mg/Kg dry	5		SW-846 8081B	11/18/20	11/25/20 6:08	PJG
delta-BHC [1]	ND	0.054	mg/Kg dry	5		SW-846 8081B	11/18/20	11/25/20 6:08	PJG
gamma-BHC (Lindane) [1]	ND	0.022	mg/Kg dry	5		SW-846 8081B	11/18/20	11/25/20 6:08	PJG
Chlordane [1]	ND	0.22	mg/Kg dry	5		SW-846 8081B	11/18/20	11/25/20 6:08	PJG
4,4'-DDD [1]	ND	0.043	mg/Kg dry	5		SW-846 8081B	11/18/20	11/25/20 6:08	PJG
4,4'-DDE [1]	ND	0.043	mg/Kg dry	5		SW-846 8081B	11/18/20	11/25/20 6:08	PJG
4,4'-DDT [1]	ND	0.043	mg/Kg dry	5		SW-846 8081B	11/18/20	11/25/20 6:08	PJG
Dieldrin [1]	ND	0.043	mg/Kg dry	5		SW-846 8081B	11/18/20	11/25/20 6:08	PJG
Endosulfan I [1]	ND	0.054	mg/Kg dry	5		SW-846 8081B	11/18/20	11/25/20 6:08	PJG
Endosulfan II [1]	ND	0.086	mg/Kg dry	5		SW-846 8081B	11/18/20	11/25/20 6:08	PJG
Endosulfan sulfate [1]	ND	0.086	mg/Kg dry	5		SW-846 8081B	11/18/20	11/25/20 6:08	PJG
Endrin [1]	ND	0.086	mg/Kg dry	5		SW-846 8081B	11/18/20	11/25/20 6:08	PJG
Endrin ketone [1]	ND	0.086	mg/Kg dry	5		SW-846 8081B	11/18/20	11/25/20 6:08	PJG
Heptachlor [1]	ND	0.054	mg/Kg dry	5		SW-846 8081B	11/18/20	11/25/20 6:08	PJG
Heptachlor epoxide [1]	ND	0.054	mg/Kg dry	5		SW-846 8081B	11/18/20	11/25/20 6:08	PJG
Hexachlorobenzene [1]	ND	0.065	mg/Kg dry	5		SW-846 8081B	11/18/20	11/25/20 6:08	PJG
Methoxychlor [1]	ND	0.54	mg/Kg dry	5		SW-846 8081B	11/18/20	11/25/20 6:08	PJG

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Decachlorobiphenyl [1]	53.6	30-150		11/25/20 6:08
Decachlorobiphenyl [2]	54.3	30-150		11/25/20 6:08
Tetrachloro-m-xylene [1]	62.3	30-150		11/25/20 6:08
Tetrachloro-m-xylene [2]	60.4	30-150		11/25/20 6:08

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Project Location: Haverhill, MA | Sample Description: | Work Order: 20K0857

Date Received: 11/17/2020

Field Sample #: 1543201117-04 | Sampled: 11/17/2020 11:15

Sample ID: 20K0857-04

Sample Matrix: Sediment

Sample Flags: O-32

Polychlorinated Biphenyls By GC/ECD

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Aroclor-1016 [1]	ND	0.17	mg/Kg dry	4		SW-846 8082A	11/18/20	11/22/20 20:57	JMB
Aroclor-1221 [1]	ND	0.17	mg/Kg dry	4		SW-846 8082A	11/18/20	11/22/20 20:57	JMB
Aroclor-1232 [1]	ND	0.17	mg/Kg dry	4		SW-846 8082A	11/18/20	11/22/20 20:57	JMB
Aroclor-1242 [1]	ND	0.17	mg/Kg dry	4		SW-846 8082A	11/18/20	11/22/20 20:57	JMB
Aroclor-1248 [1]	ND	0.17	mg/Kg dry	4		SW-846 8082A	11/18/20	11/22/20 20:57	JMB
Aroclor-1254 [1]	ND	0.17	mg/Kg dry	4		SW-846 8082A	11/18/20	11/22/20 20:57	JMB
Aroclor-1260 [1]	ND	0.17	mg/Kg dry	4		SW-846 8082A	11/18/20	11/22/20 20:57	JMB
Aroclor-1262 [1]	ND	0.17	mg/Kg dry	4		SW-846 8082A	11/18/20	11/22/20 20:57	JMB
Aroclor-1268 [1]	ND	0.17	mg/Kg dry	4		SW-846 8082A	11/18/20	11/22/20 20:57	JMB

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Decachlorobiphenyl [1]	68.3	30-150		11/22/20 20:57
Decachlorobiphenyl [2]	69.6	30-150		11/22/20 20:57
Tetrachloro-m-xylene [1]	74.4	30-150		11/22/20 20:57
Tetrachloro-m-xylene [2]	78.3	30-150		11/22/20 20:57

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39 Spruce Street * East Longmeadow, MA 01028 * FAX 413/525-6405 * TEL. 413/525-2332

Project Location: Haverhill, MA | Sample Description: | Work Order: 20K0857

Date Received: 11/17/2020

Field Sample #: 1543201117-04 | Sampled: 11/17/2020 11:15

Sample ID: 20K0857-04

Sample Matrix: Sediment

Sample Flags: DL-03

Herbicides by GC/ECD

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
2,4-D [1]	ND	270	µg/kg dry	5		SW-846 8151A	11/20/20	11/23/20 21:13	JMB
2,4-DB [2]	ND	270	µg/kg dry	5		SW-846 8151A	11/20/20	11/23/20 21:13	JMB
2,4,5-TP (Silvex) [1]	ND	27	µg/kg dry	5		SW-846 8151A	11/20/20	11/23/20 21:13	JMB
2,4,5-T [1]	ND	27	µg/kg dry	5		SW-846 8151A	11/20/20	11/23/20 21:13	JMB
Dalalpon [1]	ND	670	µg/kg dry	5		SW-846 8151A	11/20/20	11/23/20 21:13	JMB
Dicamba [1]	ND	27	µg/kg dry	5		SW-846 8151A	11/20/20	11/23/20 21:13	JMB
Dichloroprop [1]	ND	270	µg/kg dry	5		SW-846 8151A	11/20/20	11/23/20 21:13	JMB
Dinoseb [1]	ND	130	µg/kg dry	5		SW-846 8151A	11/20/20	11/23/20 21:13	JMB
MCPA [1]	ND	27000	µg/kg dry	5		SW-846 8151A	11/20/20	11/23/20 21:13	JMB
MCPP [1]	ND	27000	µg/kg dry	5		SW-846 8151A	11/20/20	11/23/20 21:13	JMB

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
2,4-Dichlorophenylacetic acid [1]	94.8	30-150		11/23/20 21:13
2,4-Dichlorophenylacetic acid [2]	**415** *	30-150	S-02	11/23/20 21:13

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Project Location: Haverhill, MA | Sample Description: | Work Order: 20K0857

Date Received: 11/17/2020

Field Sample #: 1543201117-04 | Sampled: 11/17/2020 11:15

Sample ID: 20K0857-04

Sample Matrix: Sediment

Petroleum Hydrocarbons Analyses - EPH

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
C9-C18 Aliphatics	95	22	mg/Kg dry	1		MADEP EPH rev 2.1	11/19/20	11/25/20 2:55	RMW
C19-C36 Aliphatics	860	110	mg/Kg dry	5		MADEP EPH rev 2.1	11/19/20	11/25/20 12:55	RMW
Unadjusted C11-C22 Aromatics	350	22	mg/Kg dry	1		MADEP EPH rev 2.1	11/19/20	11/25/20 2:55	RMW
C11-C22 Aromatics	320	22	mg/Kg dry	1		MADEP EPH rev 2.1	11/19/20	11/25/20 2:55	RMW
Acenaphthene	0.39	0.22	mg/Kg dry	1		MADEP EPH rev 2.1	11/19/20	11/25/20 2:55	RMW
Acenaphthylene	ND	0.22	mg/Kg dry	1		MADEP EPH rev 2.1	11/19/20	11/25/20 2:55	RMW
Anthracene	0.49	0.22	mg/Kg dry	1		MADEP EPH rev 2.1	11/19/20	11/25/20 2:55	RMW
Benzo(a)anthracene	1.5	0.22	mg/Kg dry	1		MADEP EPH rev 2.1	11/19/20	11/25/20 2:55	RMW
Benzo(a)pyrene	1.7	0.22	mg/Kg dry	1		MADEP EPH rev 2.1	11/19/20	11/25/20 2:55	RMW
Benzo(b)fluoranthene	3.7	0.22	mg/Kg dry	1		MADEP EPH rev 2.1	11/19/20	11/25/20 2:55	RMW
Benzo(g,h,i)perylene	1.6	0.22	mg/Kg dry	1		MADEP EPH rev 2.1	11/19/20	11/25/20 2:55	RMW
Benzo(k)fluoranthene	1.2	0.22	mg/Kg dry	1		MADEP EPH rev 2.1	11/19/20	11/25/20 2:55	RMW
Chrysene	4.2	0.22	mg/Kg dry	1		MADEP EPH rev 2.1	11/19/20	11/25/20 2:55	RMW
Dibenz(a,h)anthracene	ND	0.22	mg/Kg dry	1		MADEP EPH rev 2.1	11/19/20	11/25/20 2:55	RMW
Fluoranthene	5.8	0.22	mg/Kg dry	1		MADEP EPH rev 2.1	11/19/20	11/25/20 2:55	RMW
Fluorene	0.38	0.22	mg/Kg dry	1		MADEP EPH rev 2.1	11/19/20	11/25/20 2:55	RMW
Indeno(1,2,3-cd)pyrene	1.5	0.22	mg/Kg dry	1		MADEP EPH rev 2.1	11/19/20	11/25/20 2:55	RMW
2-Methylnaphthalene	0.26	0.22	mg/Kg dry	1		MADEP EPH rev 2.1	11/19/20	11/25/20 2:55	RMW
Naphthalene	ND	0.22	mg/Kg dry	1		MADEP EPH rev 2.1	11/19/20	11/25/20 2:55	RMW
Phenanthrene	3.3	0.22	mg/Kg dry	1		MADEP EPH rev 2.1	11/19/20	11/25/20 2:55	RMW
Pyrene	5.7	0.22	mg/Kg dry	1		MADEP EPH rev 2.1	11/19/20	11/25/20 2:55	RMW

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Chlorooctadecane (COD)	75.0	40-140		11/25/20 2:55
Chlorooctadecane (COD)	71.3	40-140		11/25/20 12:55
o-Terphenyl (OTP)	72.5	40-140		11/25/20 2:55
2-Bromonaphthalene	78.2	40-140		11/25/20 2:55
2-Fluorobiphenyl	89.8	40-140		11/25/20 2:55

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Project Location: Haverhill, MA | Sample Description: | Work Order: 20K0857

Date Received: 11/17/2020

Field Sample #: 1543201117-04 | Sampled: 11/17/2020 11:15

Sample ID: 20K0857-04

Sample Matrix: Sediment

Metals Analyses (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Arsenic	7.9	7.1	mg/Kg dry	1		SW-846 6010D	11/18/20	11/19/20 20:48	MJH
Barium	97	3.5	mg/Kg dry	1		SW-846 6010D	11/18/20	11/19/20 20:48	MJH
Cadmium	ND	0.71	mg/Kg dry	1		SW-846 6010D	11/18/20	11/19/20 20:48	MJH
Chromium	35	1.4	mg/Kg dry	1		SW-846 6010D	11/18/20	11/19/20 20:48	MJH
Copper	13	1.4	mg/Kg dry	1		SW-846 6010D	11/18/20	11/19/20 20:48	TBC
Lead	33	1.1	mg/Kg dry	1		SW-846 6010D	11/18/20	11/19/20 20:48	MJH
Mercury	0.068	0.053	mg/Kg dry	1		SW-846 7471B	11/18/20	11/20/20 14:55	CJV
Nickel	22	1.4	mg/Kg dry	1		SW-846 6010D	11/18/20	11/19/20 20:48	MJH
Selenium	ND	7.1	mg/Kg dry	1		SW-846 6010D	11/18/20	11/19/20 20:48	MJH
Silver	ND	0.71	mg/Kg dry	1		SW-846 6010D	11/18/20	11/19/20 20:48	MJH
Zinc	77	1.4	mg/Kg dry	1		SW-846 6010D	11/18/20	11/19/20 20:48	TBC

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Project Location: Haverhill, MA | Sample Description: | Work Order: 20K0857

Date Received: 11/17/2020

Field Sample #: 1543201117-04 | Sampled: 11/17/2020 11:15

Sample ID: 20K0857-04

Sample Matrix: Sediment

Conventional Chemistry Parameters by EPA/APHA/SW-846 Methods (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
% Solids	46.4		% Wt	1		SM 2540G	11/19/20	11/20/20 9:03	RMF
Total Organic Carbon	39000	100	mg/Kg	1		SW 846 9060A	11/19/20	11/19/20 21:45	DJM

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Sample Extraction Data

Prep Method: SW-846 3546 **Analytical Method: MADEP EPH rev 2.1**

Lab Number [Field ID]	Batch	Initial [g]	Final [mL]	Date
20K0857-02 [1543201117-02]	B271302	20.0	2.00	11/19/20
20K0857-02RE1 [1543201117-02]	B271302	20.0	2.00	11/19/20
20K0857-03 [1543201117-03]	B271302	20.0	2.00	11/19/20
20K0857-03RE1 [1543201117-03]	B271302	20.0	2.00	11/19/20
20K0857-04 [1543201117-04]	B271302	20.0	2.00	11/19/20
20K0857-04RE1 [1543201117-04]	B271302	20.0	2.00	11/19/20

Prep Method: % Solids **Analytical Method: SM 2540G**

Lab Number [Field ID]	Batch	Date
20K0857-02 [1543201117-02]	B271315	11/19/20
20K0857-03 [1543201117-03]	B271315	11/19/20
20K0857-04 [1543201117-04]	B271315	11/19/20

SW 846 9060A

Lab Number [Field ID]	Batch	Initial [g]	Final [mL]	Date
20K0857-02 [1543201117-02]	B271215	1.00	1.00	11/19/20
20K0857-03 [1543201117-03]	B271215	1.00	1.00	11/19/20
20K0857-04 [1543201117-04]	B271215	1.00	1.00	11/19/20

Prep Method: SW-846 3050B **Analytical Method: SW-846 6010D**

Lab Number [Field ID]	Batch	Initial [g]	Final [mL]	Date
20K0857-02 [1543201117-02]	B271229	1.48	50.0	11/18/20
20K0857-03 [1543201117-03]	B271229	1.52	50.0	11/18/20
20K0857-04 [1543201117-04]	B271229	1.52	50.0	11/18/20

Prep Method: SW-846 7471 **Analytical Method: SW-846 7471B**

Lab Number [Field ID]	Batch	Initial [g]	Final [mL]	Date
20K0857-02 [1543201117-02]	B271184	0.591	50.0	11/18/20
20K0857-03 [1543201117-03]	B271184	0.610	50.0	11/18/20
20K0857-04 [1543201117-04]	B271184	0.611	50.0	11/18/20

Prep Method: SW-846 3546 **Analytical Method: SW-846 8081B**

Lab Number [Field ID]	Batch	Initial [g]	Final [mL]	Date
20K0857-02 [1543201117-02]	B271223	10.0	10.0	11/18/20
20K0857-03 [1543201117-03]	B271223	10.0	10.0	11/18/20
20K0857-04 [1543201117-04]	B271223	10.0	10.0	11/18/20

Prep Method: SW-846 3546 **Analytical Method: SW-846 8082A**

Lab Number [Field ID]	Batch	Initial [g]	Final [mL]	Date
20K0857-02 [1543201117-02]	B271221	10.0	10.0	11/18/20
20K0857-03 [1543201117-03]	B271221	10.0	10.0	11/18/20

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Sample Extraction Data

Prep Method: SW-846 3546 **Analytical Method: SW-846 8082A**

Lab Number [Field ID]	Batch	Initial [g]	Final [mL]	Date
20K0857-04 [1543201117-04]	B271221	10.0	10.0	11/18/20

Prep Method: SW-846 8151 **Analytical Method: SW-846 8151A**

Lab Number [Field ID]	Batch	Initial [g]	Final [mL]	Date
20K0857-02 [1543201117-02]	B271318	20.0	5.00	11/20/20
20K0857-03 [1543201117-03]	B271318	20.0	5.00	11/20/20
20K0857-04 [1543201117-04]	B271318	20.0	5.00	11/20/20

Prep Method: SW-846 5035 **Analytical Method: SW-846 8260C-D**

Lab Number [Field ID]	Batch	Sample Amount(g)	Methanol Volume(mL)	Methanol Aliquot(mL)	Final Volume(mL)	Date
20K0857-02 [1543201117-02]	B271147	5.77	8.24	1	50	11/18/20
20K0857-03 [1543201117-03]	B271147	6.04	6.63	0.1	50	11/18/20

Prep Method: SW-846 5035 **Analytical Method: SW-846 8260C-D**

Lab Number [Field ID]	Batch	Initial [g]	Final [mL]	Date
20K0857-01 [1543201117-01]	B271149	5.00	10.0	11/18/20
20K0857-04 [1543201117-04]	B271149	6.44	10.0	11/18/20

Prep Method: SW-846 3546 **Analytical Method: SW-846 8270D-E**

Lab Number [Field ID]	Batch	Initial [g]	Final [mL]	Date
20K0857-02 [1543201117-02]	B271301	30.0	1.00	11/19/20
20K0857-03 [1543201117-03]	B271301	30.0	1.00	11/19/20
20K0857-03RE1 [1543201117-03]	B271301	30.0	1.00	11/19/20
20K0857-04 [1543201117-04]	B271301	30.0	1.00	11/19/20

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QUALITY CONTROL

Volatile Organic Compounds by GC/MS - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B271147 - SW-846 5035										
Blank (B271147-BLK1)				Prepared: 11/18/20 Analyzed: 11/19/20						
Acetone	ND	2.5	mg/Kg wet							
tert-Amyl Methyl Ether (TAME)	ND	0.025	mg/Kg wet							
Benzene	ND	0.050	mg/Kg wet							
Bromobenzene	ND	0.050	mg/Kg wet							
Bromochloromethane	ND	0.050	mg/Kg wet							
Bromodichloromethane	ND	0.050	mg/Kg wet							
Bromoform	ND	0.050	mg/Kg wet							
Bromomethane	ND	0.10	mg/Kg wet							V-34
2-Butanone (MEK)	ND	1.0	mg/Kg wet							
n-Butylbenzene	ND	0.050	mg/Kg wet							
sec-Butylbenzene	ND	0.050	mg/Kg wet							
tert-Butylbenzene	ND	0.050	mg/Kg wet							
tert-Butyl Ethyl Ether (TBEE)	ND	0.025	mg/Kg wet							
Carbon Disulfide	ND	0.50	mg/Kg wet							
Carbon Tetrachloride	ND	0.050	mg/Kg wet							
Chlorobenzene	ND	0.050	mg/Kg wet							
Chlorodibromomethane	ND	0.025	mg/Kg wet							
Chloroethane	ND	0.10	mg/Kg wet							
Chloroform	ND	0.10	mg/Kg wet							
Chloromethane	ND	0.10	mg/Kg wet							V-05, V-34
2-Chlorotoluene	ND	0.050	mg/Kg wet							
4-Chlorotoluene	ND	0.050	mg/Kg wet							
1,2-Dibromo-3-chloropropane (DBCP)	ND	0.20	mg/Kg wet							
1,2-Dibromoethane (EDB)	ND	0.025	mg/Kg wet							
Dibromomethane	ND	0.050	mg/Kg wet							
1,2-Dichlorobenzene	ND	0.050	mg/Kg wet							
1,3-Dichlorobenzene	ND	0.050	mg/Kg wet							
1,4-Dichlorobenzene	ND	0.050	mg/Kg wet							
Dichlorodifluoromethane (Freon 12)	ND	0.10	mg/Kg wet							
1,1-Dichloroethane	ND	0.050	mg/Kg wet							
1,2-Dichloroethane	ND	0.050	mg/Kg wet							
1,1-Dichloroethylene	ND	0.050	mg/Kg wet							
cis-1,2-Dichloroethylene	ND	0.050	mg/Kg wet							
trans-1,2-Dichloroethylene	ND	0.050	mg/Kg wet							
1,2-Dichloropropane	ND	0.050	mg/Kg wet							
1,3-Dichloropropane	ND	0.025	mg/Kg wet							
2,2-Dichloropropane	ND	0.050	mg/Kg wet							L-04, V-05
1,1-Dichloropropene	ND	0.10	mg/Kg wet							
cis-1,3-Dichloropropene	ND	0.025	mg/Kg wet							
trans-1,3-Dichloropropene	ND	0.025	mg/Kg wet							
Diethyl Ether	ND	0.10	mg/Kg wet							
Diisopropyl Ether (DIPE)	ND	0.025	mg/Kg wet							
1,4-Dioxane	ND	2.5	mg/Kg wet							
Ethylbenzene	ND	0.050	mg/Kg wet							
Hexachlorobutadiene	ND	0.050	mg/Kg wet							
2-Hexanone (MBK)	ND	0.50	mg/Kg wet							
Isopropylbenzene (Cumene)	ND	0.050	mg/Kg wet							
p-Isopropyltoluene (p-Cymene)	ND	0.050	mg/Kg wet							
Methyl tert-Butyl Ether (MTBE)	ND	0.050	mg/Kg wet							
Methylene Chloride	ND	0.25	mg/Kg wet							
4-Methyl-2-pentanone (MIBK)	ND	0.50	mg/Kg wet							
Naphthalene	ND	0.10	mg/Kg wet							

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QUALITY CONTROL

Volatile Organic Compounds by GC/MS - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B271147 - SW-846 5035										
Blank (B271147-BLK1)				Prepared: 11/18/20 Analyzed: 11/19/20						
n-Propylbenzene	ND	0.050	mg/Kg wet							
Styrene	ND	0.050	mg/Kg wet							
1,1,1,2-Tetrachloroethane	ND	0.050	mg/Kg wet							
1,1,2,2-Tetrachloroethane	ND	0.025	mg/Kg wet							
Tetrachloroethylene	ND	0.050	mg/Kg wet							
Tetrahydrofuran	ND	0.20	mg/Kg wet							
Toluene	ND	0.050	mg/Kg wet							
1,2,3-Trichlorobenzene	ND	0.20	mg/Kg wet							
1,2,4-Trichlorobenzene	ND	0.050	mg/Kg wet							
1,1,1-Trichloroethane	ND	0.050	mg/Kg wet							
1,1,2-Trichloroethane	ND	0.050	mg/Kg wet							
Trichloroethylene	ND	0.050	mg/Kg wet							
Trichlorofluoromethane (Freon 11)	ND	0.10	mg/Kg wet							
1,2,3-Trichloropropane	ND	0.10	mg/Kg wet							
1,2,4-Trimethylbenzene	ND	0.050	mg/Kg wet							
1,3,5-Trimethylbenzene	ND	0.050	mg/Kg wet							
Vinyl Chloride	ND	0.10	mg/Kg wet							
m+p Xylene	ND	0.10	mg/Kg wet							
o-Xylene	ND	0.050	mg/Kg wet							
Surrogate: 1,2-Dichloroethane-d4	*0.0178*		mg/Kg wet	0.0250		71.2	70-130			
Surrogate: Toluene-d8	*0.0234*		mg/Kg wet	0.0250		93.8	70-130			
Surrogate: 4-Bromofluorobenzene	*0.0243*		mg/Kg wet	0.0250		97.2	70-130			
LCS (B271147-BS1)				Prepared & Analyzed: 11/18/20						
Acetone	0.199	0.057	mg/Kg wet	0.227		87.8	40-160			†
tert-Amyl Methyl Ether (TAME)	0.0185	0.00057	mg/Kg wet	0.0227		81.4	70-130			
Benzene	0.0210	0.0011	mg/Kg wet	0.0227		92.8	70-130			
Bromobenzene	0.0231	0.0011	mg/Kg wet	0.0227		102	70-130			
Bromochloromethane	0.0235	0.0011	mg/Kg wet	0.0227		104	70-130			
Bromodichloromethane	0.0207	0.0011	mg/Kg wet	0.0227		91.4	70-130			
Bromoform	0.0236	0.0011	mg/Kg wet	0.0227		104	70-130			
Bromomethane	0.0157	0.0023	mg/Kg wet	0.0227		69.3	40-160			V-20, L-14, V-34 †
2-Butanone (MEK)	0.208	0.023	mg/Kg wet	0.227		91.7	40-160			†
n-Butylbenzene	0.0228	0.0011	mg/Kg wet	0.0227		100	70-130			
sec-Butylbenzene	0.0236	0.0011	mg/Kg wet	0.0227		104	70-130			
tert-Butylbenzene	0.0234	0.0011	mg/Kg wet	0.0227		103	70-130			
tert-Butyl Ethyl Ether (TBEE)	0.0193	0.00057	mg/Kg wet	0.0227		85.0	70-130			
Carbon Disulfide	0.0229	0.011	mg/Kg wet	0.0227		101	70-130			
Carbon Tetrachloride	0.0191	0.0011	mg/Kg wet	0.0227		84.2	70-130			
Chlorobenzene	0.0257	0.0011	mg/Kg wet	0.0227		113	70-130			
Chlorodibromomethane	0.0216	0.00057	mg/Kg wet	0.0227		95.5	70-130			
Chloroethane	0.0205	0.0023	mg/Kg wet	0.0227		90.4	70-130			
Chloroform	0.0197	0.0023	mg/Kg wet	0.0227		86.8	70-130			
Chloromethane	0.0110	0.0023	mg/Kg wet	0.0227		48.3	40-160			V-05, L-14, V-34 †
2-Chlorotoluene	0.0236	0.0011	mg/Kg wet	0.0227		104	70-130			
4-Chlorotoluene	0.0241	0.0011	mg/Kg wet	0.0227		106	70-130			
1,2-Dibromo-3-chloropropane (DBCP)	0.0201	0.0045	mg/Kg wet	0.0227		88.6	70-130			
1,2-Dibromoethane (EDB)	0.0230	0.00057	mg/Kg wet	0.0227		101	70-130			
Dibromomethane	0.0226	0.0011	mg/Kg wet	0.0227		99.6	70-130			
1,2-Dichlorobenzene	0.0232	0.0011	mg/Kg wet	0.0227		102	70-130			
1,3-Dichlorobenzene	0.0238	0.0011	mg/Kg wet	0.0227		105	70-130			
1,4-Dichlorobenzene	0.0230	0.0011	mg/Kg wet	0.0227		102	70-130			

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QUALITY CONTROL

Volatile Organic Compounds by GC/MS - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC		%REC Limits	RPD	RPD Limit	Notes	
Batch B271147 - SW-846 5035												
LCS (B271147-BS1)				Prepared & Analyzed: 11/18/20								
Dichlorodifluoromethane (Freon 12)	0.0205	0.0023	mg/Kg wet	0.0227		90.4		40-160				†
1,1-Dichloroethane	0.0220	0.0011	mg/Kg wet	0.0227		97.0		70-130				
1,2-Dichloroethane	0.0194	0.0011	mg/Kg wet	0.0227		85.8		70-130				
1,1-Dichloroethylene	0.0219	0.0011	mg/Kg wet	0.0227		96.4		70-130				
cis-1,2-Dichloroethylene	0.0205	0.0011	mg/Kg wet	0.0227		90.6		70-130				
trans-1,2-Dichloroethylene	0.0226	0.0011	mg/Kg wet	0.0227		99.6		70-130				
1,2-Dichloropropane	0.0244	0.0011	mg/Kg wet	0.0227		108		70-130				
1,3-Dichloropropane	0.0216	0.00057	mg/Kg wet	0.0227		95.4		70-130				
2,2-Dichloropropane	0.0150	0.0011	mg/Kg wet	0.0227		**66.2**	*	70-130			V-05, L-04	
1,1-Dichloropropene	0.0199	0.0023	mg/Kg wet	0.0227		87.9		70-130				
cis-1,3-Dichloropropene	0.0193	0.00057	mg/Kg wet	0.0227		85.0		70-130				
trans-1,3-Dichloropropene	0.0193	0.00057	mg/Kg wet	0.0227		85.0		70-130				
Diethyl Ether	0.0227	0.0023	mg/Kg wet	0.0227		100		70-130				
Diisopropyl Ether (DIPE)	0.0230	0.00057	mg/Kg wet	0.0227		101		70-130				
1,4-Dioxane	0.233	0.057	mg/Kg wet	0.227		103		40-160				†
Ethylbenzene	0.0248	0.0011	mg/Kg wet	0.0227		109		70-130				
Hexachlorobutadiene	0.0231	0.0011	mg/Kg wet	0.0227		102		70-130				
2-Hexanone (MBK)	0.215	0.011	mg/Kg wet	0.227		95.0		40-160				†
Isopropylbenzene (Cumene)	0.0248	0.0011	mg/Kg wet	0.0227		109		70-130				
p-Isopropyltoluene (p-Cymene)	0.0240	0.0011	mg/Kg wet	0.0227		106		70-130				
Methyl tert-Butyl Ether (MTBE)	0.0192	0.0011	mg/Kg wet	0.0227		84.9		70-130				
Methylene Chloride	0.0210	0.0057	mg/Kg wet	0.0227		92.5		70-130				
4-Methyl-2-pentanone (MIBK)	0.223	0.011	mg/Kg wet	0.227		98.2		40-160				†
Naphthalene	0.0198	0.0023	mg/Kg wet	0.0227		87.2		70-130				
n-Propylbenzene	0.0243	0.0011	mg/Kg wet	0.0227		107		70-130				
Styrene	0.0251	0.0011	mg/Kg wet	0.0227		111		70-130				
1,1,1,2-Tetrachloroethane	0.0260	0.0011	mg/Kg wet	0.0227		115		70-130				
1,1,2,2-Tetrachloroethane	0.0245	0.00057	mg/Kg wet	0.0227		108		70-130				
Tetrachloroethylene	0.0256	0.0011	mg/Kg wet	0.0227		113		70-130				
Tetrahydrofuran	0.0231	0.0045	mg/Kg wet	0.0227		102		70-130				
Toluene	0.0228	0.0011	mg/Kg wet	0.0227		101		70-130				
1,2,3-Trichlorobenzene	0.0209	0.0045	mg/Kg wet	0.0227		92.2		70-130				
1,2,4-Trichlorobenzene	0.0236	0.0011	mg/Kg wet	0.0227		104		70-130				
1,1,1-Trichloroethane	0.0198	0.0011	mg/Kg wet	0.0227		87.4		70-130				
1,1,2-Trichloroethane	0.0231	0.0011	mg/Kg wet	0.0227		102		70-130				
Trichloroethylene	0.0237	0.0011	mg/Kg wet	0.0227		105		70-130				
Trichlorofluoromethane (Freon 11)	0.0191	0.0023	mg/Kg wet	0.0227		84.1		70-130				
1,2,3-Trichloropropane	0.0257	0.0023	mg/Kg wet	0.0227		113		70-130				
1,2,4-Trimethylbenzene	0.0225	0.0011	mg/Kg wet	0.0227		99.4		70-130				
1,3,5-Trimethylbenzene	0.0246	0.0011	mg/Kg wet	0.0227		108		70-130				
Vinyl Chloride	0.0214	0.0023	mg/Kg wet	0.0227		94.4		70-130				
m+p Xylene	0.0486	0.0023	mg/Kg wet	0.0453		107		70-130				
o-Xylene	0.0244	0.0011	mg/Kg wet	0.0227		108		70-130				
Surrogate: 1,2-Dichloroethane-d4	*0.0205*		mg/Kg wet	0.0283		72.2		70-130				
Surrogate: Toluene-d8	*0.0267*		mg/Kg wet	0.0283		94.2		70-130				
Surrogate: 4-Bromofluorobenzene	*0.0279*		mg/Kg wet	0.0283		98.3		70-130				

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QUALITY CONTROL

Volatile Organic Compounds by GC/MS - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC		%REC Limits	RPD	RPD Limit	Notes	
Batch B271147 - SW-846 5035												
LCS Dup (B271147-BSD1)				Prepared: 11/18/20 Analyzed: 11/19/20								
Acetone	0.203	0.057	mg/Kg wet	0.227		89.3		40-160	1.69	20		†
tert-Amyl Methyl Ether (TAME)	0.0192	0.00057	mg/Kg wet	0.0227		84.8		70-130	4.15	20		
Benzene	0.0214	0.0011	mg/Kg wet	0.0227		94.4		70-130	1.71	20		
Bromobenzene	0.0235	0.0011	mg/Kg wet	0.0227		104		70-130	1.56	20		
Bromochloromethane	0.0249	0.0011	mg/Kg wet	0.0227		110		70-130	5.86	20		
Bromodichloromethane	0.0206	0.0011	mg/Kg wet	0.0227		91.1		70-130	0.383	20		
Bromoform	0.0238	0.0011	mg/Kg wet	0.0227		105		70-130	0.860	20		
Bromomethane	0.0181	0.0023	mg/Kg wet	0.0227		79.9		40-160	14.2	20	V-20, V-34	†
2-Butanone (MEK)	0.209	0.023	mg/Kg wet	0.227		92.2		40-160	0.554	20		†
n-Butylbenzene	0.0229	0.0011	mg/Kg wet	0.0227		101		70-130	0.497	20		
sec-Butylbenzene	0.0239	0.0011	mg/Kg wet	0.0227		105		70-130	0.954	20		
tert-Butylbenzene	0.0235	0.0011	mg/Kg wet	0.0227		104		70-130	0.0483	20		
tert-Butyl Ethyl Ether (TBEE)	0.0196	0.00057	mg/Kg wet	0.0227		86.4		70-130	1.52	20		
Carbon Disulfide	0.0227	0.011	mg/Kg wet	0.0227		100		70-130	0.547	20		
Carbon Tetrachloride	0.0191	0.0011	mg/Kg wet	0.0227		84.2		70-130	0.0594	20		
Chlorobenzene	0.0256	0.0011	mg/Kg wet	0.0227		113		70-130	0.442	20		
Chlorodibromomethane	0.0218	0.00057	mg/Kg wet	0.0227		96.2		70-130	0.730	20		
Chloroethane	0.0203	0.0023	mg/Kg wet	0.0227		89.5		70-130	0.945	20		
Chloroform	0.0199	0.0023	mg/Kg wet	0.0227		87.9		70-130	1.26	20		
Chloromethane	0.0112	0.0023	mg/Kg wet	0.0227		49.3		40-160	1.95	20	L-14, V-05, V-34	†
2-Chlorotoluene	0.0237	0.0011	mg/Kg wet	0.0227		104		70-130	0.336	20		
4-Chlorotoluene	0.0239	0.0011	mg/Kg wet	0.0227		106		70-130	0.614	20		
1,2-Dibromo-3-chloropropane (DBCP)	0.0208	0.0045	mg/Kg wet	0.0227		91.8		70-130	3.55	20		
1,2-Dibromoethane (EDB)	0.0233	0.00057	mg/Kg wet	0.0227		103		70-130	1.18	20		
Dibromomethane	0.0231	0.0011	mg/Kg wet	0.0227		102		70-130	2.38	20		
1,2-Dichlorobenzene	0.0237	0.0011	mg/Kg wet	0.0227		105		70-130	2.08	20		
1,3-Dichlorobenzene	0.0243	0.0011	mg/Kg wet	0.0227		107		70-130	2.17	20		
1,4-Dichlorobenzene	0.0234	0.0011	mg/Kg wet	0.0227		103		70-130	1.42	20		
Dichlorodifluoromethane (Freon 12)	0.0210	0.0023	mg/Kg wet	0.0227		92.4		40-160	2.24	20		†
1,1-Dichloroethane	0.0223	0.0011	mg/Kg wet	0.0227		98.5		70-130	1.48	20		
1,2-Dichloroethane	0.0199	0.0011	mg/Kg wet	0.0227		87.7		70-130	2.19	20		
1,1-Dichloroethylene	0.0221	0.0011	mg/Kg wet	0.0227		97.6		70-130	1.24	20		
cis-1,2-Dichloroethylene	0.0208	0.0011	mg/Kg wet	0.0227		91.8		70-130	1.21	20		
trans-1,2-Dichloroethylene	0.0223	0.0011	mg/Kg wet	0.0227		98.3		70-130	1.31	20		
1,2-Dichloropropane	0.0246	0.0011	mg/Kg wet	0.0227		108		70-130	0.648	20		
1,3-Dichloropropane	0.0220	0.00057	mg/Kg wet	0.0227		97.0		70-130	1.66	20		
2,2-Dichloropropane	0.0151	0.0011	mg/Kg wet	0.0227		**66.6**	*	70-130	0.677	20	L-04, V-05	
1,1-Dichloropropene	0.0196	0.0023	mg/Kg wet	0.0227		86.5		70-130	1.55	20		
cis-1,3-Dichloropropene	0.0199	0.00057	mg/Kg wet	0.0227		87.7		70-130	3.18	20		
trans-1,3-Dichloropropene	0.0197	0.00057	mg/Kg wet	0.0227		87.1		70-130	2.38	20		
Diethyl Ether	0.0241	0.0023	mg/Kg wet	0.0227		106		70-130	6.30	20		
Diisopropyl Ether (DIPE)	0.0234	0.00057	mg/Kg wet	0.0227		103		70-130	1.86	20		
1,4-Dioxane	0.239	0.057	mg/Kg wet	0.227		105		40-160	2.57	20		†
Ethylbenzene	0.0247	0.0011	mg/Kg wet	0.0227		109		70-130	0.550	20		
Hexachlorobutadiene	0.0241	0.0011	mg/Kg wet	0.0227		106		70-130	4.32	20		
2-Hexanone (MBK)	0.221	0.011	mg/Kg wet	0.227		97.3		40-160	2.46	20		†
Isopropylbenzene (Cumene)	0.0248	0.0011	mg/Kg wet	0.0227		109		70-130	0.183	20		
p-Isopropyltoluene (p-Cymene)	0.0240	0.0011	mg/Kg wet	0.0227		106		70-130	0.283	20		
Methyl tert-Butyl Ether (MTBE)	0.0199	0.0011	mg/Kg wet	0.0227		87.7		70-130	3.30	20		
Methylene Chloride	0.0217	0.0057	mg/Kg wet	0.0227		95.7		70-130	3.45	20		
4-Methyl-2-pentanone (MIBK)	0.225	0.011	mg/Kg wet	0.227		99.4		40-160	1.18	20		†
Naphthalene	0.0208	0.0023	mg/Kg wet	0.0227		91.9		70-130	5.25	20		

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QUALITY CONTROL

Volatile Organic Compounds by GC/MS - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B271147 - SW-846 5035										
LCS Dup (B271147-BSD1)				Prepared: 11/18/20 Analyzed: 11/19/20						
n-Propylbenzene	0.0244	0.0011	mg/Kg wet	0.0227		108	70-130	0.186	20	
Styrene	0.0249	0.0011	mg/Kg wet	0.0227		110	70-130	0.680	20	
1,1,1,2-Tetrachloroethane	0.0257	0.0011	mg/Kg wet	0.0227		114	70-130	0.964	20	
1,1,2,2-Tetrachloroethane	0.0252	0.00057	mg/Kg wet	0.0227		111	70-130	2.69	20	
Tetrachloroethylene	0.0258	0.0011	mg/Kg wet	0.0227		114	70-130	0.706	20	
Tetrahydrofuran	0.0255	0.0045	mg/Kg wet	0.0227		112	70-130	9.99	20	
Toluene	0.0229	0.0011	mg/Kg wet	0.0227		101	70-130	0.396	20	
1,2,3-Trichlorobenzene	0.0215	0.0045	mg/Kg wet	0.0227		94.9	70-130	2.94	20	
1,2,4-Trichlorobenzene	0.0235	0.0011	mg/Kg wet	0.0227		104	70-130	0.336	20	
1,1,1-Trichloroethane	0.0199	0.0011	mg/Kg wet	0.0227		87.7	70-130	0.342	20	
1,1,2-Trichloroethane	0.0232	0.0011	mg/Kg wet	0.0227		102	70-130	0.637	20	
Trichloroethylene	0.0240	0.0011	mg/Kg wet	0.0227		106	70-130	1.42	20	
Trichlorofluoromethane (Freon 11)	0.0176	0.0023	mg/Kg wet	0.0227		77.5	70-130	8.16	20	
1,2,3-Trichloropropane	0.0259	0.0023	mg/Kg wet	0.0227		114	70-130	0.834	20	
1,2,4-Trimethylbenzene	0.0226	0.0011	mg/Kg wet	0.0227		99.8	70-130	0.351	20	
1,3,5-Trimethylbenzene	0.0245	0.0011	mg/Kg wet	0.0227		108	70-130	0.462	20	
Vinyl Chloride	0.0214	0.0023	mg/Kg wet	0.0227		94.2	70-130	0.212	20	
m+p Xylene	0.0481	0.0023	mg/Kg wet	0.0453		106	70-130	0.938	20	
o-Xylene	0.0244	0.0011	mg/Kg wet	0.0227		108	70-130	0.0464	20	
Surrogate: 1,2-Dichloroethane-d4	*0.0203*		mg/Kg wet	0.0283		71.6	70-130			
Surrogate: Toluene-d8	*0.0266*		mg/Kg wet	0.0283		94.0	70-130			
Surrogate: 4-Bromofluorobenzene	*0.0278*		mg/Kg wet	0.0283		98.1	70-130			
Batch B271149 - SW-846 5035										
Blank (B271149-BLK1)				Prepared & Analyzed: 11/18/20						
Acetone	ND	0.10	mg/Kg wet							
tert-Amyl Methyl Ether (TAME)	ND	0.0010	mg/Kg wet							
Benzene	ND	0.0020	mg/Kg wet							
Bromobenzene	ND	0.0020	mg/Kg wet							
Bromochloromethane	ND	0.0020	mg/Kg wet							
Bromodichloromethane	ND	0.0020	mg/Kg wet							
Bromoform	ND	0.0020	mg/Kg wet							
Bromomethane	ND	0.010	mg/Kg wet							V-34
2-Butanone (MEK)	ND	0.040	mg/Kg wet							
n-Butylbenzene	ND	0.0020	mg/Kg wet							
sec-Butylbenzene	ND	0.0020	mg/Kg wet							
tert-Butylbenzene	ND	0.0020	mg/Kg wet							
tert-Butyl Ethyl Ether (TBEE)	ND	0.0010	mg/Kg wet							
Carbon Disulfide	ND	0.0060	mg/Kg wet							
Carbon Tetrachloride	ND	0.0020	mg/Kg wet							
Chlorobenzene	ND	0.0020	mg/Kg wet							
Chlorodibromomethane	ND	0.0010	mg/Kg wet							
Chloroethane	ND	0.010	mg/Kg wet							
Chloroform	ND	0.0040	mg/Kg wet							
Chloromethane	ND	0.010	mg/Kg wet							
2-Chlorotoluene	ND	0.0020	mg/Kg wet							
4-Chlorotoluene	ND	0.0020	mg/Kg wet							
1,2-Dibromo-3-chloropropane (DBCP)	ND	0.0020	mg/Kg wet							
1,2-Dibromoethane (EDB)	ND	0.0010	mg/Kg wet							
Dibromomethane	ND	0.0020	mg/Kg wet							
1,2-Dichlorobenzene	ND	0.0020	mg/Kg wet							
1,3-Dichlorobenzene	ND	0.0020	mg/Kg wet							

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QUALITY CONTROL

Volatile Organic Compounds by GC/MS - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B271149 - SW-846 5035										
Blank (B271149-BLK1)				Prepared & Analyzed: 11/18/20						
1,4-Dichlorobenzene	ND	0.0020	mg/Kg wet							
Dichlorodifluoromethane (Freon 12)	ND	0.010	mg/Kg wet							
1,1-Dichloroethane	ND	0.0020	mg/Kg wet							
1,2-Dichloroethane	ND	0.0020	mg/Kg wet							
1,1-Dichloroethylene	ND	0.0040	mg/Kg wet							
cis-1,2-Dichloroethylene	ND	0.0020	mg/Kg wet							
trans-1,2-Dichloroethylene	ND	0.0020	mg/Kg wet							
1,2-Dichloropropane	ND	0.0020	mg/Kg wet							
1,3-Dichloropropane	ND	0.0010	mg/Kg wet							
2,2-Dichloropropane	ND	0.0020	mg/Kg wet							
1,1-Dichloropropene	ND	0.0020	mg/Kg wet							
cis-1,3-Dichloropropene	ND	0.0010	mg/Kg wet							
trans-1,3-Dichloropropene	ND	0.0010	mg/Kg wet							
Diethyl Ether	ND	0.010	mg/Kg wet							
Diisopropyl Ether (DIPE)	ND	0.0010	mg/Kg wet							
1,4-Dioxane	ND	0.10	mg/Kg wet							
Ethylbenzene	ND	0.0020	mg/Kg wet							
Hexachlorobutadiene	ND	0.0020	mg/Kg wet							
2-Hexanone (MBK)	ND	0.020	mg/Kg wet							
Isopropylbenzene (Cumene)	ND	0.0020	mg/Kg wet							
p-Isopropyltoluene (p-Cymene)	ND	0.0020	mg/Kg wet							
Methyl tert-Butyl Ether (MTBE)	ND	0.0040	mg/Kg wet							
Methylene Chloride	ND	0.010	mg/Kg wet							
4-Methyl-2-pentanone (MIBK)	ND	0.020	mg/Kg wet							
Naphthalene	ND	0.0040	mg/Kg wet							
n-Propylbenzene	ND	0.0020	mg/Kg wet							
Styrene	ND	0.0020	mg/Kg wet							
1,1,1,2-Tetrachloroethane	ND	0.0020	mg/Kg wet							
1,1,2,2-Tetrachloroethane	ND	0.0010	mg/Kg wet							
Tetrachloroethylene	ND	0.0020	mg/Kg wet							
Tetrahydrofuran	ND	0.010	mg/Kg wet							
Toluene	ND	0.0020	mg/Kg wet							
1,2,3-Trichlorobenzene	ND	0.0020	mg/Kg wet							
1,2,4-Trichlorobenzene	ND	0.0020	mg/Kg wet							
1,1,1-Trichloroethane	ND	0.0020	mg/Kg wet							
1,1,2-Trichloroethane	ND	0.0020	mg/Kg wet							
Trichloroethylene	ND	0.0020	mg/Kg wet							
Trichlorofluoromethane (Freon 11)	ND	0.010	mg/Kg wet							
1,2,3-Trichloropropane	ND	0.0020	mg/Kg wet							
1,2,4-Trimethylbenzene	ND	0.0020	mg/Kg wet							
1,3,5-Trimethylbenzene	ND	0.0020	mg/Kg wet							
Vinyl Chloride	ND	0.010	mg/Kg wet							
m+p Xylene	ND	0.0040	mg/Kg wet							
o-Xylene	ND	0.0020	mg/Kg wet							
Surrogate: 1,2-Dichloroethane-d4	*0.0538*		mg/Kg wet	0.0500		108	70-130			
Surrogate: Toluene-d8	*0.0500*		mg/Kg wet	0.0500		100	70-130			
Surrogate: 4-Bromofluorobenzene	*0.0497*		mg/Kg wet	0.0500		99.4	70-130			

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QUALITY CONTROL

Volatile Organic Compounds by GC/MS - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes	
Batch B271149 - SW-846 5035											
LCS (B271149-BS1)				Prepared & Analyzed: 11/18/20							
Acetone	0.238	0.10	mg/Kg wet	0.200		119	40-160			V-20	†
tert-Amyl Methyl Ether (TAME)	0.0192	0.0010	mg/Kg wet	0.0200		96.2	70-130				
Benzene	0.0190	0.0020	mg/Kg wet	0.0200		94.8	70-130				
Bromobenzene	0.0168	0.0020	mg/Kg wet	0.0200		84.2	70-130				
Bromochloromethane	0.0199	0.0020	mg/Kg wet	0.0200		99.5	70-130				
Bromodichloromethane	0.0189	0.0020	mg/Kg wet	0.0200		94.6	70-130				
Bromoform	0.0168	0.0020	mg/Kg wet	0.0200		84.2	70-130				
Bromomethane	0.0210	0.010	mg/Kg wet	0.0200		105	40-160			V-34	†
2-Butanone (MEK)	0.217	0.040	mg/Kg wet	0.200		108	40-160				†
n-Butylbenzene	0.0165	0.0020	mg/Kg wet	0.0200		82.3	70-130				
sec-Butylbenzene	0.0165	0.0020	mg/Kg wet	0.0200		82.6	70-130				
tert-Butylbenzene	0.0158	0.0020	mg/Kg wet	0.0200		79.1	70-130				
tert-Butyl Ethyl Ether (TBEE)	0.0201	0.0010	mg/Kg wet	0.0200		101	70-130				
Carbon Disulfide	0.209	0.0060	mg/Kg wet	0.200		104	70-130				
Carbon Tetrachloride	0.0194	0.0020	mg/Kg wet	0.0200		97.2	70-130				
Chlorobenzene	0.0165	0.0020	mg/Kg wet	0.0200		82.7	70-130				
Chlorodibromomethane	0.0189	0.0010	mg/Kg wet	0.0200		94.5	70-130				
Chloroethane	0.0197	0.010	mg/Kg wet	0.0200		98.6	70-130				
Chloroform	0.0193	0.0040	mg/Kg wet	0.0200		96.7	70-130				
Chloromethane	0.0204	0.010	mg/Kg wet	0.0200		102	40-160				†
2-Chlorotoluene	0.0167	0.0020	mg/Kg wet	0.0200		83.4	70-130				
4-Chlorotoluene	0.0166	0.0020	mg/Kg wet	0.0200		83.1	70-130				
1,2-Dibromo-3-chloropropane (DBCP)	0.0159	0.0020	mg/Kg wet	0.0200		79.6	70-130				
1,2-Dibromoethane (EDB)	0.0178	0.0010	mg/Kg wet	0.0200		89.2	70-130				
Dibromomethane	0.0182	0.0020	mg/Kg wet	0.0200		91.0	70-130				
1,2-Dichlorobenzene	0.0161	0.0020	mg/Kg wet	0.0200		80.5	70-130				
1,3-Dichlorobenzene	0.0163	0.0020	mg/Kg wet	0.0200		81.6	70-130				
1,4-Dichlorobenzene	0.0164	0.0020	mg/Kg wet	0.0200		81.9	70-130				
Dichlorodifluoromethane (Freon 12)	0.0178	0.010	mg/Kg wet	0.0200		88.8	40-160				†
1,1-Dichloroethane	0.0205	0.0020	mg/Kg wet	0.0200		103	70-130				
1,2-Dichloroethane	0.0205	0.0020	mg/Kg wet	0.0200		102	70-130				
1,1-Dichloroethylene	0.0204	0.0040	mg/Kg wet	0.0200		102	70-130				
cis-1,2-Dichloroethylene	0.0198	0.0020	mg/Kg wet	0.0200		99.2	70-130				
trans-1,2-Dichloroethylene	0.0203	0.0020	mg/Kg wet	0.0200		101	70-130				
1,2-Dichloropropane	0.0191	0.0020	mg/Kg wet	0.0200		95.7	70-130				
1,3-Dichloropropane	0.0192	0.0010	mg/Kg wet	0.0200		96.1	70-130				
2,2-Dichloropropane	0.0177	0.0020	mg/Kg wet	0.0200		88.4	70-130				
1,1-Dichloropropene	0.0197	0.0020	mg/Kg wet	0.0200		98.5	70-130				
cis-1,3-Dichloropropene	0.0181	0.0010	mg/Kg wet	0.0200		90.3	70-130				
trans-1,3-Dichloropropene	0.0175	0.0010	mg/Kg wet	0.0200		87.4	70-130				
Diethyl Ether	0.0199	0.010	mg/Kg wet	0.0200		99.4	70-130				
Diisopropyl Ether (DIPE)	0.0215	0.0010	mg/Kg wet	0.0200		108	70-130				
1,4-Dioxane	0.187	0.10	mg/Kg wet	0.200		93.3	40-160				†
Ethylbenzene	0.0165	0.0020	mg/Kg wet	0.0200		82.3	70-130				
Hexachlorobutadiene	0.0159	0.0020	mg/Kg wet	0.0200		79.7	70-130				
2-Hexanone (MBK)	0.206	0.020	mg/Kg wet	0.200		103	40-160				†
Isopropylbenzene (Cumene)	0.0162	0.0020	mg/Kg wet	0.0200		81.0	70-130				
p-Isopropyltoluene (p-Cymene)	0.0162	0.0020	mg/Kg wet	0.0200		80.8	70-130				
Methyl tert-Butyl Ether (MTBE)	0.0195	0.0040	mg/Kg wet	0.0200		97.3	70-130				
Methylene Chloride	0.0219	0.010	mg/Kg wet	0.0200		110	70-130				
4-Methyl-2-pentanone (MIBK)	0.208	0.020	mg/Kg wet	0.200		104	40-160				†
Naphthalene	0.0156	0.0040	mg/Kg wet	0.0200		78.0	70-130				

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QUALITY CONTROL

Volatile Organic Compounds by GC/MS - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes	
Batch B271149 - SW-846 5035											
LCS (B271149-BS1)				Prepared & Analyzed: 11/18/20							
n-Propylbenzene	0.0165	0.0020	mg/Kg wet	0.0200		82.3	70-130				
Styrene	0.0161	0.0020	mg/Kg wet	0.0200		80.5	70-130				
1,1,1,2-Tetrachloroethane	0.0164	0.0020	mg/Kg wet	0.0200		82.1	70-130				
1,1,2,2-Tetrachloroethane	0.0165	0.0010	mg/Kg wet	0.0200		82.4	70-130				
Tetrachloroethylene	0.0179	0.0020	mg/Kg wet	0.0200		89.4	70-130				
Tetrahydrofuran	0.0207	0.010	mg/Kg wet	0.0200		103	70-130				
Toluene	0.0184	0.0020	mg/Kg wet	0.0200		92.0	70-130				
1,2,3-Trichlorobenzene	0.0165	0.0020	mg/Kg wet	0.0200		82.6	70-130				
1,2,4-Trichlorobenzene	0.0163	0.0020	mg/Kg wet	0.0200		81.3	70-130				
1,1,1-Trichloroethane	0.0195	0.0020	mg/Kg wet	0.0200		97.7	70-130				
1,1,2-Trichloroethane	0.0185	0.0020	mg/Kg wet	0.0200		92.3	70-130				
Trichloroethylene	0.0180	0.0020	mg/Kg wet	0.0200		89.8	70-130				
Trichlorofluoromethane (Freon 11)	0.0207	0.010	mg/Kg wet	0.0200		104	70-130				
1,2,3-Trichloropropane	0.0167	0.0020	mg/Kg wet	0.0200		83.6	70-130				
1,2,4-Trimethylbenzene	0.0162	0.0020	mg/Kg wet	0.0200		81.1	70-130				
1,3,5-Trimethylbenzene	0.0162	0.0020	mg/Kg wet	0.0200		81.0	70-130				
Vinyl Chloride	0.0194	0.010	mg/Kg wet	0.0200		97.2	70-130				
m+p Xylene	0.0330	0.0040	mg/Kg wet	0.0400		82.6	70-130				
o-Xylene	0.0165	0.0020	mg/Kg wet	0.0200		82.4	70-130				
Surrogate: 1,2-Dichloroethane-d4	*0.0537*		mg/Kg wet	0.0500		107	70-130				
Surrogate: Toluene-d8	*0.0513*		mg/Kg wet	0.0500		103	70-130				
Surrogate: 4-Bromofluorobenzene	*0.0494*		mg/Kg wet	0.0500		98.9	70-130				
LCS Dup (B271149-BSD1)				Prepared & Analyzed: 11/18/20							
Acetone	0.234	0.10	mg/Kg wet	0.200		117	40-160	1.62	20	V-20	†
tert-Amyl Methyl Ether (TAME)	0.0199	0.0010	mg/Kg wet	0.0200		99.7	70-130	3.54	20		
Benzene	0.0195	0.0020	mg/Kg wet	0.0200		97.7	70-130	3.00	20		
Bromobenzene	0.0176	0.0020	mg/Kg wet	0.0200		87.8	70-130	4.16	20		
Bromochloromethane	0.0207	0.0020	mg/Kg wet	0.0200		104	70-130	4.14	20		
Bromodichloromethane	0.0198	0.0020	mg/Kg wet	0.0200		99.2	70-130	4.84	20		
Bromoform	0.0186	0.0020	mg/Kg wet	0.0200		93.1	70-130	9.96	20		
Bromomethane	0.0222	0.010	mg/Kg wet	0.0200		111	40-160	5.62	20	V-34	†
2-Butanone (MEK)	0.227	0.040	mg/Kg wet	0.200		113	40-160	4.35	20		†
n-Butylbenzene	0.0174	0.0020	mg/Kg wet	0.0200		86.9	70-130	5.37	20		
sec-Butylbenzene	0.0172	0.0020	mg/Kg wet	0.0200		86.0	70-130	4.09	20		
tert-Butylbenzene	0.0169	0.0020	mg/Kg wet	0.0200		84.6	70-130	6.68	20		
tert-Butyl Ethyl Ether (TBEE)	0.0209	0.0010	mg/Kg wet	0.0200		105	70-130	3.96	20		
Carbon Disulfide	0.215	0.0060	mg/Kg wet	0.200		107	70-130	2.89	20		
Carbon Tetrachloride	0.0197	0.0020	mg/Kg wet	0.0200		98.4	70-130	1.26	20		
Chlorobenzene	0.0175	0.0020	mg/Kg wet	0.0200		87.7	70-130	5.92	20		
Chlorodibromomethane	0.0199	0.0010	mg/Kg wet	0.0200		99.3	70-130	4.99	20		
Chloroethane	0.0180	0.010	mg/Kg wet	0.0200		89.9	70-130	9.31	20		
Chloroform	0.0199	0.0040	mg/Kg wet	0.0200		99.4	70-130	2.72	20		
Chloromethane	0.0213	0.010	mg/Kg wet	0.0200		106	40-160	4.03	20		†
2-Chlorotoluene	0.0180	0.0020	mg/Kg wet	0.0200		89.8	70-130	7.42	20		
4-Chlorotoluene	0.0177	0.0020	mg/Kg wet	0.0200		88.5	70-130	6.35	20		
1,2-Dibromo-3-chloropropane (DBCP)	0.0185	0.0020	mg/Kg wet	0.0200		92.4	70-130	15.0	20		
1,2-Dibromoethane (EDB)	0.0185	0.0010	mg/Kg wet	0.0200		92.7	70-130	3.79	20		
Dibromomethane	0.0194	0.0020	mg/Kg wet	0.0200		97.2	70-130	6.65	20		
1,2-Dichlorobenzene	0.0171	0.0020	mg/Kg wet	0.0200		85.5	70-130	6.03	20		
1,3-Dichlorobenzene	0.0171	0.0020	mg/Kg wet	0.0200		85.5	70-130	4.64	20		
1,4-Dichlorobenzene	0.0172	0.0020	mg/Kg wet	0.0200		85.9	70-130	4.79	20		

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QUALITY CONTROL

Volatile Organic Compounds by GC/MS - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B271149 - SW-846 5035										
LCS Dup (B271149-BSD1)				Prepared & Analyzed: 11/18/20						
Dichlorodifluoromethane (Freon 12)	0.0185	0.010	mg/Kg wet	0.0200		92.4	40-160	3.96	20	†
1,1-Dichloroethane	0.0211	0.0020	mg/Kg wet	0.0200		106	70-130	2.90	20	
1,2-Dichloroethane	0.0211	0.0020	mg/Kg wet	0.0200		105	70-130	2.87	20	
1,1-Dichloroethylene	0.0211	0.0040	mg/Kg wet	0.0200		106	70-130	3.77	20	
cis-1,2-Dichloroethylene	0.0205	0.0020	mg/Kg wet	0.0200		103	70-130	3.45	20	
trans-1,2-Dichloroethylene	0.0207	0.0020	mg/Kg wet	0.0200		104	70-130	2.20	20	
1,2-Dichloropropane	0.0202	0.0020	mg/Kg wet	0.0200		101	70-130	5.22	20	
1,3-Dichloropropane	0.0200	0.0010	mg/Kg wet	0.0200		99.9	70-130	3.86	20	
2,2-Dichloropropane	0.0178	0.0020	mg/Kg wet	0.0200		89.0	70-130	0.575	20	
1,1-Dichloropropene	0.0203	0.0020	mg/Kg wet	0.0200		102	70-130	3.21	20	
cis-1,3-Dichloropropene	0.0187	0.0010	mg/Kg wet	0.0200		93.4	70-130	3.36	20	
trans-1,3-Dichloropropene	0.0186	0.0010	mg/Kg wet	0.0200		92.9	70-130	6.08	20	
Diethyl Ether	0.0213	0.010	mg/Kg wet	0.0200		106	70-130	6.72	20	
Diisopropyl Ether (DIPE)	0.0220	0.0010	mg/Kg wet	0.0200		110	70-130	2.34	20	
1,4-Dioxane	0.208	0.10	mg/Kg wet	0.200		104	40-160	10.9	20	†
Ethylbenzene	0.0174	0.0020	mg/Kg wet	0.0200		86.8	70-130	5.42	20	
Hexachlorobutadiene	0.0170	0.0020	mg/Kg wet	0.0200		85.1	70-130	6.59	20	
2-Hexanone (MBK)	0.213	0.020	mg/Kg wet	0.200		107	40-160	3.33	20	†
Isopropylbenzene (Cumene)	0.0170	0.0020	mg/Kg wet	0.0200		85.1	70-130	5.01	20	
p-Isopropyltoluene (p-Cymene)	0.0170	0.0020	mg/Kg wet	0.0200		85.1	70-130	5.14	20	
Methyl tert-Butyl Ether (MTBE)	0.0200	0.0040	mg/Kg wet	0.0200		100	70-130	2.82	20	
Methylene Chloride	0.0228	0.010	mg/Kg wet	0.0200		114	70-130	3.84	20	
4-Methyl-2-pentanone (MIBK)	0.219	0.020	mg/Kg wet	0.200		109	40-160	4.88	20	†
Naphthalene	0.0169	0.0040	mg/Kg wet	0.0200		84.4	70-130	7.87	20	
n-Propylbenzene	0.0177	0.0020	mg/Kg wet	0.0200		88.5	70-130	7.23	20	
Styrene	0.0173	0.0020	mg/Kg wet	0.0200		86.6	70-130	7.32	20	
1,1,1,2-Tetrachloroethane	0.0174	0.0020	mg/Kg wet	0.0200		86.8	70-130	5.52	20	
1,1,2,2-Tetrachloroethane	0.0179	0.0010	mg/Kg wet	0.0200		89.3	70-130	8.02	20	
Tetrachloroethylene	0.0186	0.0020	mg/Kg wet	0.0200		93.2	70-130	4.12	20	
Tetrahydrofuran	0.0217	0.010	mg/Kg wet	0.0200		109	70-130	4.92	20	
Toluene	0.0191	0.0020	mg/Kg wet	0.0200		95.4	70-130	3.60	20	
1,2,3-Trichlorobenzene	0.0173	0.0020	mg/Kg wet	0.0200		86.4	70-130	4.47	20	
1,2,4-Trichlorobenzene	0.0173	0.0020	mg/Kg wet	0.0200		86.6	70-130	6.33	20	
1,1,1-Trichloroethane	0.0198	0.0020	mg/Kg wet	0.0200		98.8	70-130	1.20	20	
1,1,2-Trichloroethane	0.0188	0.0020	mg/Kg wet	0.0200		94.2	70-130	2.05	20	
Trichloroethylene	0.0186	0.0020	mg/Kg wet	0.0200		92.8	70-130	3.23	20	
Trichlorofluoromethane (Freon 11)	0.0208	0.010	mg/Kg wet	0.0200		104	70-130	0.453	20	
1,2,3-Trichloropropane	0.0177	0.0020	mg/Kg wet	0.0200		88.5	70-130	5.66	20	
1,2,4-Trimethylbenzene	0.0168	0.0020	mg/Kg wet	0.0200		84.1	70-130	3.68	20	
1,3,5-Trimethylbenzene	0.0174	0.0020	mg/Kg wet	0.0200		87.1	70-130	7.19	20	
Vinyl Chloride	0.0203	0.010	mg/Kg wet	0.0200		101	70-130	4.22	20	
m+p Xylene	0.0351	0.0040	mg/Kg wet	0.0400		87.9	70-130	6.21	20	
o-Xylene	0.0173	0.0020	mg/Kg wet	0.0200		86.5	70-130	4.88	20	
Surrogate: 1,2-Dichloroethane-d4	*0.0525*		mg/Kg wet	0.0500		105	70-130			
Surrogate: Toluene-d8	*0.0514*		mg/Kg wet	0.0500		103	70-130			
Surrogate: 4-Bromofluorobenzene	*0.0506*		mg/Kg wet	0.0500		101	70-130			

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QUALITY CONTROL

Semivolatile Organic Compounds by GC/MS - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B271301 - SW-846 3546										
Blank (B271301-BLK1)				Prepared: 11/19/20 Analyzed: 11/21/20						
Acenaphthene	ND	0.085	mg/Kg wet							
Acenaphthylene	ND	0.085	mg/Kg wet							
Anthracene	ND	0.085	mg/Kg wet							
Benzo(a)anthracene	ND	0.085	mg/Kg wet							
Benzo(a)pyrene	ND	0.085	mg/Kg wet							
Benzo(b)fluoranthene	ND	0.085	mg/Kg wet							
Benzo(g,h,i)perylene	ND	0.085	mg/Kg wet							
Benzo(k)fluoranthene	ND	0.085	mg/Kg wet							
Chrysene	ND	0.085	mg/Kg wet							
Dibenz(a,h)anthracene	ND	0.085	mg/Kg wet							
Fluoranthene	ND	0.085	mg/Kg wet							
Fluorene	ND	0.085	mg/Kg wet							
Indeno(1,2,3-cd)pyrene	ND	0.085	mg/Kg wet							
2-Methylnaphthalene	ND	0.085	mg/Kg wet							
Naphthalene	ND	0.085	mg/Kg wet							
Phenanthrene	ND	0.085	mg/Kg wet							
Pyrene	ND	0.085	mg/Kg wet							
Surrogate: Nitrobenzene-d5	*2.03*		mg/Kg wet	3.33		60.9	30-130			
Surrogate: 2-Fluorobiphenyl	*2.07*		mg/Kg wet	3.33		62.1	30-130			
Surrogate: p-Terphenyl-d14	*3.07*		mg/Kg wet	3.33		92.0	30-130			
LCS (B271301-BS1)				Prepared: 11/19/20 Analyzed: 11/21/20						
Acenaphthene	1.31	0.17	mg/Kg wet	1.67		78.8	40-140			
Acenaphthylene	1.29	0.17	mg/Kg wet	1.67		77.2	40-140			
Anthracene	1.49	0.17	mg/Kg wet	1.67		89.3	40-140			
Benzo(a)anthracene	1.39	0.17	mg/Kg wet	1.67		83.3	40-140			
Benzo(a)pyrene	1.40	0.17	mg/Kg wet	1.67		84.0	40-140			
Benzo(b)fluoranthene	1.39	0.17	mg/Kg wet	1.67		83.5	40-140			
Benzo(g,h,i)perylene	1.57	0.17	mg/Kg wet	1.67		94.4	40-140			
Benzo(k)fluoranthene	1.36	0.17	mg/Kg wet	1.67		81.4	40-140			
Chrysene	1.40	0.17	mg/Kg wet	1.67		83.8	40-140			
Dibenz(a,h)anthracene	1.57	0.17	mg/Kg wet	1.67		94.0	40-140			
Fluoranthene	1.45	0.17	mg/Kg wet	1.67		87.0	40-140			
Fluorene	1.39	0.17	mg/Kg wet	1.67		83.5	40-140			
Indeno(1,2,3-cd)pyrene	1.69	0.17	mg/Kg wet	1.67		102	40-140			
2-Methylnaphthalene	1.27	0.17	mg/Kg wet	1.67		76.5	40-140			
Naphthalene	1.13	0.17	mg/Kg wet	1.67		67.9	40-140			
Phenanthrene	1.44	0.17	mg/Kg wet	1.67		86.6	40-140			
Pyrene	1.39	0.17	mg/Kg wet	1.67		83.1	40-140			
Surrogate: Nitrobenzene-d5	*2.28*		mg/Kg wet	3.33		68.6	30-130			
Surrogate: 2-Fluorobiphenyl	*2.58*		mg/Kg wet	3.33		77.5	30-130			
Surrogate: p-Terphenyl-d14	*2.99*		mg/Kg wet	3.33		89.6	30-130			

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QUALITY CONTROL

Semivolatile Organic Compounds by GC/MS - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B271301 - SW-846 3546										
LCS Dup (B271301-BSD1)				Prepared: 11/19/20 Analyzed: 11/21/20						
Acenaphthene	1.40	0.17	mg/Kg wet	1.67		83.8	40-140	6.17	30	
Acenaphthylene	1.38	0.17	mg/Kg wet	1.67		82.8	40-140	7.08	30	
Anthracene	1.52	0.17	mg/Kg wet	1.67		91.1	40-140	2.00	30	
Benzo(a)anthracene	1.47	0.17	mg/Kg wet	1.67		88.0	40-140	5.48	30	
Benzo(a)pyrene	1.44	0.17	mg/Kg wet	1.67		86.6	40-140	3.00	30	
Benzo(b)fluoranthene	1.43	0.17	mg/Kg wet	1.67		85.9	40-140	2.81	30	
Benzo(g,h,i)perylene	1.65	0.17	mg/Kg wet	1.67		99.2	40-140	5.02	30	
Benzo(k)fluoranthene	1.41	0.17	mg/Kg wet	1.67		84.5	40-140	3.79	30	
Chrysene	1.48	0.17	mg/Kg wet	1.67		88.7	40-140	5.66	30	
Dibenz(a,h)anthracene	1.59	0.17	mg/Kg wet	1.67		95.7	40-140	1.73	30	
Fluoranthene	1.44	0.17	mg/Kg wet	1.67		86.6	40-140	0.392	30	
Fluorene	1.45	0.17	mg/Kg wet	1.67		87.0	40-140	4.15	30	
Indeno(1,2,3-cd)pyrene	1.75	0.17	mg/Kg wet	1.67		105	40-140	3.33	30	
2-Methylnaphthalene	1.41	0.17	mg/Kg wet	1.67		84.4	40-140	9.92	30	
Naphthalene	1.26	0.17	mg/Kg wet	1.67		75.4	40-140	10.4	30	
Phenanthrene	1.48	0.17	mg/Kg wet	1.67		88.5	40-140	2.15	30	
Pyrene	1.50	0.17	mg/Kg wet	1.67		90.2	40-140	8.17	30	
Surrogate: Nitrobenzene-d5	*2.53*		mg/Kg wet	3.33		75.9	30-130			
Surrogate: 2-Fluorobiphenyl	*2.81*		mg/Kg wet	3.33		84.4	30-130			
Surrogate: p-Terphenyl-d14	*3.27*		mg/Kg wet	3.33		98.2	30-130			

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QUALITY CONTROL

Organochloride Pesticides by GC/ECD - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B271223 - SW-846 3546										
Blank (B271223-BLK1)				Prepared: 11/18/20 Analyzed: 11/23/20						
Aldrin	ND	0.0050	mg/Kg wet							
Aldrin [2C]	ND	0.0050	mg/Kg wet							
alpha-BHC	ND	0.0050	mg/Kg wet							
alpha-BHC [2C]	ND	0.0050	mg/Kg wet							
beta-BHC	ND	0.0050	mg/Kg wet							
beta-BHC [2C]	ND	0.0050	mg/Kg wet							
delta-BHC	ND	0.0050	mg/Kg wet							
delta-BHC [2C]	ND	0.0050	mg/Kg wet							
gamma-BHC (Lindane)	ND	0.0020	mg/Kg wet							
gamma-BHC (Lindane) [2C]	ND	0.0020	mg/Kg wet							
Chlordane	ND	0.020	mg/Kg wet							
Chlordane [2C]	ND	0.020	mg/Kg wet							
4,4'-DDD	ND	0.0040	mg/Kg wet							
4,4'-DDD [2C]	ND	0.0040	mg/Kg wet							
4,4'-DDE	ND	0.0040	mg/Kg wet							
4,4'-DDE [2C]	ND	0.0040	mg/Kg wet							
4,4'-DDT	ND	0.0040	mg/Kg wet							
4,4'-DDT [2C]	ND	0.0040	mg/Kg wet							
Dieldrin	ND	0.0040	mg/Kg wet							
Dieldrin [2C]	ND	0.0040	mg/Kg wet							
Endosulfan I	ND	0.0050	mg/Kg wet							
Endosulfan I [2C]	ND	0.0050	mg/Kg wet							
Endosulfan II	ND	0.0080	mg/Kg wet							
Endosulfan II [2C]	ND	0.0080	mg/Kg wet							
Endosulfan Sulfate	ND	0.0080	mg/Kg wet							
Endosulfan Sulfate [2C]	ND	0.0080	mg/Kg wet							
Endrin	ND	0.0080	mg/Kg wet							
Endrin [2C]	ND	0.0080	mg/Kg wet							
Endrin Aldehyde	ND	0.0080	mg/Kg wet							
Endrin Aldehyde [2C]	ND	0.0080	mg/Kg wet							
Endrin Ketone	ND	0.0080	mg/Kg wet							
Endrin Ketone [2C]	ND	0.0080	mg/Kg wet							
Heptachlor	ND	0.0050	mg/Kg wet							
Heptachlor [2C]	ND	0.0050	mg/Kg wet							
Heptachlor Epoxide	ND	0.0050	mg/Kg wet							
Heptachlor Epoxide [2C]	ND	0.0050	mg/Kg wet							
Hexachlorobenzene	ND	0.0060	mg/Kg wet							
Hexachlorobenzene [2C]	ND	0.0060	mg/Kg wet							
Methoxychlor	ND	0.050	mg/Kg wet							
Methoxychlor [2C]	ND	0.050	mg/Kg wet							
Toxaphene	ND	0.10	mg/Kg wet							
Toxaphene [2C]	ND	0.10	mg/Kg wet							
Surrogate: Decachlorobiphenyl	*0.146*		mg/Kg wet	0.200		73.0	30-150			
Surrogate: Decachlorobiphenyl [2C]	*0.159*		mg/Kg wet	0.200		79.5	30-150			
Surrogate: Tetrachloro-m-xylene	*0.138*		mg/Kg wet	0.200		68.9	30-150			
Surrogate: Tetrachloro-m-xylene [2C]	*0.154*		mg/Kg wet	0.200		76.8	30-150			

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QUALITY CONTROL

Organochloride Pesticides by GC/ECD - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B271223 - SW-846 3546										
LCS (B271223-BS1)				Prepared: 11/18/20 Analyzed: 11/23/20						
Aldrin	0.080	0.0050	mg/Kg wet	0.100		79.9	40-140			
Aldrin [2C]	0.093	0.0050	mg/Kg wet	0.100		93.3	40-140			
alpha-BHC	0.079	0.0050	mg/Kg wet	0.100		78.9	40-140			
alpha-BHC [2C]	0.088	0.0050	mg/Kg wet	0.100		88.2	40-140			
beta-BHC	0.082	0.0050	mg/Kg wet	0.100		81.9	40-140			
beta-BHC [2C]	0.089	0.0050	mg/Kg wet	0.100		88.8	40-140			
delta-BHC	0.081	0.0050	mg/Kg wet	0.100		80.6	40-140			
delta-BHC [2C]	0.085	0.0050	mg/Kg wet	0.100		84.9	40-140			
gamma-BHC (Lindane)	0.078	0.0020	mg/Kg wet	0.100		77.6	40-140			
gamma-BHC (Lindane) [2C]	0.090	0.0020	mg/Kg wet	0.100		90.4	40-140			
4,4'-DDD	0.088	0.0040	mg/Kg wet	0.100		88.3	40-140			
4,4'-DDD [2C]	0.10	0.0040	mg/Kg wet	0.100		103	40-140			
4,4'-DDE	0.085	0.0040	mg/Kg wet	0.100		85.4	40-140			
4,4'-DDE [2C]	0.10	0.0040	mg/Kg wet	0.100		104	40-140			
4,4'-DDT	0.088	0.0040	mg/Kg wet	0.100		87.7	40-140			
4,4'-DDT [2C]	0.086	0.0040	mg/Kg wet	0.100		86.5	40-140			
Dieldrin	0.080	0.0040	mg/Kg wet	0.100		80.2	40-140			
Dieldrin [2C]	0.099	0.0040	mg/Kg wet	0.100		99.3	40-140			
Endosulfan I	0.083	0.0050	mg/Kg wet	0.100		83.0	40-140			
Endosulfan I [2C]	0.094	0.0050	mg/Kg wet	0.100		94.0	40-140			
Endosulfan II	0.086	0.0080	mg/Kg wet	0.100		86.0	40-140			
Endosulfan II [2C]	0.096	0.0080	mg/Kg wet	0.100		96.0	40-140			
Endosulfan Sulfate	0.076	0.0080	mg/Kg wet	0.100		76.5	40-140			
Endosulfan Sulfate [2C]	0.091	0.0080	mg/Kg wet	0.100		90.8	40-140			
Endrin	0.088	0.0080	mg/Kg wet	0.100		87.8	40-140			
Endrin [2C]	0.097	0.0080	mg/Kg wet	0.100		97.4	40-140			
Endrin Ketone	0.087	0.0080	mg/Kg wet	0.100		87.1	40-140			
Endrin Ketone [2C]	0.092	0.0080	mg/Kg wet	0.100		92.2	40-140			
Heptachlor	0.079	0.0050	mg/Kg wet	0.100		78.9	40-140			
Heptachlor [2C]	0.093	0.0050	mg/Kg wet	0.100		93.0	40-140			
Heptachlor Epoxide	0.080	0.0050	mg/Kg wet	0.100		80.5	40-140			
Heptachlor Epoxide [2C]	0.090	0.0050	mg/Kg wet	0.100		90.3	40-140			
Hexachlorobenzene	0.085	0.0060	mg/Kg wet	0.100		84.6	40-140			
Hexachlorobenzene [2C]	0.088	0.0060	mg/Kg wet	0.100		87.7	40-140			
Methoxychlor	0.090	0.050	mg/Kg wet	0.100		90.4	40-140			
Methoxychlor [2C]	0.098	0.050	mg/Kg wet	0.100		98.3	40-140			
Surrogate: Decachlorobiphenyl	*0.164*		mg/Kg wet	0.200		82.0	30-150			
Surrogate: Decachlorobiphenyl [2C]	*0.181*		mg/Kg wet	0.200		90.5	30-150			
Surrogate: Tetrachloro-m-xylene	*0.152*		mg/Kg wet	0.200		75.8	30-150			
Surrogate: Tetrachloro-m-xylene [2C]	*0.165*		mg/Kg wet	0.200		82.6	30-150			
LCS Dup (B271223-BSD1)				Prepared: 11/18/20 Analyzed: 11/23/20						
Aldrin	0.071	0.0050	mg/Kg wet	0.100		71.2	40-140	11.5	30	
Aldrin [2C]	0.082	0.0050	mg/Kg wet	0.100		82.4	40-140	12.4	30	
alpha-BHC	0.071	0.0050	mg/Kg wet	0.100		71.0	40-140	10.5	30	
alpha-BHC [2C]	0.079	0.0050	mg/Kg wet	0.100		78.7	40-140	11.5	30	
beta-BHC	0.073	0.0050	mg/Kg wet	0.100		73.2	40-140	11.2	30	
beta-BHC [2C]	0.079	0.0050	mg/Kg wet	0.100		79.3	40-140	11.4	30	
delta-BHC	0.072	0.0050	mg/Kg wet	0.100		71.5	40-140	11.9	30	
delta-BHC [2C]	0.075	0.0050	mg/Kg wet	0.100		74.9	40-140	12.5	30	
gamma-BHC (Lindane)	0.068	0.0020	mg/Kg wet	0.100		68.1	40-140	13.2	30	
gamma-BHC (Lindane) [2C]	0.080	0.0020	mg/Kg wet	0.100		80.3	40-140	11.8	30	

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QUALITY CONTROL

Organochloride Pesticides by GC/ECD - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B271223 - SW-846 3546										
LCS Dup (B271223-BSD1)				Prepared: 11/18/20 Analyzed: 11/23/20						
4,4'-DDD	0.078	0.0040	mg/Kg wet	0.100		78.2	40-140	12.2	30	
4,4'-DDD [2C]	0.091	0.0040	mg/Kg wet	0.100		90.7	40-140	12.6	30	
4,4'-DDE	0.076	0.0040	mg/Kg wet	0.100		76.2	40-140	11.5	30	
4,4'-DDE [2C]	0.091	0.0040	mg/Kg wet	0.100		91.1	40-140	13.0	30	
4,4'-DDT	0.078	0.0040	mg/Kg wet	0.100		77.7	40-140	12.1	30	
4,4'-DDT [2C]	0.076	0.0040	mg/Kg wet	0.100		76.2	40-140	12.6	30	
Dieldrin	0.072	0.0040	mg/Kg wet	0.100		71.6	40-140	11.3	30	
Dieldrin [2C]	0.087	0.0040	mg/Kg wet	0.100		87.5	40-140	12.7	30	
Endosulfan I	0.074	0.0050	mg/Kg wet	0.100		73.8	40-140	11.8	30	
Endosulfan I [2C]	0.083	0.0050	mg/Kg wet	0.100		82.8	40-140	12.7	30	
Endosulfan II	0.077	0.0080	mg/Kg wet	0.100		76.7	40-140	11.4	30	
Endosulfan II [2C]	0.084	0.0080	mg/Kg wet	0.100		84.4	40-140	12.8	30	
Endosulfan Sulfate	0.068	0.0080	mg/Kg wet	0.100		68.2	40-140	11.4	30	
Endosulfan Sulfate [2C]	0.081	0.0080	mg/Kg wet	0.100		80.6	40-140	11.9	30	
Endrin	0.078	0.0080	mg/Kg wet	0.100		77.7	40-140	12.3	30	
Endrin [2C]	0.086	0.0080	mg/Kg wet	0.100		85.6	40-140	12.9	30	
Endrin Ketone	0.077	0.0080	mg/Kg wet	0.100		76.9	40-140	12.5	30	
Endrin Ketone [2C]	0.081	0.0080	mg/Kg wet	0.100		81.3	40-140	12.6	30	
Heptachlor	0.070	0.0050	mg/Kg wet	0.100		70.3	40-140	11.6	30	
Heptachlor [2C]	0.082	0.0050	mg/Kg wet	0.100		82.2	40-140	12.3	30	
Heptachlor Epoxide	0.071	0.0050	mg/Kg wet	0.100		71.4	40-140	12.0	30	
Heptachlor Epoxide [2C]	0.079	0.0050	mg/Kg wet	0.100		79.4	40-140	12.9	30	
Hexachlorobenzene	0.076	0.0060	mg/Kg wet	0.100		76.4	40-140	10.2	30	
Hexachlorobenzene [2C]	0.079	0.0060	mg/Kg wet	0.100		78.9	40-140	10.6	30	
Methoxychlor	0.081	0.050	mg/Kg wet	0.100		81.0	40-140	11.0	30	
Methoxychlor [2C]	0.087	0.050	mg/Kg wet	0.100		87.0	40-140	12.2	30	
Surrogate: Decachlorobiphenyl	*0.143*		mg/Kg wet	0.200		71.4	30-150			
Surrogate: Decachlorobiphenyl [2C]	*0.157*		mg/Kg wet	0.200		78.3	30-150			
Surrogate: Tetrachloro-m-xylene	*0.136*		mg/Kg wet	0.200		67.9	30-150			
Surrogate: Tetrachloro-m-xylene [2C]	*0.146*		mg/Kg wet	0.200		73.1	30-150			

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QUALITY CONTROL

Polychlorinated Biphenyls By GC/ECD - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B271221 - SW-846 3546										
Blank (B271221-BLK1)				Prepared: 11/18/20 Analyzed: 11/20/20						
Aroclor-1016	ND	0.020	mg/Kg wet							
Aroclor-1016 [2C]	ND	0.020	mg/Kg wet							
Aroclor-1221	ND	0.020	mg/Kg wet							
Aroclor-1221 [2C]	ND	0.020	mg/Kg wet							
Aroclor-1232	ND	0.020	mg/Kg wet							
Aroclor-1232 [2C]	ND	0.020	mg/Kg wet							
Aroclor-1242	ND	0.020	mg/Kg wet							
Aroclor-1242 [2C]	ND	0.020	mg/Kg wet							
Aroclor-1248	ND	0.020	mg/Kg wet							
Aroclor-1248 [2C]	ND	0.020	mg/Kg wet							
Aroclor-1254	ND	0.020	mg/Kg wet							
Aroclor-1254 [2C]	ND	0.020	mg/Kg wet							
Aroclor-1260	ND	0.020	mg/Kg wet							
Aroclor-1260 [2C]	ND	0.020	mg/Kg wet							
Aroclor-1262	ND	0.020	mg/Kg wet							
Aroclor-1262 [2C]	ND	0.020	mg/Kg wet							
Aroclor-1268	ND	0.020	mg/Kg wet							
Aroclor-1268 [2C]	ND	0.020	mg/Kg wet							
Surrogate: Decachlorobiphenyl	*0.156*		mg/Kg wet	0.200		78.0	30-150			
Surrogate: Decachlorobiphenyl [2C]	*0.177*		mg/Kg wet	0.200		88.5	30-150			
Surrogate: Tetrachloro-m-xylene	*0.158*		mg/Kg wet	0.200		79.2	30-150			
Surrogate: Tetrachloro-m-xylene [2C]	*0.174*		mg/Kg wet	0.200		87.0	30-150			
LCS (B271221-BS1)				Prepared: 11/18/20 Analyzed: 11/20/20						
Aroclor-1016	0.18	0.020	mg/Kg wet	0.200		88.5	40-140			
Aroclor-1016 [2C]	0.18	0.020	mg/Kg wet	0.200		92.1	40-140			
Aroclor-1260	0.17	0.020	mg/Kg wet	0.200		85.7	40-140			
Aroclor-1260 [2C]	0.18	0.020	mg/Kg wet	0.200		90.6	40-140			
Surrogate: Decachlorobiphenyl	*0.199*		mg/Kg wet	0.200		99.3	30-150			
Surrogate: Decachlorobiphenyl [2C]	*0.228*		mg/Kg wet	0.200		114	30-150			
Surrogate: Tetrachloro-m-xylene	*0.182*		mg/Kg wet	0.200		90.8	30-150			
Surrogate: Tetrachloro-m-xylene [2C]	*0.200*		mg/Kg wet	0.200		100	30-150			
LCS Dup (B271221-BSD1)				Prepared: 11/18/20 Analyzed: 11/20/20						
Aroclor-1016	0.19	0.020	mg/Kg wet	0.200		97.2	40-140	9.41	30	
Aroclor-1016 [2C]	0.19	0.020	mg/Kg wet	0.200		92.7	40-140	0.576	30	
Aroclor-1260	0.19	0.020	mg/Kg wet	0.200		94.9	40-140	10.2	30	
Aroclor-1260 [2C]	0.20	0.020	mg/Kg wet	0.200		98.6	40-140	8.49	30	
Surrogate: Decachlorobiphenyl	*0.224*		mg/Kg wet	0.200		112	30-150			
Surrogate: Decachlorobiphenyl [2C]	*0.255*		mg/Kg wet	0.200		128	30-150			
Surrogate: Tetrachloro-m-xylene	*0.187*		mg/Kg wet	0.200		93.6	30-150			
Surrogate: Tetrachloro-m-xylene [2C]	*0.206*		mg/Kg wet	0.200		103	30-150			

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QUALITY CONTROL

Herbicides by GC/ECD - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B271318 - SW-846 8151										
Blank (B271318-BLK1)				Prepared: 11/19/20 Analyzed: 11/23/20						
2,4-D	ND	24	µg/kg wet							
2,4-D [2C]	ND	24	µg/kg wet							
2,4-DB	ND	24	µg/kg wet							
2,4-DB [2C]	ND	24	µg/kg wet							
2,4,5-TP (Silvex)	ND	2.4	µg/kg wet							
2,4,5-TP (Silvex) [2C]	ND	2.4	µg/kg wet							
2,4,5-T	ND	2.4	µg/kg wet							
2,4,5-T [2C]	ND	2.4	µg/kg wet							
Dalapon	ND	60	µg/kg wet							
Dalapon [2C]	ND	60	µg/kg wet							
Dicamba	ND	2.4	µg/kg wet							
Dicamba [2C]	ND	2.4	µg/kg wet							
Dichloroprop	ND	24	µg/kg wet							
Dichloroprop [2C]	ND	24	µg/kg wet							
Dinoseb	ND	12	µg/kg wet							
Dinoseb [2C]	ND	12	µg/kg wet							
MCPA	ND	2400	µg/kg wet							
MCPA [2C]	ND	2400	µg/kg wet							
MCPP	ND	2400	µg/kg wet							
MCPP [2C]	ND	2400	µg/kg wet							
Surrogate: 2,4-Dichlorophenylacetic acid	*67.3*		µg/kg wet	95.2		70.7	30-150			
Surrogate: 2,4-Dichlorophenylacetic acid [2C]	*66.4*		µg/kg wet	95.2		69.7	30-150			
LCS (B271318-BS1)				Prepared: 11/19/20 Analyzed: 11/23/20						
2,4-D	85.2	25	µg/kg wet	125		68.1	40-140			
2,4-D [2C]	103	25	µg/kg wet	125		82.4	40-140			
2,4-DB	58.5	25	µg/kg wet	125		46.8	40-140			
2,4-DB [2C]	67.1	25	µg/kg wet	125		53.7	40-140			
2,4,5-TP (Silvex)	8.84	2.5	µg/kg wet	12.5		70.7	40-140			
2,4,5-TP (Silvex) [2C]	9.86	2.5	µg/kg wet	12.5		78.9	40-140			
2,4,5-T	8.23	2.5	µg/kg wet	12.5		65.9	40-140			
2,4,5-T [2C]	10.1	2.5	µg/kg wet	12.5		80.5	40-140			
Dalapon	175	62	µg/kg wet	312		56.0	40-140			
Dalapon [2C]	176	62	µg/kg wet	312		56.2	40-140			
Dicamba	9.30	2.5	µg/kg wet	12.5		74.4	40-140			
Dicamba [2C]	9.86	2.5	µg/kg wet	12.5		78.9	40-140			
Dichloroprop	99.5	25	µg/kg wet	125		79.6	40-140			
Dichloroprop [2C]	103	25	µg/kg wet	125		82.6	40-140			
Dinoseb	9.89	12	µg/kg wet	62.5		15.8	13.6-36			
Dinoseb [2C]	11.1	12	µg/kg wet	62.5		17.7	12.1-38.4			
MCPA	8790	2500	µg/kg wet	12500		70.3	40-140			
MCPA [2C]	8940	2500	µg/kg wet	12500		71.5	40-140			
MCPP	9610	2500	µg/kg wet	12500		76.9	40-140			
MCPP [2C]	9370	2500	µg/kg wet	12500		75.0	40-140			
Surrogate: 2,4-Dichlorophenylacetic acid	*75.0*		µg/kg wet	100		75.0	30-150			
Surrogate: 2,4-Dichlorophenylacetic acid [2C]	*79.7*		µg/kg wet	100		79.7	30-150			

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QUALITY CONTROL

Herbicides by GC/ECD - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B271318 - SW-846 8151										
LCS Dup (B271318-BSD1)				Prepared: 11/19/20 Analyzed: 11/23/20						
2,4-D	96.5	25	µg/kg wet	125		77.2	40-140	12.5	30	
2,4-D [2C]	117	25	µg/kg wet	125		93.9	40-140	13.1	30	
2,4-DB	72.1	25	µg/kg wet	125		57.7	40-140	20.7	30	
2,4-DB [2C]	86.5	25	µg/kg wet	125		69.2	40-140	25.2	30	
2,4,5-TP (Silvex)	10.0	2.5	µg/kg wet	12.5		80.3	40-140	12.8	30	
2,4,5-TP (Silvex) [2C]	11.6	2.5	µg/kg wet	12.5		92.4	40-140	15.8	30	
2,4,5-T	9.57	2.5	µg/kg wet	12.5		76.6	40-140	15.0	30	
2,4,5-T [2C]	11.8	2.5	µg/kg wet	12.5		94.7	40-140	16.2	30	
Dalapon	192	62	µg/kg wet	312		61.5	40-140	9.24	30	
Dalapon [2C]	196	62	µg/kg wet	312		62.6	40-140	10.8	30	
Dicamba	10.4	2.5	µg/kg wet	12.5		83.2	40-140	11.2	30	
Dicamba [2C]	10.9	2.5	µg/kg wet	12.5		87.0	40-140	9.86	30	
Dichloroprop	111	25	µg/kg wet	125		89.0	40-140	11.2	30	
Dichloroprop [2C]	114	25	µg/kg wet	125		91.2	40-140	9.88	30	
Dinoseb	11.5	12	µg/kg wet	62.5		18.5	13.6-36	15.3	30	
Dinoseb [2C]	14.5	12	µg/kg wet	62.5		23.3	12.1-38.4	27.2	30	
MCPA	9810	2500	µg/kg wet	12500		78.5	40-140	11.0	30	
MCPA [2C]	9750	2500	µg/kg wet	12500		78.0	40-140	8.69	30	
MCPP	10800	2500	µg/kg wet	12500		86.4	40-140	11.7	30	
MCPP [2C]	10400	2500	µg/kg wet	12500		83.1	40-140	10.3	30	
Surrogate: 2,4-Dichlorophenylacetic acid	*79.7*		µg/kg wet	100		79.7	30-150			
Surrogate: 2,4-Dichlorophenylacetic acid [2C]	*84.5*		µg/kg wet	100		84.5	30-150			

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QUALITY CONTROL

Petroleum Hydrocarbons Analyses - EPH - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B271302 - SW-846 3546										
Blank (B271302-BLK1)				Prepared: 11/19/20 Analyzed: 11/23/20						
C9-C18 Aliphatics	ND	10	mg/Kg wet							
C19-C36 Aliphatics	ND	10	mg/Kg wet							
Unadjusted C11-C22 Aromatics	ND	10	mg/Kg wet							
C11-C22 Aromatics	ND	10	mg/Kg wet							
Acenaphthene	ND	0.10	mg/Kg wet							
Acenaphthylene	ND	0.10	mg/Kg wet							
Anthracene	ND	0.10	mg/Kg wet							
Benzo(a)anthracene	ND	0.10	mg/Kg wet							
Benzo(a)pyrene	ND	0.10	mg/Kg wet							
Benzo(b)fluoranthene	ND	0.10	mg/Kg wet							
Benzo(g,h,i)perylene	ND	0.10	mg/Kg wet							
Benzo(k)fluoranthene	ND	0.10	mg/Kg wet							
Chrysene	ND	0.10	mg/Kg wet							
Dibenz(a,h)anthracene	ND	0.10	mg/Kg wet							
Fluoranthene	ND	0.10	mg/Kg wet							
Fluorene	ND	0.10	mg/Kg wet							
Indeno(1,2,3-cd)pyrene	ND	0.10	mg/Kg wet							
2-Methylnaphthalene	ND	0.10	mg/Kg wet							
Naphthalene	ND	0.10	mg/Kg wet							
Phenanthrene	ND	0.10	mg/Kg wet							
Pyrene	ND	0.10	mg/Kg wet							
Naphthalene-aliphatic fraction	ND	0.10	mg/Kg wet							
2-Methylnaphthalene-aliphatic fraction	ND	0.10	mg/Kg wet							
Surrogate: Chlorooctadecane (COD)	*4.28*		mg/Kg wet	5.00		85.6	40-140			
Surrogate: o-Terphenyl (OTP)	*4.14*		mg/Kg wet	5.00		82.9	40-140			
Surrogate: 2-Bromonaphthalene	*4.19*		mg/Kg wet	5.00		83.8	40-140			
Surrogate: 2-Fluorobiphenyl	*4.65*		mg/Kg wet	5.00		93.0	40-140			
LCS (B271302-BS1)				Prepared: 11/19/20 Analyzed: 11/23/20						
C9-C18 Aliphatics	22.4	10	mg/Kg wet	30.0		74.7	40-140			
C19-C36 Aliphatics	39.5	10	mg/Kg wet	40.0		98.7	40-140			
Unadjusted C11-C22 Aromatics	77.1	10	mg/Kg wet	85.0		90.8	40-140			
Acenaphthene	4.21	0.10	mg/Kg wet	5.00		84.2	40-140			
Acenaphthylene	3.72	0.10	mg/Kg wet	5.00		74.3	40-140			
Anthracene	4.47	0.10	mg/Kg wet	5.00		89.4	40-140			
Benzo(a)anthracene	4.54	0.10	mg/Kg wet	5.00		90.9	40-140			
Benzo(a)pyrene	4.57	0.10	mg/Kg wet	5.00		91.4	40-140			
Benzo(b)fluoranthene	4.97	0.10	mg/Kg wet	5.00		99.4	40-140			
Benzo(g,h,i)perylene	4.34	0.10	mg/Kg wet	5.00		86.8	40-140			
Benzo(k)fluoranthene	3.87	0.10	mg/Kg wet	5.00		77.4	40-140			
Chrysene	4.46	0.10	mg/Kg wet	5.00		89.1	40-140			
Dibenz(a,h)anthracene	4.70	0.10	mg/Kg wet	5.00		94.1	40-140			
Fluoranthene	4.36	0.10	mg/Kg wet	5.00		87.3	40-140			
Fluorene	4.27	0.10	mg/Kg wet	5.00		85.5	40-140			
Indeno(1,2,3-cd)pyrene	4.39	0.10	mg/Kg wet	5.00		87.8	40-140			
2-Methylnaphthalene	3.52	0.10	mg/Kg wet	5.00		70.4	40-140			
Naphthalene	3.25	0.10	mg/Kg wet	5.00		65.0	40-140			
Phenanthrene	4.33	0.10	mg/Kg wet	5.00		86.6	40-140			
Pyrene	4.46	0.10	mg/Kg wet	5.00		89.3	40-140			
Naphthalene-aliphatic fraction	ND	0.10	mg/Kg wet	5.00			0-5			
2-Methylnaphthalene-aliphatic fraction	ND	0.10	mg/Kg wet	5.00			0-5			
Surrogate: Chlorooctadecane (COD)	*4.15*		mg/Kg wet	5.00		83.1	40-140			

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QUALITY CONTROL

Petroleum Hydrocarbons Analyses - EPH - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B271302 - SW-846 3546										
LCS (B271302-BS1)				Prepared: 11/19/20 Analyzed: 11/23/20						
Surrogate: o-Terphenyl (OTP)	*4.34*		mg/Kg wet	5.00		86.7	40-140			
Surrogate: 2-Bromonaphthalene	*3.88*		mg/Kg wet	5.00		77.6	40-140			
Surrogate: 2-Fluorobiphenyl	*4.69*		mg/Kg wet	5.00		93.9	40-140			
LCS Dup (B271302-BSD1)				Prepared: 11/19/20 Analyzed: 11/23/20						
C9-C18 Aliphatics	23.4	10	mg/Kg wet	30.0		77.8	40-140	4.06	25	
C19-C36 Aliphatics	39.5	10	mg/Kg wet	40.0		98.9	40-140	0.151	25	
Unadjusted C11-C22 Aromatics	80.7	10	mg/Kg wet	85.0		94.9	40-140	4.46	25	
Acenaphthene	4.63	0.10	mg/Kg wet	5.00		92.7	40-140	9.58	25	
Acenaphthylene	4.06	0.10	mg/Kg wet	5.00		81.1	40-140	8.77	25	
Anthracene	4.66	0.10	mg/Kg wet	5.00		93.2	40-140	4.21	25	
Benzo(a)anthracene	4.71	0.10	mg/Kg wet	5.00		94.1	40-140	3.52	25	
Benzo(a)pyrene	4.69	0.10	mg/Kg wet	5.00		93.8	40-140	2.61	25	
Benzo(b)fluoranthene	5.10	0.10	mg/Kg wet	5.00		102	40-140	2.60	25	
Benzo(g,h,i)perylene	4.41	0.10	mg/Kg wet	5.00		88.2	40-140	1.52	25	
Benzo(k)fluoranthene	3.99	0.10	mg/Kg wet	5.00		79.8	40-140	3.05	25	
Chrysene	4.62	0.10	mg/Kg wet	5.00		92.5	40-140	3.70	25	
Dibenz(a,h)anthracene	4.77	0.10	mg/Kg wet	5.00		95.4	40-140	1.37	25	
Fluoranthene	4.53	0.10	mg/Kg wet	5.00		90.7	40-140	3.81	25	
Fluorene	4.54	0.10	mg/Kg wet	5.00		90.8	40-140	6.04	25	
Indeno(1,2,3-cd)pyrene	4.47	0.10	mg/Kg wet	5.00		89.4	40-140	1.79	25	
2-Methylnaphthalene	3.92	0.10	mg/Kg wet	5.00		78.4	40-140	10.8	25	
Naphthalene	3.74	0.10	mg/Kg wet	5.00		74.8	40-140	13.9	25	
Phenanthrene	4.54	0.10	mg/Kg wet	5.00		90.8	40-140	4.74	25	
Pyrene	4.63	0.10	mg/Kg wet	5.00		92.5	40-140	3.57	25	
Naphthalene-aliphatic fraction	ND	0.10	mg/Kg wet	5.00			0-5			
2-Methylnaphthalene-aliphatic fraction	ND	0.10	mg/Kg wet	5.00			0-5			
Surrogate: Chlorooctadecane (COD)	*4.15*		mg/Kg wet	5.00		83.0	40-140			
Surrogate: o-Terphenyl (OTP)	*4.47*		mg/Kg wet	5.00		89.5	40-140			
Surrogate: 2-Bromonaphthalene	*4.21*		mg/Kg wet	5.00		84.3	40-140			
Surrogate: 2-Fluorobiphenyl	*5.02*		mg/Kg wet	5.00		100	40-140			

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QUALITY CONTROL

Metals Analyses (Total) - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B271184 - SW-846 7471										
Blank (B271184-BLK1)				Prepared: 11/18/20 Analyzed: 11/20/20						
Mercury	ND	0.025	mg/Kg wet							
LCS (B271184-BS1)				Prepared: 11/18/20 Analyzed: 11/20/20						
Mercury	17.8	0.75	mg/Kg wet	15.6		114	59.3-140.4			
LCS Dup (B271184-BSD1)				Prepared: 11/18/20 Analyzed: 11/20/20						
Mercury	16.4	0.75	mg/Kg wet	15.6		105	59.3-140.4	8.08	20	
Batch B271229 - SW-846 3050B										
Blank (B271229-BLK1)				Prepared: 11/18/20 Analyzed: 11/19/20						
Arsenic	ND	3.3	mg/Kg wet							
Barium	ND	1.7	mg/Kg wet							
Cadmium	ND	0.33	mg/Kg wet							
Chromium	ND	0.67	mg/Kg wet							
Copper	ND	0.67	mg/Kg wet							
Lead	ND	0.50	mg/Kg wet							
Nickel	ND	0.67	mg/Kg wet							
Selenium	ND	3.3	mg/Kg wet							
Silver	ND	0.33	mg/Kg wet							
Zinc	ND	0.67	mg/Kg wet							
LCS (B271229-BS1)				Prepared: 11/18/20 Analyzed: 11/19/20						
Arsenic	142	9.8	mg/Kg wet	170		83.7	82.9-117.6			
Barium	170	4.9	mg/Kg wet	183		92.9	82.5-117.5			
Cadmium	82.7	0.98	mg/Kg wet	89.5		92.5	82.8-117.3			
Chromium	90.1	2.0	mg/Kg wet	101		89.2	82.1-117.8			
Copper	136	2.0	mg/Kg wet	149		91.4	83.9-116.1			
Lead	121	1.5	mg/Kg wet	140		86.8	82.9-117.1			
Nickel	64.6	2.0	mg/Kg wet	68.3		94.5	82.1-117.7			
Selenium	150	9.8	mg/Kg wet	182		82.3	79.7-120.3			
Silver	48.4	0.98	mg/Kg wet	50.1		96.5	80.2-120			
Zinc	203	2.0	mg/Kg wet	228		89.1	80.7-118.9			
LCS Dup (B271229-BSD1)				Prepared: 11/18/20 Analyzed: 11/19/20						
Arsenic	150	9.9	mg/Kg wet	170		88.4	82.9-117.6	5.49	30	
Barium	181	4.9	mg/Kg wet	183		98.8	82.5-117.5	6.11	20	
Cadmium	85.6	0.99	mg/Kg wet	89.5		95.7	82.8-117.3	3.44	20	
Chromium	95.3	2.0	mg/Kg wet	101		94.3	82.1-117.8	5.63	30	
Copper	142	2.0	mg/Kg wet	149		95.4	83.9-116.1	4.26	30	
Lead	128	1.5	mg/Kg wet	140		91.7	82.9-117.1	5.47	30	
Nickel	67.7	2.0	mg/Kg wet	68.3		99.1	82.1-117.7	4.76	30	
Selenium	161	9.9	mg/Kg wet	182		88.3	79.7-120.3	6.98	30	
Silver	50.5	0.99	mg/Kg wet	50.1		101	80.2-120	4.34	30	
Zinc	211	2.0	mg/Kg wet	228		92.5	80.7-118.9	3.68	30	

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QUALITY CONTROL

Metals Analyses (Total) - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B271229 - SW-846 3050B										
Reference (B271229-SRM1) MRL Check				Prepared: 11/18/20 Analyzed: 11/19/20						
Lead	0.504	0.52	mg/Kg wet	0.519		97.1	80-120			

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QUALITY CONTROL

Conventional Chemistry Parameters by EPA/APHA/SW-846 Methods (Total) - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B271215 - SW 846 9060A										
Blank (B271215-BLK1)				Prepared & Analyzed: 11/19/20						
Total Organic Carbon	ND	100	mg/Kg							
LCS (B271215-BS1)				Prepared & Analyzed: 11/19/20						
Total Organic Carbon	670	100	mg/Kg	750		89.4	65.8-127			
LCS Dup (B271215-BSD1)				Prepared & Analyzed: 11/19/20						
Total Organic Carbon	657	100	mg/Kg	750		87.6	65.8-127	2.00	11.4	

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BREAKDOWN REPORT

Lab Sample ID:	S054820-PEM1	Analyzed:	11/22/2020

Column Number: 1

Analyte	% Breakdown
4,4'-DDT [1]	0.63
Endrin [1]	1.33

Column Number: 2

Analyte	% Breakdown
4,4'-DDT [2]	0.35
Endrin [2]	0.94

BREAKDOWN REPORT

Lab Sample ID:	S054820-PEM2	Analyzed:	11/22/2020

Column Number: 1

Analyte	% Breakdown
4,4'-DDT [1]	0.87
Endrin [1]	1.94

Column Number: 2

Analyte	% Breakdown
4,4'-DDT [2]	0.47
Endrin [2]	1.37

BREAKDOWN REPORT

Lab Sample ID:	S054820-PEM3	Analyzed:	11/23/2020

Column Number: 1

Analyte	% Breakdown
4,4'-DDT [1]	1.14
Endrin [1]	1.93

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BREAKDOWN REPORT

Lab Sample ID:	S054820-PEM3	Analyzed:	11/23/2020

Column Number: 2

Analyte	% Breakdown
4,4'-DDT [2]	0.60
Endrin [2]	1.33

BREAKDOWN REPORT

Lab Sample ID:	S054820-PEM4	Analyzed:	11/23/2020

Column Number: 1

Analyte	% Breakdown
4,4'-DDT [1]	1.43
Endrin [1]	2.02

Column Number: 2

Analyte	% Breakdown
4,4'-DDT [2]	0.82
Endrin [2]	1.40

BREAKDOWN REPORT

Lab Sample ID:	S054820-PEM5	Analyzed:	11/23/2020

Column Number: 1

Analyte	% Breakdown
4,4'-DDT [1]	1.51
Endrin [1]	1.94

Column Number: 2

Analyte	% Breakdown
4,4'-DDT [2]	0.89
Endrin [2]	1.35

BREAKDOWN REPORT

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39 Spruce Street * East Longmeadow, MA 01028 * FAX 413/525-6405 * TEL. 413/525-2332

BREAKDOWN REPORT

Lab Sample ID:	S054849-PEM1	Analyzed:	11/24/2020

Column Number: 1

Analyte	% Breakdown
4,4'-DDT [1]	2.08
Endrin [1]	2.67

Column Number: 2

Analyte	% Breakdown
4,4'-DDT [2]	1.19
Endrin [2]	1.82

BREAKDOWN REPORT

Lab Sample ID:	S054849-PEM2	Analyzed:	11/25/2020

Column Number: 1

Analyte	% Breakdown
4,4'-DDT [1]	2.27
Endrin [1]	3.16

Column Number: 2

Analyte	% Breakdown
4,4'-DDT [2]	1.25
Endrin [2]	1.93

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IDENTIFICATION SUMMARY FOR SINGLE COMPONENT ANALYTES

SW-846 8082A

1543201117-03

Lab Sample ID: 20K0857-03 Date(s) Analyzed: 11/23/2020 11/23/2020

Instrument ID (1): ECD1 Instrument ID (2): ECD1

GC Column (1): ID: (mm) GC Column (2): ID: (mm)

ANALYTE	COL	RT	RT WINDOW		CONCENTRATION	%RPD
			FROM	TO		
Aroclor-1260	1	0.000	0.000	0.000	4.2	
	2	0.000	0.000	0.000	4.2	0.0

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IDENTIFICATION SUMMARY FOR SINGLE COMPONENT ANALYTES

SW-846 8082A

LCS

Lab Sample ID: B271221-BS1 Date(s) Analyzed: 11/20/2020 11/20/2020

Instrument ID (1): ECD 9 Instrument ID (2): ECD 9

GC Column (1): ID: (mm) GC Column (2): ID: (mm)

ANALYTE	COL	RT	RT WINDOW		CONCENTRATION	%RPD
			FROM	TO		
Aroclor-1016	1	0.000	0.000	0.000	0.18	
	2	0.000	0.000	0.000	0.18	0.0
Aroclor-1260	1	0.000	0.000	0.000	0.17	
	2	0.000	0.000	0.000	0.18	5.7

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IDENTIFICATION SUMMARY FOR SINGLE COMPONENT ANALYTES

SW-846 8082A

LCS Dup

Lab Sample ID: B271221-BSD1 Date(s) Analyzed: 11/20/2020 11/20/2020

Instrument ID (1): ECD 9 Instrument ID (2): ECD 9

GC Column (1): ID: (mm) GC Column (2): ID: (mm)

ANALYTE	COL	RT	RT WINDOW		CONCENTRATION	%RPD
			FROM	TO		
Aroclor-1016	1	0.000	0.000	0.000	0.19	
	2	0.000	0.000	0.000	0.19	0.0
Aroclor-1260	1	0.000	0.000	0.000	0.19	
	2	0.000	0.000	0.000	0.20	5.1

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IDENTIFICATION SUMMARY FOR SINGLE COMPONENT ANALYTES

SW-846 8081B

LCS

Lab Sample ID: B271223-BS1 Date(s) Analyzed: 11/23/2020 11/23/2020

Instrument ID (1): ECD6 Instrument ID (2): ECD6

GC Column (1): ID: (mm) GC Column (2): ID: (mm)

ANALYTE	COL	RT	RT WINDOW		CONCENTRATION	%RPD
			FROM	TO		
4,4'-DDD	1	7.258	0.000	0.000	0.088	
	2	7.245	0.000	0.000	0.10	12.8
4,4'-DDE	1	6.815	0.000	0.000	0.085	
	2	6.815	0.000	0.000	0.10	16.2
4,4'-DDT	1	7.470	0.000	0.000	0.088	
	2	7.484	0.000	0.000	0.086	2.3
Aldrin	1	6.155	0.000	0.000	0.080	
	2	6.063	0.000	0.000	0.093	15.0
alpha-BHC	1	5.448	0.000	0.000	0.079	
	2	5.368	0.000	0.000	0.088	10.8
beta-BHC	1	5.701	0.000	0.000	0.082	
	2	5.635	0.000	0.000	0.089	8.2
delta-BHC	1	5.817	0.000	0.000	0.081	
	2	5.818	0.000	0.000	0.085	4.8
Dieldrin	1	7.033	0.000	0.000	0.080	
	2	6.923	0.000	0.000	0.099	21.2
Endosulfan I	1	6.858	0.000	0.000	0.083	
	2	6.725	0.000	0.000	0.094	12.4
Endosulfan II	1	7.374	0.000	0.000	0.086	
	2	7.308	0.000	0.000	0.096	11.0
Endosulfan Sulfate	1	8.027	0.000	0.000	0.076	
	2	7.783	0.000	0.000	0.091	16.7
Endrin	1	7.205	0.000	0.000	0.088	
	2	7.146	0.000	0.000	0.097	9.7
Endrin Ketone	1	8.219	0.000	0.000	0.087	
	2	8.168	0.000	0.000	0.092	5.6
gamma-BHC (Lindane)	1	5.646	0.000	0.000	0.078	
	2	5.581	0.000	0.000	0.090	14.3
Heptachlor	1	5.953	0.000	0.000	0.079	
	2	5.855	0.000	0.000	0.093	16.3
Heptachlor Epoxide	1	6.575	0.000	0.000	0.080	

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IDENTIFICATION SUMMARY FOR SINGLE COMPONENT ANALYTES

SW-846 8081B

LCS

Lab Sample ID: B271223-BS1 Date(s) Analyzed: 11/23/2020 11/23/2020

Instrument ID (1): ECD6 Instrument ID (2): ECD6

GC Column (1): ID: (mm) GC Column (2): ID: (mm)

ANALYTE	COL	RT	RT WINDOW		CONCENTRATION	%RPD
			FROM	TO		
	2	6.451	0.000	0.000	0.090	10.5
Hexachlorobenzene	1	5.341	0.000	0.000	0.085	
	2	5.284	0.000	0.000	0.088	3.5
Methoxychlor	1	7.852	0.000	0.000	0.090	
	2	8.024	0.000	0.000	0.098	8.5

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IDENTIFICATION SUMMARY FOR SINGLE COMPONENT ANALYTES

SW-846 8081B

LCS Dup

Lab Sample ID: B271223-BSD1 Date(s) Analyzed: 11/23/2020 11/23/2020

Instrument ID (1): ECD6 Instrument ID (2): ECD6

GC Column (1): ID: (mm) GC Column (2): ID: (mm)

ANALYTE	COL	RT	RT WINDOW		CONCENTRATION	%RPD
			FROM	TO		
4,4'-DDD	1	7.257	0.000	0.000	0.078	
	2	7.245	0.000	0.000	0.091	15.4
4,4'-DDE	1	6.814	0.000	0.000	0.076	
	2	6.815	0.000	0.000	0.091	18.0
4,4'-DDT	1	7.469	0.000	0.000	0.078	
	2	7.483	0.000	0.000	0.076	2.6
Aldrin	1	6.154	0.000	0.000	0.071	
	2	6.063	0.000	0.000	0.082	14.4
alpha-BHC	1	5.446	0.000	0.000	0.071	
	2	5.368	0.000	0.000	0.079	10.7
beta-BHC	1	5.701	0.000	0.000	0.073	
	2	5.634	0.000	0.000	0.079	7.9
delta-BHC	1	5.816	0.000	0.000	0.072	
	2	5.817	0.000	0.000	0.075	4.1
Dieldrin	1	7.032	0.000	0.000	0.072	
	2	6.923	0.000	0.000	0.087	18.9
Endosulfan I	1	6.857	0.000	0.000	0.074	
	2	6.724	0.000	0.000	0.083	11.5
Endosulfan II	1	7.374	0.000	0.000	0.077	
	2	7.308	0.000	0.000	0.084	8.7
Endosulfan Sulfate	1	8.027	0.000	0.000	0.068	
	2	7.783	0.000	0.000	0.081	17.4
Endrin	1	7.204	0.000	0.000	0.078	
	2	7.146	0.000	0.000	0.086	9.8
Endrin Ketone	1	8.219	0.000	0.000	0.077	
	2	8.168	0.000	0.000	0.081	5.1
gamma-BHC (Lindane)	1	5.645	0.000	0.000	0.068	
	2	5.581	0.000	0.000	0.080	16.2
Heptachlor	1	5.952	0.000	0.000	0.070	
	2	5.854	0.000	0.000	0.082	15.8
Heptachlor Epoxide	1	6.575	0.000	0.000	0.071	

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IDENTIFICATION SUMMARY FOR SINGLE COMPONENT ANALYTES

SW-846 8081B

LCS Dup

Lab Sample ID: B271223-BSD1 Date(s) Analyzed: 11/23/2020 11/23/2020

Instrument ID (1): ECD6 Instrument ID (2): ECD6

GC Column (1): ID: (mm) GC Column (2): ID: (mm)

ANALYTE	COL	RT	RT WINDOW		CONCENTRATION	%RPD
			FROM	TO		
	2	6.450	0.000	0.000	0.079	10.7
Hexachlorobenzene	1	5.340	0.000	0.000	0.076	
	2	5.283	0.000	0.000	0.079	3.9
Methoxychlor	1	7.852	0.000	0.000	0.081	
	2	8.023	0.000	0.000	0.087	7.1

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IDENTIFICATION SUMMARY FOR SINGLE COMPONENT ANALYTES

SW-846 8151A

LCS

Lab Sample ID: B271318-BS1 Date(s) Analyzed: 11/23/2020 11/23/2020

Instrument ID (1): ECD 8 Instrument ID (2): ECD 8

GC Column (1): ID: (mm) GC Column (2): ID: (mm)

ANALYTE	COL	RT	RT WINDOW		CONCENTRATION	%RPD
			FROM	TO		
2,4,5-T	1	16.588	0.000	0.000	8.23	
	2	16.153	0.000	0.000	10.1	20.8
2,4,5-TP (Silvex)	1	15.962	0.000	0.000	8.84	
	2	15.298	0.000	0.000	9.86	11.4
2,4-D	1	14.098	0.000	0.000	85.2	
	2	13.559	0.000	0.000	103	19.1
2,4-DB	1	17.139	0.000	0.000	58.5	
	2	16.931	0.000	0.000	67.1	12.8
Dalapon	1	4.779	0.000	0.000	175	
	2	4.296	0.000	0.000	176	2.3
Dicamba	1	11.934	0.000	0.000	9.30	
	2	11.345	0.000	0.000	9.86	5.9
Dichloroprop	1	13.572	0.000	0.000	99.5	
	2	12.871	0.000	0.000	103	3.0
Dinoseb	1	17.725	0.000	0.000	9.89	
	2	17.142	0.000	0.000	11.1	11.4
MCPA	1	12.767	0.000	0.000	8790	
	2	12.178	0.000	0.000	8940	1.6
MCPP	1	12.430	0.000	0.000	9610	
	2	11.681	0.000	0.000	9370	2.4

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IDENTIFICATION SUMMARY FOR SINGLE COMPONENT ANALYTES

SW-846 8151A

LCS Dup

Lab Sample ID: B271318-BSD1 Date(s) Analyzed: 11/23/2020 11/23/2020

Instrument ID (1): ECD 8 Instrument ID (2): ECD 8

GC Column (1): ID: (mm) GC Column (2): ID: (mm)

ANALYTE	COL	RT	RT WINDOW		CONCENTRATION	%RPD
			FROM	TO		
2,4,5-T	1	16.585	0.000	0.000	9.57	
	2	16.149	0.000	0.000	11.8	20.6
2,4,5-TP (Silvex)	1	15.958	0.000	0.000	10.0	
	2	15.294	0.000	0.000	11.6	14.8
2,4-D	1	14.094	0.000	0.000	96.5	
	2	13.556	0.000	0.000	117	18.7
2,4-DB	1	17.137	0.000	0.000	72.1	
	2	16.929	0.000	0.000	86.5	18.3
Dalapon	1	4.779	0.000	0.000	192	
	2	4.295	0.000	0.000	196	3.1
Dicamba	1	11.933	0.000	0.000	10.4	
	2	11.345	0.000	0.000	10.9	8.6
Dichloroprop	1	13.571	0.000	0.000	111	
	2	12.871	0.000	0.000	114	3.6
Dinoseb	1	17.726	0.000	0.000	11.5	
	2	17.141	0.000	0.000	14.5	18.9
MCPA	1	12.769	0.000	0.000	9810	
	2	12.180	0.000	0.000	9750	0.5
MCPP	1	12.431	0.000	0.000	10800	
	2	11.682	0.000	0.000	10400	5.6

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FLAG/QUALIFIER SUMMARY

*	QC result is outside of established limits.
†	Wide recovery limits established for difficult compound.
‡	Wide RPD limits established for difficult compound.
#	Data exceeded client recommended or regulatory level
ND	Not Detected
RL	Reporting Limit is at the level of quantitation (LOQ)
DL	Detection Limit is the lower limit of detection determined by the MDL study
MCL	Maximum Contaminant Level
	Percent recoveries and relative percent differences (RPDs) are determined by the software using values in the calculation which have not been rounded.
	No results have been blank subtracted unless specified in the case narrative section.
DL-03	Elevated reporting limit due to matrix interference.
L-04	Laboratory fortified blank/laboratory control sample recovery and duplicate recovery are outside of control limits. Reported value for this compound is likely to be biased on the low side.
L-14	Compound classified by MA CAM as difficult with acceptable recoveries of 40-160%. Recovery does not meet 70-130% criteria but does meet difficult compound criteria.
O-32	A dilution was performed as part of the standard analytical procedure.
RL-05	Elevated reporting limit due to high concentration of target compounds. MA CAM reporting limit not met.
RL-07	Elevated reporting limit based on lowest point in calibration. MA CAM reporting limit not met.
S-02	The surrogate recovery for this sample cannot be accurately quantified due to interference from coeluting organic compounds present in the sample extract.
V-05	Continuing calibration verification (CCV) did not meet method specifications and was biased on the low side for this compound.
V-16	Response factor is less than method specified minimum acceptable value. Reduced precision and accuracy may be associated with reported result.
V-20	Continuing calibration verification (CCV) did not meet method specifications and was biased on the high side. Data validation is not affected since sample result was "not detected" for this compound.
V-34	Initial calibration verification (ICV) did not meet method specifications and was biased on the low side for this compound. Reported result is estimated.
Z-01	Sample results were outside of the curve and could not be analyzed within the curve due to method's physical limitations. Results are estimated.

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CERTIFICATIONS

Certified Analyses included in this Report

Analyte	Certifications
MADEP EPH rev 2.1 in Soil	
C9-C18 Aliphatics	CT,NC,ME,NH-P
C19-C36 Aliphatics	CT,NC,ME,NH-P
Unadjusted C11-C22 Aromatics	CT,NC,ME,NH-P
C11-C22 Aromatics	CT,NC,ME,NH-P
Acenaphthene	CT,NC,ME,NH-P
Acenaphthylene	CT,NC,ME,NH-P
Anthracene	CT,NC,ME,NH-P
Benzo(a)anthracene	CT,NC,ME,NH-P
Benzo(a)pyrene	CT,NC,ME,NH-P
Benzo(b)fluoranthene	CT,NC,ME,NH-P
Benzo(g,h,i)perylene	CT,NC,ME,NH-P
Benzo(k)fluoranthene	CT,NC,ME,NH-P
Chrysene	CT,NC,ME,NH-P
Dibenz(a,h)anthracene	CT,NC,ME,NH-P
Fluoranthene	CT,NC,ME,NH-P
Fluorene	CT,NC,ME
Indeno(1,2,3-cd)pyrene	CT,NC,ME,NH-P
2-Methylnaphthalene	CT,NC
Naphthalene	CT,NC,ME,NH-P
Phenanthrene	CT,NC,ME,NH-P
Pyrene	CT,NC,ME,NH-P
MADEP EPH rev 2.1 in Water	
C9-C18 Aliphatics	CT,NC,ME,NH-P
C19-C36 Aliphatics	CT,NC,ME,NH-P
Unadjusted C11-C22 Aromatics	CT,NC,ME,NH-P
C11-C22 Aromatics	CT,NC,ME,NH-P
Acenaphthene	CT,NC,ME,NH-P
Acenaphthylene	CT,NC,ME,NH-P
Anthracene	CT,NC,ME,NH-P
Benzo(a)anthracene	CT,NC,ME,NH-P
Benzo(a)pyrene	CT,NC,ME,NH-P
Benzo(b)fluoranthene	CT,NC,ME,NH-P
Benzo(g,h,i)perylene	CT,NC,ME,NH-P
Benzo(k)fluoranthene	CT,NC,ME,NH-P
Chrysene	CT,NC,ME,NH-P
Dibenz(a,h)anthracene	CT,NC,ME,NH-P
Fluoranthene	CT,NC,ME,NH-P
Fluorene	CT,NC,ME
Indeno(1,2,3-cd)pyrene	CT,NC,ME,NH-P
2-Methylnaphthalene	CT,NC
Naphthalene	CT,NC,ME,NH-P
Phenanthrene	CT,NC,ME,NH-P
Pyrene	CT,NC,ME,NH-P
SW 846 9060A in Soil	
Total Organic Carbon	NY,CT,ME,VA,NH
SW-846 6010D in Soil	

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CERTIFICATIONS

Certified Analyses included in this Report

Analyte	Certifications
SW-846 6010D in Soil	
Arsenic	CT,NH,NY,ME,VA,NC
Barium	CT,NH,NY,ME,VA,NC
Cadmium	CT,NH,NY,ME,VA,NC
Chromium	CT,NH,NY,ME,VA,NC
Copper	CT,NH,NY,ME,VA,NC
Lead	CT,NH,NY,AIHA,ME,VA,NC
Nickel	CT,NH,NY,ME,VA,NC
Selenium	CT,NH,NY,ME,VA,NC
Silver	CT,NH,NY,ME,VA,NC
Zinc	CT,NH,NY,ME,VA,NC
SW-846 7471B in Soil	
Mercury	CT,NH,NY,NC,ME,VA
SW-846 8081B in Soil	
Aldrin	CT,NC,NH,NY,ME,VA
Aldrin [2C]	CT,NC,NH,NY,ME,VA
alpha-BHC	CT,NC,NH,NY,ME,VA
alpha-BHC [2C]	CT,NC,NH,NY,ME,VA
beta-BHC	CT,NC,NH,NY,ME,VA
beta-BHC [2C]	CT,NC,NH,NY,ME,VA
delta-BHC	CT,NC,NH,NY,ME,VA
delta-BHC [2C]	CT,NC,NH,NY,ME,VA
gamma-BHC (Lindane)	CT,NC,NH,NY,ME,VA
gamma-BHC (Lindane) [2C]	CT,NC,NH,NY,ME,VA
Chlordane	CT,NC,NH,NY,ME,VA
Chlordane [2C]	CT,NC,NH,NY,ME,VA
4,4'-DDD	CT,NC,NH,NY,ME,VA
4,4'-DDD [2C]	CT,NC,NH,NY,ME,VA
4,4'-DDE	CT,NC,NH,NY,ME,VA
4,4'-DDE [2C]	CT,NC,NH,NY,ME,VA
4,4'-DDT	CT,NC,NH,NY,ME,VA
4,4'-DDT [2C]	CT,NC,NH,NY,ME,VA
Dieldrin	CT,NC,NH,NY,ME,VA
Dieldrin [2C]	CT,NC,NH,NY,ME,VA
Endosulfan I	CT,NC,NH,NY,ME,VA
Endosulfan I [2C]	CT,NC,NH,NY,ME,VA
Endosulfan II	CT,NC,NH,NY,ME,VA
Endosulfan II [2C]	CT,NC,NH,NY,ME,VA
Endosulfan Sulfate	CT,NC,NH,NY,ME,VA
Endosulfan Sulfate [2C]	CT,NC,NH,NY,ME,VA
Endrin	CT,NC,NH,NY,ME,VA
Endrin [2C]	CT,NC,NH,NY,ME,VA
Endrin Ketone	NC
Endrin Ketone [2C]	NC
Heptachlor	CT,NC,NH,NY,ME,VA
Heptachlor [2C]	CT,NC,NH,NY,ME,VA
Heptachlor Epoxide	CT,NC,NH,NY,ME,VA

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CERTIFICATIONS

Certified Analyses included in this Report

Analyte	Certifications
SW-846 8081B in Soil	
Heptachlor Epoxide [2C]	CT,NC,NH,NY,ME,VA
Hexachlorobenzene	NC
Hexachlorobenzene [2C]	NC
Methoxychlor	CT,NC,NH,NY,ME,VA
Methoxychlor [2C]	CT,NC,NH,NY,ME,VA
SW-846 8081B in Water	
Aldrin	CT,NC,NH,NY,ME,VA
Aldrin [2C]	CT,NC,NH,NY,ME,VA
alpha-BHC	CT,NC,NH,NY,ME,VA
alpha-BHC [2C]	CT,NC,NH,NY,ME,VA
beta-BHC	CT,NC,NH,NY,ME,VA
beta-BHC [2C]	CT,NC,NH,NY,ME,VA
delta-BHC	CT,NC,NH,NY,ME,VA
delta-BHC [2C]	CT,NC,NH,NY,ME,VA
gamma-BHC (Lindane)	CT,NC,NH,NY,ME,VA
gamma-BHC (Lindane) [2C]	CT,NC,NH,NY,ME,VA
Chlordane	CT,NC,NH,NY,ME,VA
Chlordane [2C]	CT,NC,NH,NY,ME,VA
4,4'-DDD	CT,NC,NH,NY,ME,VA
4,4'-DDD [2C]	CT,NC,NH,NY,ME,VA
4,4'-DDE	CT,NC,NH,NY,ME,VA
4,4'-DDE [2C]	CT,NC,NH,NY,ME,VA
4,4'-DDT	CT,NC,NH,NY,ME,VA
4,4'-DDT [2C]	CT,NC,NH,NY,ME,VA
Dieldrin	CT,NC,NH,NY,ME,VA
Dieldrin [2C]	CT,NC,NH,NY,ME,VA
Endosulfan I	CT,NC,NH,NY,ME,VA
Endosulfan I [2C]	CT,NC,NH,NY,ME,VA
Endosulfan II	CT,NC,NH,NY,ME,VA
Endosulfan II [2C]	CT,NC,NH,NY,ME,VA
Endosulfan Sulfate	CT,NC,NH,NY,ME,VA
Endosulfan Sulfate [2C]	CT,NC,NH,NY,ME,VA
Endrin	CT,NC,NH,NY,ME,VA
Endrin [2C]	CT,NC,NH,NY,ME,VA
Endrin Ketone	NC
Endrin Ketone [2C]	NC
Heptachlor	CT,NC,NH,NY,ME,VA
Heptachlor [2C]	CT,NC,NH,NY,ME,VA
Heptachlor Epoxide	CT,NC,NH,NY,ME,VA
Heptachlor Epoxide [2C]	CT,NC,NH,NY,ME,VA
Hexachlorobenzene	NC
Hexachlorobenzene [2C]	NC
Methoxychlor	CT,NC,NH,NY,ME,VA
Methoxychlor [2C]	CT,NC,NH,NY,ME,VA
SW-846 8082A in Soil	
Aroclor-1016	CT,NH,NY,NC,ME,VA,PA

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CERTIFICATIONS

Certified Analyses included in this Report

Analyte	Certifications
SW-846 8082A in Soil	
Aroclor-1016 [2C]	CT,NH,NY,NC,ME,VA,PA
Aroclor-1221	CT,NH,NY,NC,ME,VA,PA
Aroclor-1221 [2C]	CT,NH,NY,NC,ME,VA,PA
Aroclor-1232	CT,NH,NY,NC,ME,VA,PA
Aroclor-1232 [2C]	CT,NH,NY,NC,ME,VA,PA
Aroclor-1242	CT,NH,NY,NC,ME,VA,PA
Aroclor-1242 [2C]	CT,NH,NY,NC,ME,VA,PA
Aroclor-1248	CT,NH,NY,NC,ME,VA,PA
Aroclor-1248 [2C]	CT,NH,NY,NC,ME,VA,PA
Aroclor-1254	CT,NH,NY,NC,ME,VA,PA
Aroclor-1254 [2C]	CT,NH,NY,NC,ME,VA,PA
Aroclor-1260	CT,NH,NY,NC,ME,VA,PA
Aroclor-1260 [2C]	CT,NH,NY,NC,ME,VA,PA
Aroclor-1262	NH,NY,NC,ME,VA,PA
Aroclor-1262 [2C]	NH,NY,NC,ME,VA,PA
Aroclor-1268	NH,NY,NC,ME,VA,PA
Aroclor-1268 [2C]	NH,NY,NC,ME,VA,PA
SW-846 8082A in Water	
Aroclor-1016	CT,NH,NY,NC,ME,VA,PA
Aroclor-1016 [2C]	CT,NH,NY,NC,ME,VA,PA
Aroclor-1221	CT,NH,NY,NC,ME,VA,PA
Aroclor-1221 [2C]	CT,NH,NY,NC,ME,VA,PA
Aroclor-1232	CT,NH,NY,NC,ME,VA,PA
Aroclor-1232 [2C]	CT,NH,NY,NC,ME,VA,PA
Aroclor-1242	CT,NH,NY,NC,ME,VA,PA
Aroclor-1242 [2C]	CT,NH,NY,NC,ME,VA,PA
Aroclor-1248	CT,NH,NY,NC,ME,VA,PA
Aroclor-1248 [2C]	CT,NH,NY,NC,ME,VA,PA
Aroclor-1254	CT,NH,NY,NC,ME,VA,PA
Aroclor-1254 [2C]	CT,NH,NY,NC,ME,VA,PA
Aroclor-1260	CT,NH,NY,NC,ME,VA,PA
Aroclor-1260 [2C]	CT,NH,NY,NC,ME,VA,PA
Aroclor-1262	NH,NY,NC,ME,VA,PA
Aroclor-1262 [2C]	NH,NY,NC,ME,VA,PA
Aroclor-1268	NH,NY,NC,ME,VA,PA
Aroclor-1268 [2C]	NH,NY,NC,ME,VA,PA
SW-846 8151A in Soil	
2,4-D	NY,ME,NC,NH,VA,CT
2,4-D [2C]	NY,ME,NC,NH,VA,CT
2,4-DB	NY,ME,NC,NH,VA,CT
2,4-DB [2C]	NY,ME,NC,NH,VA,CT
2,4,5-TP (Silvex)	NY,ME,NC,NH,VA,CT
2,4,5-TP (Silvex) [2C]	NY,ME,NC,NH,VA,CT
2,4,5-T	NY,ME,NC,NH,VA,CT
2,4,5-T [2C]	NY,ME,NC,NH,VA,CT
Dalapon	NY,ME,NC,NH,VA,CT

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CERTIFICATIONS

Certified Analyses included in this Report

Analyte	Certifications
SW-846 8151A in Soil	
Dalapon [2C]	NY,ME,NC,NH,VA,CT
Dicamba	NY,ME,NC,NH,VA,CT
Dicamba [2C]	NY,ME,NC,NH,VA,CT
Dichloroprop	NY,ME,NC,NH,VA,CT
Dichloroprop [2C]	NY,ME,NC,NH,VA,CT
Dinoseb	NY,ME,NC,NH,VA,CT
Dinoseb [2C]	NY,ME,NC,NH,VA,CT
MCPA	NY,ME,NC,NH,VA,CT
MCPA [2C]	NY,ME,NC,NH,VA,CT
MCPP	NY,ME,NC,NH,VA,CT
MCPP [2C]	NY,ME,NC,NH,VA,CT
SW-846 8260C-D in Soil	
Acetone	CT,NH,NY,ME
Acetone	CT,NH,NY,ME
Benzene	CT,NH,NY,ME
Benzene	CT,NH,NY,ME
Bromobenzene	NH,NY,ME
Bromobenzene	NH,NY,ME
Bromochloromethane	NH,NY,ME
Bromochloromethane	NH,NY,ME
Bromodichloromethane	CT,NH,NY,ME
Bromodichloromethane	CT,NH,NY,ME
Bromoform	CT,NH,NY,ME
Bromoform	CT,NH,NY,ME
Bromomethane	CT,NH,NY,ME
Bromomethane	CT,NH,NY,ME
2-Butanone (MEK)	CT,NH,NY,ME
2-Butanone (MEK)	CT,NH,NY,ME
n-Butylbenzene	CT,NH,NY,ME
n-Butylbenzene	CT,NH,NY,ME
sec-Butylbenzene	CT,NH,NY,ME
sec-Butylbenzene	CT,NH,NY,ME
tert-Butylbenzene	CT,NH,NY,ME
tert-Butylbenzene	CT,NH,NY,ME
Carbon Disulfide	CT,NH,NY,ME
Carbon Disulfide	CT,NH,NY,ME
Carbon Tetrachloride	CT,NH,NY,ME
Carbon Tetrachloride	CT,NH,NY,ME
Chlorobenzene	CT,NH,NY,ME
Chlorobenzene	CT,NH,NY,ME
Chlorodibromomethane	CT,NH,NY,ME
Chlorodibromomethane	CT,NH,NY,ME
Chloroethane	CT,NH,NY,ME
Chloroethane	CT,NH,NY,ME
Chloroform	CT,NH,NY,ME
Chloroform	CT,NH,NY,ME

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CERTIFICATIONS

Certified Analyses included in this Report

Analyte	Certifications
SW-846 8260C-D in Soil	
Chloromethane	CT,NH,NY,ME
Chloromethane	CT,NH,NY,ME
2-Chlorotoluene	CT,NH,NY,ME
2-Chlorotoluene	CT,NH,NY,ME
4-Chlorotoluene	CT,NH,NY,ME
4-Chlorotoluene	CT,NH,NY,ME
1,2-Dibromo-3-chloropropane (DBCP)	NY
1,2-Dibromo-3-chloropropane (DBCP)	NY
1,2-Dibromoethane (EDB)	NY
1,2-Dibromoethane (EDB)	NY
Dibromomethane	NH,NY,ME
Dibromomethane	NH,NY,ME
1,2-Dichlorobenzene	CT,NH,NY,ME
1,2-Dichlorobenzene	CT,NH,NY,ME
1,3-Dichlorobenzene	CT,NH,NY,ME
1,3-Dichlorobenzene	CT,NH,NY,ME
1,4-Dichlorobenzene	CT,NH,NY,ME
1,4-Dichlorobenzene	CT,NH,NY,ME
Dichlorodifluoromethane (Freon 12)	NY,ME
Dichlorodifluoromethane (Freon 12)	NY,ME
1,1-Dichloroethane	CT,NH,NY,ME
1,1-Dichloroethane	CT,NH,NY,ME
1,2-Dichloroethane	CT,NH,NY,ME
1,2-Dichloroethane	CT,NH,NY,ME
1,1-Dichloroethylene	CT,NH,NY,ME
1,1-Dichloroethylene	CT,NH,NY,ME
cis-1,2-Dichloroethylene	CT,NH,NY,ME
cis-1,2-Dichloroethylene	CT,NH,NY,ME
trans-1,2-Dichloroethylene	CT,NH,NY,ME
trans-1,2-Dichloroethylene	CT,NH,NY,ME
1,2-Dichloropropane	CT,NH,NY,ME
1,2-Dichloropropane	CT,NH,NY,ME
1,3-Dichloropropane	NH,NY,ME
1,3-Dichloropropane	NH,NY,ME
2,2-Dichloropropane	NH,NY,ME
2,2-Dichloropropane	NH,NY,ME
1,1-Dichloropropene	NH,NY,ME
1,1-Dichloropropene	NH,NY,ME
cis-1,3-Dichloropropene	CT,NH,NY,ME
cis-1,3-Dichloropropene	CT,NH,NY,ME
trans-1,3-Dichloropropene	CT,NH,NY,ME
trans-1,3-Dichloropropene	CT,NH,NY,ME
1,4-Dioxane	NY
Ethylbenzene	CT,NH,NY,ME
Ethylbenzene	CT,NH,NY,ME
Hexachlorobutadiene	NH,NY,ME
Hexachlorobutadiene	NH,NY,ME

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CERTIFICATIONS

Certified Analyses included in this Report

Analyte	Certifications
SW-846 8260C-D in Soil	
2-Hexanone (MBK)	CT,NH,NY,ME
2-Hexanone (MBK)	CT,NH,NY,ME
Isopropylbenzene (Cumene)	CT,NH,NY,ME
Isopropylbenzene (Cumene)	CT,NH,NY,ME
p-Isopropyltoluene (p-Cymene)	NH,NY
p-Isopropyltoluene (p-Cymene)	NH,NY
Methyl tert-Butyl Ether (MTBE)	NY
Methyl tert-Butyl Ether (MTBE)	NH,NY
Methylene Chloride	CT,NH,NY,ME
Methylene Chloride	CT,NH,NY,ME
4-Methyl-2-pentanone (MIBK)	CT,NH,NY
4-Methyl-2-pentanone (MIBK)	CT,NH,NY
Naphthalene	NH,NY,ME
Naphthalene	NH,NY,ME
n-Propylbenzene	NH,NY
n-Propylbenzene	NH,NY
Styrene	CT,NH,NY,ME
Styrene	CT,NH,NY,ME
1,1,1,2-Tetrachloroethane	CT,NH,NY,ME
1,1,1,2-Tetrachloroethane	CT,NH,NY,ME
1,1,2,2-Tetrachloroethane	CT,NH,NY,ME
1,1,2,2-Tetrachloroethane	CT,NH,NY,ME
Tetrachloroethylene	CT,NH,NY,ME
Tetrachloroethylene	CT,NH,NY,ME
Toluene	CT,NH,NY,ME
Toluene	CT,NH,NY,ME
1,2,3-Trichlorobenzene	ME
1,2,3-Trichlorobenzene	NY
1,2,4-Trichlorobenzene	NH,NY,ME
1,2,4-Trichlorobenzene	NH,NY,ME
1,1,1-Trichloroethane	CT,NH,NY,ME
1,1,1-Trichloroethane	CT,NH,NY,ME
1,1,2-Trichloroethane	CT,NH,NY,ME
1,1,2-Trichloroethane	CT,NH,NY,ME
Trichloroethylene	CT,NH,NY,ME
Trichloroethylene	CT,NH,NY,ME
Trichlorofluoromethane (Freon 11)	CT,NH,NY,ME
Trichlorofluoromethane (Freon 11)	CT,NH,NY,ME
1,2,3-Trichloropropane	NH,NY,ME
1,2,3-Trichloropropane	NH,NY,ME
1,2,4-Trimethylbenzene	CT,NH,NY,ME
1,2,4-Trimethylbenzene	CT,NH,NY,ME
1,3,5-Trimethylbenzene	CT,NH,NY,ME
1,3,5-Trimethylbenzene	CT,NH,NY,ME
Vinyl Chloride	CT,NH,NY,ME
Vinyl Chloride	CT,NH,NY,ME
m+p Xylene	CT,NH,NY,ME

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CERTIFICATIONS

Certified Analyses included in this Report

Analyte	Certifications
SW-846 8260C-D in Soil	
m+p Xylene	CT,NH,NY,ME
o-Xylene	CT,NH,NY,ME
o-Xylene	CT,NH,NY,ME
SW-846 8270D-E in Soil	
Acenaphthene	CT,NY,NH,ME,NC,VA
Acenaphthylene	CT,NY,NH,ME,NC,VA
Anthracene	CT,NY,NH,ME,NC,VA
Benzo(a)anthracene	CT,NY,NH,ME,NC,VA
Benzo(a)pyrene	CT,NY,NH,ME,NC,VA
Benzo(b)fluoranthene	CT,NY,NH,ME,NC,VA
Benzo(g,h,i)perylene	CT,NY,NH,ME,NC,VA
Benzo(k)fluoranthene	CT,NY,NH,ME,NC,VA
Chrysene	CT,NY,NH,ME,NC,VA
Dibenz(a,h)anthracene	CT,NY,NH,ME,NC,VA
Fluoranthene	CT,NY,NH,ME,NC,VA
Fluorene	CT,NY,NH,ME,NC,VA
Indeno(1,2,3-cd)pyrene	CT,NY,NH,ME,NC,VA
2-Methylnaphthalene	CT,NY,NH,ME,NC,VA
Naphthalene	CT,NY,NH,ME,NC,VA
Phenanthrene	CT,NY,NH,ME,NC,VA
Pyrene	CT,NY,NH,ME,NC,VA
SW-846 8270D-E in Water	
Acenaphthene	CT,NY,NH,ME,NC,VA
Acenaphthylene	CT,NY,NH,ME,NC,VA
Anthracene	CT,NY,NH,ME,NC,VA
Benzo(a)anthracene	CT,NY,NH,ME,NC,VA
Benzo(a)pyrene	CT,NY,NH,ME,NC,VA
Benzo(b)fluoranthene	CT,NY,NH,ME,NC,VA
Benzo(g,h,i)perylene	CT,NY,NH,ME,NC,VA
Benzo(k)fluoranthene	CT,NY,NH,ME,NC,VA
Chrysene	CT,NY,NH,ME,NC,VA
Dibenz(a,h)anthracene	CT,NY,NH,ME,NC,VA
Fluoranthene	CT,NY,NH,ME,NC,VA
Fluorene	CT,NY,NH,ME,NC,VA
Indeno(1,2,3-cd)pyrene	CT,NY,NH,ME,NC,VA
2-Methylnaphthalene	CT,NY,NH,ME,NC,VA
Naphthalene	CT,NY,NH,ME,NC,VA
Phenanthrene	CT,NY,NH,ME,NC,VA
Pyrene	CT,NY,NH,ME,NC,VA

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The CON-TEST Environmental Laboratory operates under the following certifications and accreditations:

Code	Description	Number	Expires
AIHA	AIHA-LAP, LLC - ISO17025:2017	100033	03/1/2022
MA	Massachusetts DEP	M-MA100	06/30/2021
CT	Connecticut Department of Publilc Health	PH-0567	09/30/2021
NY	New York State Department of Health	10899 NELAP	04/1/2021
NH-S	New Hampshire Environmental Lab	2516 NELAP	02/5/2021
RI	Rhode Island Department of Health	LAO00112	12/30/2020
NC	North Carolina Div. of Water Quality	652	12/31/2020
NJ	New Jersey DEP	MA007 NELAP	06/30/2021
FL	Florida Department of Health	E871027 NELAP	06/30/2021
VT	Vermont Department of Health Lead Laboratory	LL015036	07/30/2021
ME	State of Maine	2011028	06/9/2021
VA	Commonwealth of Virginia	460217	12/14/2020
NH-P	New Hampshire Environmental Lab	2557 NELAP	09/6/2021
VT-DW	Vermont Department of Health Drinking Water	VT-255716	06/12/2021
NC-DW	North Carolina Department of Health	25703	07/31/2021
PA	Commonwealth of Pennsylvania DEP	68-05812	06/30/2021
MI	Dept. of Env, Great Lakes, and Energy	9100	09/6/2021

20R0857

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☐ 56 Quarry Road, Trumbull, CT 06611
☐ 1419 Richland Street, Columbia, SC 29201
☐ 78 Interstate Drive, West Springfield, MA 01089
☒ 108 Myrtle Street, #502, North Quincy, MA 02171
☐ 317 Iron Horse Way, Suite 204, Providence, RI 02908
☐ 80 Washington Street, Suite 301, Poughkeepsie, NY
☐ Other _____

CHAIN-OF-CUSTODY RECORD

41736

Turnaround
☐ 24-Hour* ☐ 72-Hour* ☐ Other _____ (days)
☐ 48-Hour* ☒ Standard (____ days) *Surcharge Applies

PROJECT NAME: MVP Action Grant FY21
PROJECT LOCATION: Haverhill, MA
PROJECT NUMBER: 20170390.U20
LABORATORY: Con-Test

REPORT TO: Dan LaFrance (dlafrance@fando.com)
INVOICE TO: Matt Kissane (mkissane@fando.com)
P.O. NO.: 154320170390.U20
Sampler's Signature: _____ Date: 11/17/20

Source Codes:
MW=Monitoring Well PW=Potable Water T=Treatment Facility S=Soil B=Sediment
SW=Surface Water ST=Stormwater W=Waste A=Air C=Concrete
X=Other Trip Blank

Analysis Request / Containers

Item No.	Transfer Check 1	2	3	4	Sample Number	Source Code	Date Sampled	Time Sampled	RCRA 8 Metals	VOC (8270)	PAHs	PCBs	EPH	Pesticides & Herbicides	TCLP *	Total Cr/Pb/VOC Chlorine	Soil VOA Vial, ☒ methanol	Soil VOA Vial, ☐ water ☒ $Na(SO_4)_2$	Glass Soil Container (lb) oz	Other: Glass (8) oz	Other: Glass (2) oz	Water VOA Vial, ☐ As is ☐ HCl	Glass Amber ( ) ml, ☐ As is ☐ H_2SO_4	Plastic - As is, ☐ 250 ml ☐ 500 ☐ 1000 ml	Plastic - H_2SO_4, ☐ 250 ml ☐ 500 ml	Plastic - HNO_3, 250 ml ☐ Filtered ☐ 0.45µ ☐ 10µ	Plastic - NaOH, 250 ml	Comments
1	X				154320117-01	X	11/17/20	0924	X								1	2										
2	X				154320117-02	B	↓	0950	X	X	X	X	X	X	X	X	1	2	1	2	1							
3	X				154320117-03	B		1015	X	X	X	X	X	X	X	X	1	2	1	2	1							
4	X				154320117-04	B		1115	X	X	X	X	X	X	X	X	1	2	1	2	1							

Transfer Number	Relinquished By	Accepted By	Date	Time
1	[signature]	FTO Fridge	11/17/20	1402
2	Paul Chetkauskas	[signature]	11-17-20	1607
3	Paul Chetkauskas 11/17/20	[signature]	11-17-20	1730
4	[signature] 11/17/20 1916	[signature] MA 2-7	11/17/20	1910

Charge Exceptions: ☐ CT Tax Exempt ☐ QA/QC ☐ Other _____
____ Duplicates ☒ Blanks (Item Nos: 1)
Reporting and Detection Limit Requirements: ☐ RCP Deliverables ☐ MCP CAM Cert.
Additional Comments: * Hold for TCLP

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I Have Not Confirmed Sample Container Numbers With Lab Staff Before Relinquishing Over Samples_____

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Doc# 277 Rev 5 2017

Login Sample Receipt Checklist - (Rejection Criteria Listing - Using Acceptance Policy) Any False Statement will be brought to the attention of the Client - State True or False

Client Fuss and O'Neill

Received By _____ Date 11/17/20 Time 1910

How were the samples received? In Cooler T No Cooler _____ On Ice T No Ice _____ Direct from Sampling _____ Ambient _____ Melted Ice _____

Were samples within Temperature? 2-6°C T By Gun # 2 Actual Temp - 2.7 By Blank # _____ Actual Temp - _____

Was Custody Seal Intact? NA Were Samples Tampered with? NA

Was COC Relinquished ? T Does Chain Agree With Samples? T

Are there broken/leaking/loose caps on any samples? F

Is COC in ink/ Legible? T Were samples received within holding time? T

Did COC include all pertinent Information? Client T Analysis T Sampler Name T Project T ID's T Collection Dates/Times T

Are Sample labels filled out and legible? T

Are there Lab to Filters? F Who was notified? _____

Are there Rushes? F Who was notified? _____

Are there Short Holds? F Who was notified? _____

Is there enough Volume? T

Is there Headspace where applicable? T MS/MSD? F

Proper Media/Containers Used? T Is splitting samples required? F

Were trip blanks received? T On COC? F

Do all samples have the proper pH? NA Acid _____ Base _____

Vials	#	Containers:	#		#		#
Unp-		1 Liter Amb.		1 Liter Plastic		16 oz Amb.	3
HCL-		500 mL Amb.		500 mL Plastic		8oz Amb/Clear	6
Meoh-	4	250 mL Amb.		250 mL Plastic		4oz Amb/Clear	
Bisulfate-	3	Flashpoint		Col./Bacteria		2oz Amb/Clear	3
DI-		Other Glass		Other Plastic		Encore	
Thiosulfate-		SOC Kit		Plastic Bag		Frozen:	
Sulfuric-		Perchlorate		Ziplock			

Unused Media

Vials	#	Containers:	#		#		#
Unp-		1 Liter Amb.		1 Liter Plastic		16 oz Amb.	
HCL-		500 mL Amb.		500 mL Plastic		8oz Amb/Clear	
Meoh-		250 mL Amb.		250 mL Plastic		4oz Amb/Clear	
Bisulfate-		Col./Bacteria		Flashpoint		2oz Amb/Clear	
DI-		Other Plastic		Other Glass		Encore	
Thiosulfate-		SOC Kit		Plastic Bag		Frozen:	
Sulfuric-		Perchlorate		Ziplock			

Comments:

MADEP MCP Analytical Method Report Certification Form

Laboratory Name: Con-Test Analytical Laboratory	Project #: 20K0857
Project Location: Haverhill, MA	RTN:

This Form provides certifications for the following data set: [list Laboratory Sample ID Number(s)]

20K0857-01 thru 20K0857-04

Matrices: Soil

CAM Protocol (check all that below)

8260 VOC CAM II A (X)	7470/7471 Hg CAM IIIB (X)	MassDEP VPH CAM IV A ( )	8082 PCB CAM V A (X)	9014 Total Cyanide/PAC CAM VI A ( )	6860 Perchlorate CAM VIII B ( )
8270 SVOC CAM II B (X)	7010 Metals CAM III C ( )	MassDEP VPH CAM IV C ( )	8081 Pesticides CAM V B (X)	7196 Hex Cr CAM VI B ( )	MassDEP APH CAM IX A ( )
6010 Metals CAM III A (X)	6020 Metals CAM III D ( )	MassDEP EPH CAM IV B (X)	8151 Herbicides CAM V C (X)	8330 Explosives CAM VIII A ( )	TO-15 VOC CAM IX B ( )

Affirmative response to Questions A throughF is required for "Presumptive Certainty" status

A	Were all samples received in a condition consistent with those described on the Chain-of-Custody, properly preserved (including temperature) in the field or laboratory, and prepared/analyzed within method holding times?	☑ Yes	☐ No[1]
B	Were the analytical method(s) and all associated QC requirements specificed in the selected CAM protocol(s) followed?	☑ Yes	☐ No[1]
C	Were all required corrective actions and analytical response actions specified in the selected CAM protocol(s) implemented for all identified performance standard non-conformances?	☑ Yes	☐ No[1]
D	Does the laboratory report comply with all the reporting requirements specified in CAM VII A, Quality Assurance and Quality Control Guidlines for the Acquisition and Reporting of Analytical Data?	☑ Yes	☐ No[1]
E a	VPH, EPH, and APH Methods only: Was each method conducted without significant modification(s)? (Refer to the individual method(s) for a list of significant modifications).	☑ Yes	☐ No[1]
E b	APH and TO-15 Methods only: Was the complete analyte list reported for each method?	☐ Yes	☐ No[1]
F	Were all applicable CAM protocol QC and performance standard non-conformances identified and evaluated in a laboratory narrative (including all No responses to Qestions A through E)?	☑ Yes	☐ No[1]

A response to questions G, H and I below is required for "Presumptive Certainty" status

G	Were the reporting limits at or below all CAM reporting limits specified in the selected CAM protocol(s)?	☐ Yes	☑ No[1]

<u>Data User Note:</u> Data that achieve "Presumptive Certainty" status may not necessarily meet the data usability and representativeness requirements described in 310 CMR 40. 1056 (2)(k) and WSC-07-350.

H	Were all QC perfomance standards specified in the CAM protocol(s) achieved?	☐ Yes	☑ No[1]
I	Were results reported for the complete analyte list specified in the selected CAM protocol(s)?	☐ Yes	☑ No[1]

[1] *All Negative responses must be addressed in an attached Environmental Laboratory case narrative.*

I, the undersigned, attest under the pains and penalties of perjury that, based upon my personal inquiry of those responsible for obtaining the information, the material contained in this analytical report is, to the best of my knowledge and belief, accurate and complete.

Signature: Lisa Worthington Position: Technical Representative

Printed Name: Lisa A. Worthington Date: 11/25/20

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December 7, 2020

Matt Kissane
Fuss & O'Neill EnviroScience, LLC - MA
108 Myrtle St,
Quincy, MA 02171

Project Location: Haverhill, MA
Client Job Number:
Project Number: 20170390.U20
Laboratory Work Order Number: 20L0078

Enclosed are results of analyses for samples received by the laboratory on December 2, 2020. If you have any questions concerning this report, please feel free to contact me.

Sincerely,

Jessica L. Hoffman
Project Manager

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Fuss & O'Neill EnviroScience, LLC - MA
108 Myrtle St,
Quincy, MA 02171
ATTN: Matt Kissane

REPORT DATE: 12/7/2020

PURCHASE ORDER NUMBER:

PROJECT NUMBER: 20170390.U20

ANALYTICAL SUMMARY

WORK ORDER NUMBER: 20L0078

The results of analyses performed on the following samples submitted to the CON-TEST Analytical Laboratory are found in this report.

PROJECT LOCATION: Haverhill, MA

FIELD SAMPLE #	LAB ID:	MATRIX	SAMPLE DESCRIPTION	TEST	SUB LAB
1543201117-03	20L0078-02	Sediment		SM 2540G SW-846 6010D	

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CASE NARRATIVE SUMMARY

All reported results are within defined laboratory quality control objectives unless listed below or otherwise qualified in this report.

The results of analyses reported only relate to samples submitted to the Con-Test Analytical Laboratory for testing.
I certify that the analyses listed above, unless specifically listed as subcontracted, if any, were performed under my direction according to the approved methodologies listed in this document, and that based upon my inquiry of those individuals immediately responsible for obtaining the information, the material contained in this report is, to the best of my knowledge and belief, accurate and complete.

Tod E. Kopyscinski
Laboratory Director

39 Spruce Street * East Longmeadow, MA 01028 * FAX 413/525-6405 * TEL. 413/525-2332

Project Location: Haverhill, MA | Sample Description: | Work Order: 20L0078

Date Received: 12/2/2020

Field Sample #: 1543201117-03 | Sampled: 11/17/2020 10:15

Sample ID: 20L0078-02

Sample Matrix: Sediment

Conventional Chemistry Parameters by EPA/APHA/SW-846 Methods (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
% Solids	73.0		% Wt	1		SM 2540G	12/2/20	12/2/20 12:08	CJT

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Project Location: Haverhill, MA
Sample Description:
Work Order: 20L0078
Date Received: 12/2/2020
Field Sample #: 1543201117-03
Sampled: 11/17/2020 10:15
Sample ID: 20L0078-02
Sample Matrix: Sediment

TCLP - Metals Analyses

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Lead	0.15	0.10	mg/L	1		SW-846 6010D	12/3/20	12/4/20 17:08	MJH

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Sample Extraction Data

Prep Method: % Solids **Analytical Method: SM 2540G**

Lab Number [Field ID]	Batch	Date
20L0078-02 [1543201117-03]	B271979	12/02/20

Prep Method: SW-846 3010A **Analytical Method: SW-846 6010D** **Leachates were extracted on 12/2/2020 per SW-846 1311 in Batch B271980**

Lab Number [Field ID]	Batch	Initial [mL]	Final [mL]	Date
20L0078-02 [1543201117-03]	B272095	50.0	50.0	12/03/20

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QUALITY CONTROL

TCLP - Metals Analyses - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B272095 - SW-846 3010A										
Blank (B272095-BLK1)				Prepared: 12/03/20 Analyzed: 12/04/20						
Lead	ND	0.10	mg/L							
LCS (B272095-BS1)				Prepared: 12/03/20 Analyzed: 12/04/20						
Lead	0.485	0.10	mg/L	0.500		96.9	80-120			
LCS Dup (B272095-BSD1)				Prepared: 12/03/20 Analyzed: 12/04/20						
Lead	0.490	0.10	mg/L	0.500		98.1	80-120	1.19	20	

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FLAG/QUALIFIER SUMMARY

*	QC result is outside of established limits.
†	Wide recovery limits established for difficult compound.
‡	Wide RPD limits established for difficult compound.
#	Data exceeded client recommended or regulatory level
ND	Not Detected
RL	Reporting Limit is at the level of quantitation (LOQ)
DL	Detection Limit is the lower limit of detection determined by the MDL study
MCL	Maximum Contaminant Level

Percent recoveries and relative percent differences (RPDs) are determined by the software using values in the calculation which have not been rounded.

No results have been blank subtracted unless specified in the case narrative section.

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CERTIFICATIONS

Certified Analyses included in this Report

Analyte	Certifications
SW-846 6010D in Soil	
Lead	NY,CT,ME,NC,NH,VA
SW-846 6010D in Water	
Lead	NY,CT,ME,NC,NH,VA

The CON-TEST Environmental Laboratory operates under the following certifications and accreditations:

Code	Description	Number	Expires
AIHA	AIHA-LAP, LLC - ISO17025:2017	100033	03/1/2022
MA	Massachusetts DEP	M-MA100	06/30/2021
CT	Connecticut Department of Publilc Health	PH-0567	09/30/2021
NY	New York State Department of Health	10899 NELAP	04/1/2021
NH-S	New Hampshire Environmental Lab	2516 NELAP	02/5/2021
RI	Rhode Island Department of Health	LAO00112	12/30/2020
NC	North Carolina Div. of Water Quality	652	12/31/2020
NJ	New Jersey DEP	MA007 NELAP	06/30/2021
FL	Florida Department of Health	E871027 NELAP	06/30/2021
VT	Vermont Department of Health Lead Laboratory	LL015036	07/30/2021
ME	State of Maine	2011028	06/9/2021
VA	Commonwealth of Virginia	460217	12/14/2020
NH-P	New Hampshire Environmental Lab	2557 NELAP	09/6/2021
VT-DW	Vermont Department of Health Drinking Water	VT-255716	06/12/2021
NC-DW	North Carolina Department of Health	25703	07/31/2021
PA	Commonwealth of Pennsylvania DEP	68-05812	06/30/2021
MI	Dept. of Env, Great Lakes, and Energy	9100	09/6/2021

NONE57

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☒ 108 Myrtle Street, #502, North Quincy, MA 02171
☐ 317 Iron Horse Way, Suite 204, Providence, RI 02908
☐ 80 Washington Street, Suite 301, Poughkeepsie, NY
☐ Other _____

20L0078

CHAIN-OF-CUSTODY RECORD

41736

Turnaround
☐ 24-Hour* ☐ 72-Hour* ☐ Other _____ (days)
☐ 48-Hour* ☒ Standard (____ days) *Surcharge Applies

PROJECT NAME: MVP Action Grant FY21
PROJECT LOCATION: Haverhill, MA
PROJECT NUMBER: 20170390.020
LABORATORY: Con-Test

REPORT TO: Dan LaFrance (dlafrance@fando.com)
INVOICE TO: Matt Kissane (mkissane@fando.com)
P.O. NO.: 1543201170390.020

Sampler's Signature: _____ Date: 11/17/20

Source Codes:
MW=Monitoring Well PW=Potable Water T=Treatment Facility S=Soil B=Sediment
SW=Surface Water ST=Stormwater W=Waste A=Air C=Concrete
X=Other Trip Blank

Item No.	Transfer Check 1	2	3	4	Sample Number	Source Code	Date Sampled	Time Sampled	RCRA 8 Metals	VOC (8270)	PAHs	PCBs	EPH	Pesticides & Herbicides	TCLP *	Total Cyanide (Diabem)	Soil VOA Vial, ☐ methanol ☒ $Na(SO_4)_2$	Soil VOA Vial, ☐ water ☒ $Na(SO_4)_2$	Glass Soil Container (16) oz	Other: Glass (8) oz	Other: Glass (2) oz	Water VOA Vial, ☐ As is ☐ HCl	Glass Amber ( ) ml, ☐ As is ☐ H_2SO_4	Plastic - As is, ☐ 250 ml ☐ 500 ☐ 1000 ml	Plastic - H_2SO_4, ☐ 250 ml ☐ 500 ml	Plastic - HNO_3, 250 ml ☐ Filtered ☐ 0.45µ ☐ 10µ	Plastic - NaOH, 250 ml	Comments
1	X				1543201117-01	X	11/17/20	0924		X												1	2					
2	X				1543201117-02	B	↓	0950	X	X	X	X	X	X	X	X							1	2	1	2	1		
3	X		02		1543201117-03	B		1015	X	X	X	X	X	X	X	X							1	2	1	2	1		
4	X				1543201117-04	B	↓	1115	X	X	X	X	X	X	X	X							1	2	1	2	1		

per client run TCLP Lead on 1543201117-03 only JLH 12/2/2020

Transfer Number	Relinquished By	Accepted By	Date	Time
1		FED EDGE	11/17/20	1407
2		Paul Chatterton	11-17-20	1637
3	Paul Chatterton	11/17/20	11/17/20	1734
4	11/17/20 1916	2-7	11/17/20	1910

Charge Exceptions: ☐ CT Tax Exempt ☐ QA/QC ☐ Other _____
____ Duplicates ☒ Blanks (Item Nos: 1)
Reporting and Detection Limit Requirements: ☐ RCP Deliverables ☐ MCP CAM Cert.
Additional Comments: * Hold for TCLP

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I Have Not Confirmed Sample Container Numbers With Lab Staff Before Relinquishing Over Samples_____

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Doc# 277 Rev 5 2017

Login Sample Receipt Checklist - (Rejection Criteria Listing - Using Acceptance Policy) Any False Statement will be brought to the attention of the Client - State True or False

Client Fuss and O'Neill

Received By _____ Date 11/17/20 Time 1910

How were the samples received? In Cooler T No Cooler _____ On Ice T No Ice _____ Direct from Sampling _____ Ambient _____ Melted Ice _____

Were samples within Temperature? 2-6°C T By Gun # 2 Actual Temp - 2.7 By Blank # _____ Actual Temp - _____

Was Custody Seal Intact? NA Were Samples Tampered with? NA

Was COC Relinquished ? T Does Chain Agree With Samples? T

Are there broken/leaking/loose caps on any samples? F

Is COC in ink/ Legible? T Were samples received within holding time? T

Did COC include all pertinent Information? Client T Analysis T Sampler Name T Project T ID's T Collection Dates/Times T

Are Sample labels filled out and legible? T

Are there Lab to Filters? F Who was notified? _____

Are there Rushes? F Who was notified? _____

Are there Short Holds? F Who was notified? _____

Is there enough Volume? T

Is there Headspace where applicable? T MS/MSD? F

Proper Media/Containers Used? T Is splitting samples required? F

Were trip blanks received? T On COC? F

Do all samples have the proper pH? NA Acid _____ Base _____

Vials	#	Containers:	#		#		#
Unp-		1 Liter Amb.		1 Liter Plastic		16 oz Amb.	3
HCL-		500 mL Amb.		500 mL Plastic		8oz Amb/Clear	6
Meoh-	4	250 mL Amb.		250 mL Plastic		4oz Amb/Clear	
Bisulfate-	3	Flashpoint		Col./Bacteria		2oz Amb/Clear	3
DI-		Other Glass		Other Plastic		Encore	
Thiosulfate-		SOC Kit		Plastic Bag		Frozen:	
Sulfuric-		Perchlorate		Ziplock			

Unused Media

Vials	#	Containers:	#		#		#
Unp-		1 Liter Amb.		1 Liter Plastic		16 oz Amb.	
HCL-		500 mL Amb.		500 mL Plastic		8oz Amb/Clear	
Meoh-		250 mL Amb.		250 mL Plastic		4oz Amb/Clear	
Bisulfate-		Col./Bacteria		Flashpoint		2oz Amb/Clear	
DI-		Other Plastic		Other Glass		Encore	
Thiosulfate-		SOC Kit		Plastic Bag		Frozen:	
Sulfuric-		Perchlorate		Ziplock			

Comments:

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September 20, 2021

Matt Kissane
Fuss & O'Neill EnviroScience, LLC - MA
108 Myrtle St,
Quincy, MA 02171

Project Location: Haverhill, MA
Client Job Number:
Project Number: 20170390.U30
Laboratory Work Order Number: 21I0471

Enclosed are results of analyses for samples received by the laboratory on September 9, 2021. If you have any questions concerning this report, please feel free to contact me.

Sincerely,

Jessica L. Hoffman
Project Manager

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Fuss & O'Neill EnviroScience, LLC - MA
108 Myrtle St,
Quincy, MA 02171
ATTN: Matt Kissane

REPORT DATE: 9/20/2021

PURCHASE ORDER NUMBER:

PROJECT NUMBER: 20170390.U30

ANALYTICAL SUMMARY

WORK ORDER NUMBER: 21I0471

The results of analyses performed on the following samples submitted to CON-TEST, a Pace Analytical Laboratory, are found in this report.

PROJECT LOCATION: Haverhill, MA

FIELD SAMPLE #	LAB ID:	MATRIX	SAMPLE DESCRIPTION	TEST	SUB LAB
1543210907-01	21I0471-01	Soil		SW-846 8260C-D	
1543210907-02	21I0471-02	Soil		MADEP EPH rev 2.1	
				SM 2540G	
				SW 846 9060A	
				SW-846 6010D	
				SW-846 7471B	
				SW-846 8081B	
				SW-846 8082A	
				SW-846 8151A	
				SW-846 8260C-D	
				SW-846 8270D-E	
1543210907-03	21I0471-03	Soil		MADEP EPH rev 2.1	
				SM 2540G	
				SW 846 9060A	
				SW-846 6010D	
				SW-846 7471B	
				SW-846 8081B	
				SW-846 8082A	
				SW-846 8151A	
				SW-846 8260C-D	
				SW-846 8270D-E	
1543210907-04	21I0471-04	Soil		MADEP EPH rev 2.1	
				SM 2540G	
				SW 846 9060A	
				SW-846 6010D	
				SW-846 7471B	
				SW-846 8081B	
				SW-846 8082A	
				SW-846 8151A	
				SW-846 8260C-D	
				SW-846 8270D-E	
1543210907-05	21I0471-05	Soil		MADEP EPH rev 2.1	
				SM 2540G	
				SW 846 9060A	
				SW-846 6010D	
				SW-846 7471B	
				SW-846 8081B	
				SW-846 8082A	
				SW-846 8151A	
				SW-846 8260C-D	
				SW-846 8270D-E	

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Fuss & O'Neill EnviroScience, LLC - MA
108 Myrtle St,
Quincy, MA 02171
ATTN: Matt Kissane

REPORT DATE: 9/20/2021

PURCHASE ORDER NUMBER:

PROJECT NUMBER: 20170390.U30

ANALYTICAL SUMMARY

WORK ORDER NUMBER: 21I0471

The results of analyses performed on the following samples submitted to CON-TEST, a Pace Analytical Laboratory, are found in this report.

PROJECT LOCATION: Haverhill, MA

FIELD SAMPLE #	LAB ID:	MATRIX	SAMPLE DESCRIPTION	TEST	SUB LAB
1543210908-06	21I0471-06	Soil		SW-846 8260C-D	
1543210908-07	21I0471-07	Soil		MADEP EPH rev 2.1	
				SM 2540G	
				SW 846 9060A	
				SW-846 6010D	
				SW-846 7471B	
				SW-846 8081B	
				SW-846 8082A	
				SW-846 8151A	
				SW-846 8260C-D	
				SW-846 8270D-E	
1543210908-08	21I0471-08	Soil		MADEP EPH rev 2.1	
				SM 2540G	
				SW 846 9060A	
				SW-846 6010D	
				SW-846 7471B	
				SW-846 8081B	
				SW-846 8082A	
				SW-846 8151A	
				SW-846 8260C-D	
				SW-846 8270D-E	

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CASE NARRATIVE SUMMARY

All reported results are within defined laboratory quality control objectives unless listed below or otherwise qualified in this report.

For method 8270E, only PAHs were requested and reported.

For method 8151 samples were derivatized on 09/14/21.

For method 8151 samples analysis bracketed by LCS to monitor esterification. All recoveries in the bracketing LCS met method criteria.

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SM 2540G

Qualifications:

R-02

Duplicate RPD is outside of control limits. Outlier can be attributed to sample non-homogeneity encountered during sample prep.

Analyte & Samples(s) Qualified:

% Solids
21I0471-02[1543210907-02], 21I0471-07[1543210908-07], B289999-DUP2, B289999-DUP6

SW 846 9060A

Qualifications:

MS-07

Matrix spike recovery is outside of control limits. Analysis is in control based on laboratory fortified blank recovery.Possibility of sample matrix effects that lead to low bias for reported result or non-homogeneous sample aliquot cannot be eliminated.

Analyte & Samples(s) Qualified:

Total Organic Carbon
B290031-MS1

Z-01

Results over calibration curve. Results are estimitated due to method limitations.

Analyte & Samples(s) Qualified:

Total Organic Carbon
21I0471-02[1543210907-02], B290031-DUP1

SW-846 8081B

Qualifications:

DL-03

Elevated reporting limit due to matrix interference.

Analyte & Samples(s) Qualified:

21I0471-02[1543210907-02], 21I0471-03[1543210907-03], 21I0471-04[1543210907-04], 21I0471-05[1543210907-05], 21I0471-07[1543210908-07], 21I0471-08[1543210908-08]

SW-846 8082A

Qualifications:

O-32

A dilution was performed as part of the standard analytical procedure.

Analyte & Samples(s) Qualified:

21I0471-04[1543210907-04], 21I0471-05[1543210907-05], 21I0471-07[1543210908-07], 21I0471-08[1543210908-08]

SW-846 8151A

Qualifications:

V-06

Continuing calibration verification (CCV) did not meet method specifications and was biased on the high side for this compound.

Analyte & Samples(s) Qualified:

2,4,5-T [2C]
B290112-BS1, B290112-BSD1

Dinoseb
B290112-BS1, B290112-BSD1

Dinoseb [2C]
B290112-BS1, B290112-BSD1

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V-20

Continuing calibration verification (CCV) did not meet method specifications and was biased on the high side. Data validation is not affected since sample result was "not detected" for this compound.

Analyte & Samples(s) Qualified:

Dalapon

21I0471-02[1543210907-02], 21I0471-03[1543210907-03], 21I0471-04[1543210907-04], 21I0471-05[1543210907-05], 21I0471-07[1543210908-07], 21I0471-08[1543210908-08], B290112-BLK1

Dalapon [2C]

21I0471-02[1543210907-02], 21I0471-03[1543210907-03], 21I0471-04[1543210907-04], 21I0471-05[1543210907-05], 21I0471-07[1543210908-07], 21I0471-08[1543210908-08], B290112-BLK1

SW-846 8260C-D

Qualifications:

RL-07

Elevated reporting limit based on lowest point in calibration.
MA CAM reporting limit not met.

Analyte & Samples(s) Qualified:

Carbon Disulfide

21I0471-02[1543210907-02], 21I0471-03[1543210907-03]

Methylene Chloride

21I0471-02[1543210907-02], 21I0471-03[1543210907-03]

V-05

Continuing calibration verification (CCV) did not meet method specifications and was biased on the low side for this compound.

Analyte & Samples(s) Qualified:

1,2,3-Trichlorobenzene

21I0471-02[1543210907-02], 21I0471-03[1543210907-03], B289949-BLK1, B289949-BS1, B289949-BSD1, S063175-CCV1

Bromoform

21I0471-01[1543210907-01], 21I0471-04[1543210907-04], 21I0471-05[1543210907-05], 21I0471-06[1543210908-06], 21I0471-07[1543210908-07], 21I0471-08[1543210908-08], B289971-BLK1, B289971-BS1, B289971-BSD1, S063160-CCV1

Bromomethane

21I0471-02[1543210907-02], 21I0471-03[1543210907-03], B289949-BLK1, B289949-BS1, B289949-BSD1, S063175-CCV1

Hexachlorobutadiene

21I0471-01[1543210907-01], 21I0471-04[1543210907-04], 21I0471-05[1543210907-05], 21I0471-06[1543210908-06], 21I0471-07[1543210908-07], 21I0471-08[1543210908-08], B289971-BLK1, B289971-BS1, B289971-BSD1, S063160-CCV1

m+p Xylene

21I0471-01[1543210907-01], 21I0471-04[1543210907-04], 21I0471-05[1543210907-05], 21I0471-06[1543210908-06], 21I0471-07[1543210908-07], 21I0471-08[1543210908-08], B289971-BLK1, B289971-BS1, B289971-BSD1, S063160-CCV1

Naphthalene

21I0471-01[1543210907-01], 21I0471-02[1543210907-02], 21I0471-03[1543210907-03], 21I0471-04[1543210907-04], 21I0471-05[1543210907-05], 21I0471-06[1543210908-06], 21I0471-07[1543210908-07], 21I0471-08[1543210908-08], B289949-BLK1, B289949-BS1, B289949-BSD1, B289971-BLK1, B289971-BS1, B289971-BSD1, S063160-CCV1, S063175-CCV1

V-16

Response factor is less than method specified minimum acceptable value. Reduced precision and accuracy may be associated with reported result.

Analyte & Samples(s) Qualified:

1,4-Dioxane

S063160-CCV1, S063175-CCV1

V-34

Initial calibration verification (ICV) did not meet method specifications and was biased on the low side for this compound. Reported result is estimated.

Analyte & Samples(s) Qualified:

Bromomethane

21I0471-01[1543210907-01], 21I0471-04[1543210907-04], 21I0471-05[1543210907-05], 21I0471-06[1543210908-06], 21I0471-07[1543210908-07], 21I0471-08[1543210908-08], B289971-BLK1, B289971-BS1, B289971-BSD1, S063160-CCV1

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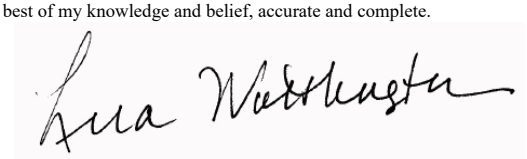
The results of analyses reported only relate to samples submitted to Con-Test, a Pace Analytical Laboratory, for testing.
I certify that the analyses listed above, unless specifically listed as subcontracted, if any, were performed under my direction according to the approved methodologies listed in this document, and that based upon my inquiry of those individuals immediately responsible for obtaining the information, the material contained in this report is, to the best of my knowledge and belief, accurate and complete.



Lisa A. Worthington
Technical Representative

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39 Spruce Street * East Longmeadow, MA 01028 * FAX 413/525-6405 * TEL. 413/525-2332

Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0471

Date Received: 9/9/2021

Field Sample #: 1543210907-01 | Sampled: 9/7/2021 08:42

Sample ID: 21I0471-01

Sample Matrix: Soil

Volatile Organic Compounds by GC/MS

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Acetone	ND	0.10	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
tert-Amyl Methyl Ether (TAME)	ND	0.0010	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
Benzene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
Bromobenzene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
Bromochloromethane	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
Bromodichloromethane	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
Bromoform	ND	0.0020	mg/Kg wet	1	V-05	SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
Bromomethane	ND	0.010	mg/Kg wet	1	V-34	SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
2-Butanone (MEK)	ND	0.040	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
n-Butylbenzene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
sec-Butylbenzene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
tert-Butylbenzene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
tert-Butyl Ethyl Ether (TBEE)	ND	0.0010	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
Carbon Disulfide	ND	0.0060	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
Carbon Tetrachloride	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
Chlorobenzene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
Chlorodibromomethane	ND	0.0010	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
Chloroethane	ND	0.010	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
Chloroform	ND	0.0040	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
Chloromethane	ND	0.010	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
2-Chlorotoluene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
4-Chlorotoluene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
1,2-Dibromo-3-chloropropane (DBCP)	ND	0.0040	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
1,2-Dibromoethane (EDB)	ND	0.0010	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
Dibromomethane	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
1,2-Dichlorobenzene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
1,3-Dichlorobenzene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
1,4-Dichlorobenzene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
Dichlorodifluoromethane (Freon 12)	ND	0.010	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
1,1-Dichloroethane	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
1,2-Dichloroethane	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
1,1-Dichloroethylene	ND	0.0040	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
cis-1,2-Dichloroethylene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
trans-1,2-Dichloroethylene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
1,2-Dichloropropane	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
1,3-Dichloropropane	ND	0.0010	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
2,2-Dichloropropane	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
1,1-Dichloropropene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
cis-1,3-Dichloropropene	ND	0.0010	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
trans-1,3-Dichloropropene	ND	0.0010	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
Diethyl Ether	ND	0.010	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
Diisopropyl Ether (DIPE)	ND	0.0010	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
1,4-Dioxane	ND	0.10	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
Ethylbenzene	ND	0.0040	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0471

Date Received: 9/9/2021

Field Sample #: 1543210907-01 | Sampled: 9/7/2021 08:42

Sample ID: 21I0471-01

Sample Matrix: Soil

Volatile Organic Compounds by GC/MS

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Hexachlorobutadiene	ND	0.0020	mg/Kg wet	1	V-05	SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
2-Hexanone (MBK)	ND	0.020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
Isopropylbenzene (Cumene)	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
p-Isopropyltoluene (p-Cymene)	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
Methyl tert-Butyl Ether (MTBE)	ND	0.0040	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
Methylene Chloride	ND	0.010	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
4-Methyl-2-pentanone (MIBK)	ND	0.020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
Naphthalene	ND	0.0040	mg/Kg wet	1	V-05	SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
n-Propylbenzene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
Styrene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
1,1,1,2-Tetrachloroethane	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
1,1,2,2-Tetrachloroethane	ND	0.0010	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
Tetrachloroethylene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
Tetrahydrofuran	ND	0.010	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
Toluene	ND	0.0040	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
1,2,3-Trichlorobenzene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
1,2,4-Trichlorobenzene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
1,1,1-Trichloroethane	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
1,1,2-Trichloroethane	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
Trichloroethylene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
Trichlorofluoromethane (Freon 11)	ND	0.010	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
1,2,3-Trichloropropane	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
1,2,4-Trimethylbenzene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
1,3,5-Trimethylbenzene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
Vinyl Chloride	ND	0.010	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
m+p Xylene	ND	0.0080	mg/Kg wet	1	V-05	SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF
o-Xylene	ND	0.0040	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 13:33	MFF

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
1,2-Dichloroethane-d4	108	70-130		9/10/21 13:33
Toluene-d8	102	70-130		9/10/21 13:33
4-Bromofluorobenzene	94.5	70-130		9/10/21 13:33

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0471

Date Received: 9/9/2021

Field Sample #: 1543210907-02 | Sampled: 9/7/2021 09:41

Sample ID: 21I0471-02

Sample Matrix: Soil

Volatile Organic Compounds by GC/MS

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Acetone	ND	7.2	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
tert-Amyl Methyl Ether (TAME)	ND	0.072	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
Benzene	ND	0.14	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
Bromobenzene	ND	0.14	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
Bromochloromethane	ND	0.14	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
Bromodichloromethane	ND	0.14	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
Bromoform	ND	0.14	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
Bromomethane	ND	0.29	mg/Kg dry	1	V-05	SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
2-Butanone (MEK)	ND	2.9	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
n-Butylbenzene	1.1	0.14	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
sec-Butylbenzene	0.46	0.14	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
tert-Butylbenzene	ND	0.14	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
tert-Butyl Ethyl Ether (TBEE)	ND	0.072	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
Carbon Disulfide	ND	1.4	mg/Kg dry	1	RL-07	SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
Carbon Tetrachloride	ND	0.14	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
Chlorobenzene	ND	0.14	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
Chlorodibromomethane	ND	0.072	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
Chloroethane	ND	0.29	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
Chloroform	ND	0.29	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
Chloromethane	ND	0.29	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
2-Chlorotoluene	ND	0.14	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
4-Chlorotoluene	ND	0.14	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
1,2-Dibromo-3-chloropropane (DBCP)	ND	0.57	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
1,2-Dibromoethane (EDB)	ND	0.072	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
Dibromomethane	ND	0.14	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
1,2-Dichlorobenzene	ND	0.14	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
1,3-Dichlorobenzene	ND	0.14	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
1,4-Dichlorobenzene	ND	0.14	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
Dichlorodifluoromethane (Freon 12)	ND	0.29	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
1,1-Dichloroethane	ND	0.14	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
1,2-Dichloroethane	ND	0.14	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
1,1-Dichloroethylene	ND	0.14	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
cis-1,2-Dichloroethylene	ND	0.14	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
trans-1,2-Dichloroethylene	ND	0.14	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
1,2-Dichloropropane	ND	0.14	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
1,3-Dichloropropane	ND	0.072	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
2,2-Dichloropropane	ND	0.14	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
1,1-Dichloropropene	ND	0.29	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
cis-1,3-Dichloropropene	ND	0.072	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
trans-1,3-Dichloropropene	ND	0.072	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
Diethyl Ether	ND	0.29	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
Diisopropyl Ether (DIPE)	ND	0.072	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
1,4-Dioxane	ND	7.2	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
Ethylbenzene	ND	0.14	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0471

Date Received: 9/9/2021

Field Sample #: 1543210907-02 | Sampled: 9/7/2021 09:41

Sample ID: 21I0471-02

Sample Matrix: Soil

Volatile Organic Compounds by GC/MS

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Hexachlorobutadiene	ND	0.14	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
2-Hexanone (MBK)	ND	1.4	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
Isopropylbenzene (Cumene)	0.38	0.14	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
p-Isopropyltoluene (p-Cymene)	0.82	0.14	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
Methyl tert-Butyl Ether (MTBE)	ND	0.14	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
Methylene Chloride	ND	0.72	mg/Kg dry	1	RL-07	SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
4-Methyl-2-pentanone (MIBK)	ND	1.4	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
Naphthalene	3.7	0.29	mg/Kg dry	1	V-05	SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
n-Propylbenzene	0.24	0.14	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
Styrene	ND	0.14	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
1,1,1,2-Tetrachloroethane	ND	0.14	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
1,1,2,2-Tetrachloroethane	ND	0.072	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
Tetrachloroethylene	ND	0.14	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
Tetrahydrofuran	ND	0.57	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
Toluene	ND	0.14	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
1,2,3-Trichlorobenzene	ND	0.57	mg/Kg dry	1	V-05	SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
1,2,4-Trichlorobenzene	ND	0.14	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
1,1,1-Trichloroethane	ND	0.14	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
1,1,2-Trichloroethane	ND	0.14	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
Trichloroethylene	ND	0.14	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
Trichlorofluoromethane (Freon 11)	ND	0.29	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
1,2,3-Trichloropropane	ND	0.29	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
1,2,4-Trimethylbenzene	4.6	0.14	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
1,3,5-Trimethylbenzene	2.2	0.14	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
Vinyl Chloride	ND	0.29	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
m+p Xylene	0.32	0.29	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH
o-Xylene	ND	0.14	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:32	EEH

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
1,2-Dichloroethane-d4	114	70-130		9/10/21 16:32
Toluene-d8	112	70-130		9/10/21 16:32
4-Bromofluorobenzene	116	70-130		9/10/21 16:32

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0471

Date Received: 9/9/2021

Field Sample #: 1543210907-02 | Sampled: 9/7/2021 09:41

Sample ID: 21I0471-02

Sample Matrix: Soil

Semivolatile Organic Compounds by GC/MS

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Acenaphthene	0.83	0.36	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 17:52	IMR
Acenaphthylene	0.45	0.36	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 17:52	IMR
Anthracene	0.96	0.36	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 17:52	IMR
Benzo(a)anthracene	2.9	0.36	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 17:52	IMR
Benzo(a)pyrene	2.8	0.36	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 17:52	IMR
Benzo(b)fluoranthene	3.5	0.36	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 17:52	IMR
Benzo(g,h,i)perylene	2.5	0.36	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 17:52	IMR
Benzo(k)fluoranthene	1.4	0.36	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 17:52	IMR
Chrysene	3.5	0.36	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 17:52	IMR
Dibenz(a,h)anthracene	0.52	0.36	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 17:52	IMR
Fluoranthene	7.0	0.36	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 17:52	IMR
Fluorene	1.4	0.36	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 17:52	IMR
Indeno(1,2,3-cd)pyrene	2.5	0.36	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 17:52	IMR
2-Methylnaphthalene	5.4	0.36	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 17:52	IMR
Naphthalene	3.2	0.36	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 17:52	IMR
Phenanthrene	6.8	0.36	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 17:52	IMR
Pyrene	7.7	0.36	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 17:52	IMR

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Nitrobenzene-d5	62.7	30-130		9/13/21 17:52
2-Fluorobiphenyl	59.9	30-130		9/13/21 17:52
p-Terphenyl-d14	89.5	30-130		9/13/21 17:52

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0471

Date Received: 9/9/2021

Field Sample #: 1543210907-02 | Sampled: 9/7/2021 09:41

Sample ID: 21I0471-02

Sample Matrix: Soil

Sample Flags: DL-03

Organochloride Pesticides by GC/ECD

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Aldrin [1]	ND	0.21	mg/Kg dry	20		SW-846 8081B	9/10/21	9/17/21 10:52	TG
alpha-BHC [1]	ND	0.21	mg/Kg dry	20		SW-846 8081B	9/10/21	9/17/21 10:52	TG
beta-BHC [1]	ND	0.21	mg/Kg dry	20		SW-846 8081B	9/10/21	9/17/21 10:52	TG
delta-BHC [1]	ND	0.21	mg/Kg dry	20		SW-846 8081B	9/10/21	9/17/21 10:52	TG
gamma-BHC (Lindane) [1]	ND	0.084	mg/Kg dry	20		SW-846 8081B	9/10/21	9/17/21 10:52	TG
Chlordane [1]	ND	0.84	mg/Kg dry	20		SW-846 8081B	9/10/21	9/17/21 10:52	TG
4,4'-DDD [1]	ND	0.17	mg/Kg dry	20		SW-846 8081B	9/10/21	9/17/21 10:52	TG
4,4'-DDE [1]	ND	0.17	mg/Kg dry	20		SW-846 8081B	9/10/21	9/17/21 10:52	TG
4,4'-DDT [1]	ND	0.17	mg/Kg dry	20		SW-846 8081B	9/10/21	9/17/21 10:52	TG
Dieldrin [1]	ND	0.17	mg/Kg dry	20		SW-846 8081B	9/10/21	9/17/21 10:52	TG
Endosulfan I [1]	ND	0.21	mg/Kg dry	20		SW-846 8081B	9/10/21	9/17/21 10:52	TG
Endosulfan II [1]	ND	0.34	mg/Kg dry	20		SW-846 8081B	9/10/21	9/17/21 10:52	TG
Endosulfan sulfate [1]	ND	0.34	mg/Kg dry	20		SW-846 8081B	9/10/21	9/17/21 10:52	TG
Endrin [1]	ND	0.34	mg/Kg dry	20		SW-846 8081B	9/10/21	9/17/21 10:52	TG
Endrin ketone [1]	ND	0.34	mg/Kg dry	20		SW-846 8081B	9/10/21	9/17/21 10:52	TG
Heptachlor [1]	ND	0.21	mg/Kg dry	20		SW-846 8081B	9/10/21	9/17/21 10:52	TG
Heptachlor epoxide [1]	ND	0.21	mg/Kg dry	20		SW-846 8081B	9/10/21	9/17/21 10:52	TG
Hexachlorobenzene [1]	ND	0.25	mg/Kg dry	20		SW-846 8081B	9/10/21	9/17/21 10:52	TG
Methoxychlor [1]	ND	2.1	mg/Kg dry	20		SW-846 8081B	9/10/21	9/17/21 10:52	TG

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Decachlorobiphenyl [1]	91.1	30-150		9/17/21 10:52
Decachlorobiphenyl [2]	74.3	30-150		9/17/21 10:52
Tetrachloro-m-xylene [1]	75.9	30-150		9/17/21 10:52
Tetrachloro-m-xylene [2]	77.9	30-150		9/17/21 10:52

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0471

Date Received: 9/9/2021

Field Sample #: 1543210907-02 | Sampled: 9/7/2021 09:41

Sample ID: 21I0471-02

Sample Matrix: Soil

Polychlorinated Biphenyls By GC/ECD

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Aroclor-1016 [1]	ND	0.17	mg/Kg dry	4		SW-846 8082A	9/10/21	9/15/21 21:36	TG
Aroclor-1221 [1]	ND	0.17	mg/Kg dry	4		SW-846 8082A	9/10/21	9/15/21 21:36	TG
Aroclor-1232 [1]	ND	0.17	mg/Kg dry	4		SW-846 8082A	9/10/21	9/15/21 21:36	TG
Aroclor-1242 [1]	ND	0.17	mg/Kg dry	4		SW-846 8082A	9/10/21	9/15/21 21:36	TG
Aroclor-1248 [1]	ND	0.17	mg/Kg dry	4		SW-846 8082A	9/10/21	9/15/21 21:36	TG
Aroclor-1254 [1]	0.33	0.17	mg/Kg dry	4		SW-846 8082A	9/10/21	9/15/21 21:36	TG
Aroclor-1260 [1]	ND	0.17	mg/Kg dry	4		SW-846 8082A	9/10/21	9/15/21 21:36	TG
Aroclor-1262 [1]	ND	0.17	mg/Kg dry	4		SW-846 8082A	9/10/21	9/15/21 21:36	TG
Aroclor-1268 [1]	ND	0.17	mg/Kg dry	4		SW-846 8082A	9/10/21	9/15/21 21:36	TG

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Decachlorobiphenyl [1]	72.2	30-150		9/15/21 21:36
Decachlorobiphenyl [2]	69.0	30-150		9/15/21 21:36
Tetrachloro-m-xylene [1]	64.5	30-150		9/15/21 21:36
Tetrachloro-m-xylene [2]	55.4	30-150		9/15/21 21:36

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0471

Date Received: 9/9/2021

Field Sample #: 1543210907-02 | Sampled: 9/7/2021 09:41

Sample ID: 21I0471-02

Sample Matrix: Soil

Herbicides by GC/ECD

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
2,4-D [1]	ND	210	µg/kg dry	4		SW-846 8151A	9/13/21	9/17/21 20:00	JMB
2,4-DB [1]	ND	210	µg/kg dry	4		SW-846 8151A	9/13/21	9/17/21 20:00	JMB
2,4,5-TP (Silvex) [1]	ND	21	µg/kg dry	4		SW-846 8151A	9/13/21	9/17/21 20:00	JMB
2,4,5-T [1]	ND	21	µg/kg dry	4		SW-846 8151A	9/13/21	9/17/21 20:00	JMB
Dalalpon [1]	ND	530	µg/kg dry	4	V-20	SW-846 8151A	9/13/21	9/17/21 20:00	JMB
Dicamba [1]	ND	21	µg/kg dry	4		SW-846 8151A	9/13/21	9/17/21 20:00	JMB
Dichloroprop [1]	ND	210	µg/kg dry	4		SW-846 8151A	9/13/21	9/17/21 20:00	JMB
Dinoseb [1]	ND	110	µg/kg dry	4		SW-846 8151A	9/13/21	9/17/21 20:00	JMB
MCPA [1]	ND	21000	µg/kg dry	4		SW-846 8151A	9/13/21	9/17/21 20:00	JMB
MCPP [1]	ND	21000	µg/kg dry	4		SW-846 8151A	9/13/21	9/17/21 20:00	JMB

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
2,4-Dichlorophenylacetic acid [1]	79.2	30-150		9/17/21 20:00
2,4-Dichlorophenylacetic acid [2]	65.5	30-150		9/17/21 20:00

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0471

Date Received: 9/9/2021

Field Sample #: 1543210907-02 | Sampled: 9/7/2021 09:41

Sample ID: 21I0471-02

Sample Matrix: Soil

Petroleum Hydrocarbons Analyses - EPH

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
C9-C18 Aliphatics	630	84	mg/Kg dry	4		MADEP EPH rev 2.1	9/10/21	9/19/21 18:00	AYH
C19-C36 Aliphatics	390	84	mg/Kg dry	4		MADEP EPH rev 2.1	9/10/21	9/19/21 18:00	AYH
Unadjusted C11-C22 Aromatics	1500	84	mg/Kg dry	4		MADEP EPH rev 2.1	9/10/21	9/19/21 18:00	AYH
C11-C22 Aromatics	1400	84	mg/Kg dry	4		MADEP EPH rev 2.1	9/10/21	9/19/21 18:00	AYH
Acenaphthene	4.2	0.21	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 21:04	AYH
Acenaphthylene	0.87	0.21	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 21:04	AYH
Anthracene	3.7	0.21	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 21:04	AYH
Benzo(a)anthracene	5.1	0.21	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 21:04	AYH
Benzo(a)pyrene	7.2	0.21	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 21:04	AYH
Benzo(b)fluoranthene	6.7	0.21	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 21:04	AYH
Benzo(g,h,i)perylene	2.9	0.21	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 21:04	AYH
Benzo(k)fluoranthene	2.5	0.21	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 21:04	AYH
Chrysene	5.8	0.21	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 21:04	AYH
Dibenz(a,h)anthracene	0.77	0.21	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 21:04	AYH
Fluoranthene	13	0.21	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 21:04	AYH
Fluorene	6.6	0.21	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 21:04	AYH
Indeno(1,2,3-cd)pyrene	2.4	0.21	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 21:04	AYH
2-Methylnaphthalene	8.8	0.21	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 21:04	AYH
Naphthalene	11	0.21	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 21:04	AYH
Phenanthrene	15	0.21	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 21:04	AYH
Pyrene	14	0.21	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 21:04	AYH

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Chlorooctadecane (COD)	62.2	40-140		9/17/21 21:04
o-Terphenyl (OTP)	90.7	40-140		9/17/21 21:04
2-Bromonaphthalene	127	40-140		9/17/21 21:04
2-Fluorobiphenyl	128	40-140		9/17/21 21:04

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0471

Date Received: 9/9/2021

Field Sample #: 1543210907-02 | Sampled: 9/7/2021 09:41

Sample ID: 21I0471-02

Sample Matrix: Soil

Metals Analyses (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Arsenic	23	6.7	mg/Kg dry	1		SW-846 6010D	9/15/21	9/15/21 15:54	QNW
Cadmium	1.4	0.67	mg/Kg dry	1		SW-846 6010D	9/15/21	9/15/21 15:54	QNW
Chromium	52	1.3	mg/Kg dry	1		SW-846 6010D	9/15/21	9/15/21 15:54	QNW
Copper	63	1.3	mg/Kg dry	1		SW-846 6010D	9/15/21	9/15/21 15:54	QNW
Lead	260	1.0	mg/Kg dry	1		SW-846 6010D	9/15/21	9/15/21 15:54	QNW
Mercury	0.22	0.054	mg/Kg dry	1		SW-846 7471B	9/10/21	9/13/21 14:05	DRL
Nickel	29	1.3	mg/Kg dry	1		SW-846 6010D	9/15/21	9/15/21 15:54	QNW
Zinc	210	1.3	mg/Kg dry	1		SW-846 6010D	9/15/21	9/15/21 15:54	QNW

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0471

Date Received: 9/9/2021

Field Sample #: 1543210907-02 | Sampled: 9/7/2021 09:41

Sample ID: 21I0471-02

Sample Matrix: Soil

Conventional Chemistry Parameters by EPA/APHA/SW-846 Methods (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
% Solids	47.4		% Wt	1	R-02	SM 2540G	9/10/21	9/13/21 9:51	CJV
Total Organic Carbon	66000	100	mg/Kg	1	Z-01	SW 846 9060A	9/13/21	9/13/21 21:18	DJM

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0471

Date Received: 9/9/2021

Field Sample #: 1543210907-03 | Sampled: 9/7/2021 10:57

Sample ID: 21I0471-03

Sample Matrix: Soil

Volatile Organic Compounds by GC/MS

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Acetone	ND	4.3	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
tert-Amyl Methyl Ether (TAME)	ND	0.043	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
Benzene	ND	0.086	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
Bromobenzene	ND	0.086	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
Bromochloromethane	ND	0.086	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
Bromodichloromethane	ND	0.086	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
Bromoform	ND	0.086	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
Bromomethane	ND	0.17	mg/Kg dry	1	V-05	SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
2-Butanone (MEK)	ND	1.7	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
n-Butylbenzene	0.14	0.086	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
sec-Butylbenzene	ND	0.086	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
tert-Butylbenzene	ND	0.086	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
tert-Butyl Ethyl Ether (TBEE)	ND	0.043	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
Carbon Disulfide	ND	0.86	mg/Kg dry	1	RL-07	SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
Carbon Tetrachloride	ND	0.086	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
Chlorobenzene	ND	0.086	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
Chlorodibromomethane	ND	0.043	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
Chloroethane	ND	0.17	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
Chloroform	ND	0.17	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
Chloromethane	ND	0.17	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
2-Chlorotoluene	ND	0.086	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
4-Chlorotoluene	ND	0.086	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
1,2-Dibromo-3-chloropropane (DBCP)	ND	0.34	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
1,2-Dibromoethane (EDB)	ND	0.043	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
Dibromomethane	ND	0.086	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
1,2-Dichlorobenzene	ND	0.086	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
1,3-Dichlorobenzene	ND	0.086	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
1,4-Dichlorobenzene	ND	0.086	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
Dichlorodifluoromethane (Freon 12)	ND	0.17	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
1,1-Dichloroethane	ND	0.086	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
1,2-Dichloroethane	ND	0.086	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
1,1-Dichloroethylene	ND	0.086	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
cis-1,2-Dichloroethylene	ND	0.086	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
trans-1,2-Dichloroethylene	ND	0.086	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
1,2-Dichloropropane	ND	0.086	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
1,3-Dichloropropane	ND	0.043	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
2,2-Dichloropropane	ND	0.086	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
1,1-Dichloropropene	ND	0.17	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
cis-1,3-Dichloropropene	ND	0.043	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
trans-1,3-Dichloropropene	ND	0.043	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
Diethyl Ether	ND	0.17	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
Diisopropyl Ether (DIPE)	ND	0.043	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
1,4-Dioxane	ND	4.3	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
Ethylbenzene	ND	0.086	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0471

Date Received: 9/9/2021

Field Sample #: 1543210907-03 | Sampled: 9/7/2021 10:57

Sample ID: 21I0471-03

Sample Matrix: Soil

Volatile Organic Compounds by GC/MS

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Hexachlorobutadiene	ND	0.086	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
2-Hexanone (MBK)	ND	0.86	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
Isopropylbenzene (Cumene)	0.28	0.086	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
p-Isopropyltoluene (p-Cymene)	ND	0.086	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
Methyl tert-Butyl Ether (MTBE)	ND	0.086	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
Methylene Chloride	ND	0.43	mg/Kg dry	1	RL-07	SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
4-Methyl-2-pentanone (MIBK)	ND	0.86	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
Naphthalene	0.93	0.17	mg/Kg dry	1	V-05	SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
n-Propylbenzene	0.089	0.086	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
Styrene	ND	0.086	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
1,1,1,2-Tetrachloroethane	ND	0.086	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
1,1,2,2-Tetrachloroethane	ND	0.043	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
Tetrachloroethylene	ND	0.086	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
Tetrahydrofuran	ND	0.34	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
Toluene	ND	0.086	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
1,2,3-Trichlorobenzene	ND	0.34	mg/Kg dry	1	V-05	SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
1,2,4-Trichlorobenzene	ND	0.086	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
1,1,1-Trichloroethane	ND	0.086	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
1,1,2-Trichloroethane	ND	0.086	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
Trichloroethylene	ND	0.086	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
Trichlorofluoromethane (Freon 11)	ND	0.17	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
1,2,3-Trichloropropane	ND	0.17	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
1,2,4-Trimethylbenzene	2.7	0.086	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
1,3,5-Trimethylbenzene	0.12	0.086	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
Vinyl Chloride	ND	0.17	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
m+p Xylene	ND	0.17	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH
o-Xylene	0.12	0.086	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 16:56	EEH

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
1,2-Dichloroethane-d4	109	70-130		9/10/21 16:56
Toluene-d8	110	70-130		9/10/21 16:56
4-Bromofluorobenzene	113	70-130		9/10/21 16:56

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0471

Date Received: 9/9/2021

Field Sample #: 1543210907-03 | Sampled: 9/7/2021 10:57

Sample ID: 21I0471-03

Sample Matrix: Soil

Semivolatile Organic Compounds by GC/MS

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Acenaphthene	0.31	0.26	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 18:15	IMR
Acenaphthylene	ND	0.26	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 18:15	IMR
Anthracene	0.85	0.26	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 18:15	IMR
Benzo(a)anthracene	2.4	0.26	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 18:15	IMR
Benzo(a)pyrene	2.3	0.26	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 18:15	IMR
Benzo(b)fluoranthene	2.7	0.26	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 18:15	IMR
Benzo(g,h,i)perylene	1.7	0.26	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 18:15	IMR
Benzo(k)fluoranthene	1.1	0.26	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 18:15	IMR
Chrysene	2.7	0.26	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 18:15	IMR
Dibenz(a,h)anthracene	0.43	0.26	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 18:15	IMR
Fluoranthene	5.3	0.26	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 18:15	IMR
Fluorene	0.55	0.26	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 18:15	IMR
Indeno(1,2,3-cd)pyrene	1.7	0.26	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 18:15	IMR
2-Methylnaphthalene	ND	0.26	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 18:15	IMR
Naphthalene	0.33	0.26	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 18:15	IMR
Phenanthrene	4.2	0.26	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 18:15	IMR
Pyrene	5.8	0.26	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 18:15	IMR

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Nitrobenzene-d5	64.5	30-130		9/13/21 18:15
2-Fluorobiphenyl	67.7	30-130		9/13/21 18:15
p-Terphenyl-d14	94.4	30-130		9/13/21 18:15

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0471

Date Received: 9/9/2021

Field Sample #: 1543210907-03 | Sampled: 9/7/2021 10:57

Sample ID: 21I0471-03

Sample Matrix: Soil

Sample Flags: DL-03

Organochloride Pesticides by GC/ECD

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Aldrin [1]	ND	0.16	mg/Kg dry	20		SW-846 8081B	9/10/21	9/17/21 11:20	TG
alpha-BHC [1]	ND	0.16	mg/Kg dry	20		SW-846 8081B	9/10/21	9/17/21 11:20	TG
beta-BHC [1]	ND	0.16	mg/Kg dry	20		SW-846 8081B	9/10/21	9/17/21 11:20	TG
delta-BHC [1]	ND	0.16	mg/Kg dry	20		SW-846 8081B	9/10/21	9/17/21 11:20	TG
gamma-BHC (Lindane) [1]	ND	0.062	mg/Kg dry	20		SW-846 8081B	9/10/21	9/17/21 11:20	TG
Chlordane [1]	ND	0.62	mg/Kg dry	20		SW-846 8081B	9/10/21	9/17/21 11:20	TG
4,4'-DDD [1]	ND	0.12	mg/Kg dry	20		SW-846 8081B	9/10/21	9/17/21 11:20	TG
4,4'-DDE [1]	ND	0.12	mg/Kg dry	20		SW-846 8081B	9/10/21	9/17/21 11:20	TG
4,4'-DDT [1]	ND	0.12	mg/Kg dry	20		SW-846 8081B	9/10/21	9/17/21 11:20	TG
Dieldrin [1]	ND	0.12	mg/Kg dry	20		SW-846 8081B	9/10/21	9/17/21 11:20	TG
Endosulfan I [1]	ND	0.16	mg/Kg dry	20		SW-846 8081B	9/10/21	9/17/21 11:20	TG
Endosulfan II [1]	ND	0.25	mg/Kg dry	20		SW-846 8081B	9/10/21	9/17/21 11:20	TG
Endosulfan sulfate [1]	ND	0.25	mg/Kg dry	20		SW-846 8081B	9/10/21	9/17/21 11:20	TG
Endrin [1]	ND	0.25	mg/Kg dry	20		SW-846 8081B	9/10/21	9/17/21 11:20	TG
Endrin ketone [1]	ND	0.25	mg/Kg dry	20		SW-846 8081B	9/10/21	9/17/21 11:20	TG
Heptachlor [1]	ND	0.16	mg/Kg dry	20		SW-846 8081B	9/10/21	9/17/21 11:20	TG
Heptachlor epoxide [1]	ND	0.16	mg/Kg dry	20		SW-846 8081B	9/10/21	9/17/21 11:20	TG
Hexachlorobenzene [1]	ND	0.19	mg/Kg dry	20		SW-846 8081B	9/10/21	9/17/21 11:20	TG
Methoxychlor [1]	ND	1.6	mg/Kg dry	20		SW-846 8081B	9/10/21	9/17/21 11:20	TG

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Decachlorobiphenyl [1]	85.4	30-150		9/17/21 11:20
Decachlorobiphenyl [2]	86.8	30-150		9/17/21 11:20
Tetrachloro-m-xylene [1]	67.6	30-150		9/17/21 11:20
Tetrachloro-m-xylene [2]	69.0	30-150		9/17/21 11:20

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0471

Date Received: 9/9/2021

Field Sample #: 1543210907-03 | Sampled: 9/7/2021 10:57

Sample ID: 21I0471-03

Sample Matrix: Soil

Polychlorinated Biphenyls By GC/ECD

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Aroclor-1016 [1]	ND	0.12	mg/Kg dry	4		SW-846 8082A	9/10/21	9/15/21 21:54	TG
Aroclor-1221 [1]	ND	0.12	mg/Kg dry	4		SW-846 8082A	9/10/21	9/15/21 21:54	TG
Aroclor-1232 [1]	ND	0.12	mg/Kg dry	4		SW-846 8082A	9/10/21	9/15/21 21:54	TG
Aroclor-1242 [1]	ND	0.12	mg/Kg dry	4		SW-846 8082A	9/10/21	9/15/21 21:54	TG
Aroclor-1248 [1]	ND	0.12	mg/Kg dry	4		SW-846 8082A	9/10/21	9/15/21 21:54	TG
Aroclor-1254 [2]	0.13	0.12	mg/Kg dry	4		SW-846 8082A	9/10/21	9/15/21 21:54	TG
Aroclor-1260 [1]	ND	0.12	mg/Kg dry	4		SW-846 8082A	9/10/21	9/15/21 21:54	TG
Aroclor-1262 [1]	ND	0.12	mg/Kg dry	4		SW-846 8082A	9/10/21	9/15/21 21:54	TG
Aroclor-1268 [1]	ND	0.12	mg/Kg dry	4		SW-846 8082A	9/10/21	9/15/21 21:54	TG

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Decachlorobiphenyl [1]	76.1	30-150		9/15/21 21:54
Decachlorobiphenyl [2]	77.5	30-150		9/15/21 21:54
Tetrachloro-m-xylene [1]	77.0	30-150		9/15/21 21:54
Tetrachloro-m-xylene [2]	80.1	30-150		9/15/21 21:54

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0471

Date Received: 9/9/2021

Field Sample #: 1543210907-03 | Sampled: 9/7/2021 10:57

Sample ID: 21I0471-03

Sample Matrix: Soil

Herbicides by GC/ECD

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
2,4-D [1]	ND	160	µg/kg dry	4		SW-846 8151A	9/13/21	9/17/21 20:40	JMB
2,4-DB [1]	ND	160	µg/kg dry	4		SW-846 8151A	9/13/21	9/17/21 20:40	JMB
2,4,5-TP (Silvex) [1]	ND	16	µg/kg dry	4		SW-846 8151A	9/13/21	9/17/21 20:40	JMB
2,4,5-T [1]	ND	16	µg/kg dry	4		SW-846 8151A	9/13/21	9/17/21 20:40	JMB
Dalalpon [1]	ND	390	µg/kg dry	4	V-20	SW-846 8151A	9/13/21	9/17/21 20:40	JMB
Dicamba [1]	ND	16	µg/kg dry	4		SW-846 8151A	9/13/21	9/17/21 20:40	JMB
Dichloroprop [1]	ND	160	µg/kg dry	4		SW-846 8151A	9/13/21	9/17/21 20:40	JMB
Dinoseb [1]	ND	78	µg/kg dry	4		SW-846 8151A	9/13/21	9/17/21 20:40	JMB
MCPA [1]	ND	16000	µg/kg dry	4		SW-846 8151A	9/13/21	9/17/21 20:40	JMB
MCPP [1]	ND	16000	µg/kg dry	4		SW-846 8151A	9/13/21	9/17/21 20:40	JMB

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
2,4-Dichlorophenylacetic acid [1]	97.5	30-150		9/17/21 20:40
2,4-Dichlorophenylacetic acid [2]	82.6	30-150		9/17/21 20:40

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0471

Date Received: 9/9/2021

Field Sample #: 1543210907-03 | Sampled: 9/7/2021 10:57

Sample ID: 21I0471-03

Sample Matrix: Soil

Petroleum Hydrocarbons Analyses - EPH

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
C9-C18 Aliphatics	55	16	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 21:24	AYH
C19-C36 Aliphatics	260	31	mg/Kg dry	2		MADEP EPH rev 2.1	9/10/21	9/19/21 17:21	AYH
Unadjusted C11-C22 Aromatics	220	16	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 21:24	AYH
C11-C22 Aromatics	190	16	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 21:24	AYH
Acenaphthene	0.40	0.16	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 21:24	AYH
Acenaphthylene	0.27	0.16	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 21:24	AYH
Anthracene	0.76	0.16	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 21:24	AYH
Benzo(a)anthracene	3.2	0.16	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 21:24	AYH
Benzo(a)pyrene	3.7	0.16	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 21:24	AYH
Benzo(b)fluoranthene	3.2	0.16	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 21:24	AYH
Benzo(g,h,i)perylene	1.5	0.16	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 21:24	AYH
Benzo(k)fluoranthene	1.2	0.16	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 21:24	AYH
Chrysene	3.0	0.16	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 21:24	AYH
Dibenz(a,h)anthracene	0.39	0.16	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 21:24	AYH
Fluoranthene	5.6	0.16	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 21:24	AYH
Fluorene	0.49	0.16	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 21:24	AYH
Indeno(1,2,3-cd)pyrene	1.2	0.16	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 21:24	AYH
2-Methylnaphthalene	0.17	0.16	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 21:24	AYH
Naphthalene	0.44	0.16	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 21:24	AYH
Phenanthrene	3.7	0.16	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 21:24	AYH
Pyrene	5.6	0.16	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 21:24	AYH

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Chlorooctadecane (COD)	70.9	40-140		9/17/21 21:24
o-Terphenyl (OTP)	81.3	40-140		9/17/21 21:24
2-Bromonaphthalene	132	40-140		9/17/21 21:24
2-Fluorobiphenyl	125	40-140		9/17/21 21:24

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0471

Date Received: 9/9/2021

Field Sample #: 1543210907-03 | Sampled: 9/7/2021 10:57

Sample ID: 21I0471-03

Sample Matrix: Soil

Metals Analyses (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Arsenic	7.5	5.1	mg/Kg dry	1		SW-846 6010D	9/15/21	9/15/21 16:01	QNW
Cadmium	0.54	0.51	mg/Kg dry	1		SW-846 6010D	9/15/21	9/15/21 16:01	QNW
Chromium	27	1.0	mg/Kg dry	1		SW-846 6010D	9/15/21	9/15/21 16:01	QNW
Copper	25	1.0	mg/Kg dry	1		SW-846 6010D	9/15/21	9/15/21 16:01	QNW
Lead	87	0.77	mg/Kg dry	1		SW-846 6010D	9/15/21	9/15/21 16:01	QNW
Mercury	0.093	0.040	mg/Kg dry	1		SW-846 7471B	9/10/21	9/13/21 14:51	DRL
Nickel	15	1.0	mg/Kg dry	1		SW-846 6010D	9/15/21	9/15/21 16:01	QNW
Zinc	93	1.0	mg/Kg dry	1		SW-846 6010D	9/15/21	9/15/21 16:01	QNW

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0471

Date Received: 9/9/2021

Field Sample #: 1543210907-03 | Sampled: 9/7/2021 10:57

Sample ID: 21I0471-03

Sample Matrix: Soil

Conventional Chemistry Parameters by EPA/APHA/SW-846 Methods (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
% Solids	64.4		% Wt	1		SM 2540G	9/10/21	9/13/21 9:51	CJV
Total Organic Carbon	29000	100	mg/Kg	1		SW 846 9060A	9/13/21	9/13/21 22:28	DJM

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0471

Date Received: 9/9/2021

Field Sample #: 1543210907-04 | Sampled: 9/7/2021 11:23

Sample ID: 21I0471-04

Sample Matrix: Soil

Volatile Organic Compounds by GC/MS

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Acetone	ND	0.12	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
tert-Amyl Methyl Ether (TAME)	ND	0.0012	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
Benzene	ND	0.0023	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
Bromobenzene	ND	0.0023	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
Bromochloromethane	ND	0.0023	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
Bromodichloromethane	ND	0.0023	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
Bromoform	ND	0.0023	mg/Kg dry	1	V-05	SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
Bromomethane	ND	0.012	mg/Kg dry	1	V-34	SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
2-Butanone (MEK)	ND	0.046	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
n-Butylbenzene	ND	0.0023	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
sec-Butylbenzene	ND	0.0023	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
tert-Butylbenzene	ND	0.0023	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
tert-Butyl Ethyl Ether (TBEE)	ND	0.0012	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
Carbon Disulfide	ND	0.0070	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
Carbon Tetrachloride	ND	0.0023	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
Chlorobenzene	ND	0.0023	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
Chlorodibromomethane	ND	0.0012	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
Chloroethane	ND	0.012	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
Chloroform	ND	0.0046	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
Chloromethane	ND	0.012	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
2-Chlorotoluene	ND	0.0023	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
4-Chlorotoluene	ND	0.0023	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
1,2-Dibromo-3-chloropropane (DBCP)	ND	0.0046	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
1,2-Dibromoethane (EDB)	ND	0.0012	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
Dibromomethane	ND	0.0023	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
1,2-Dichlorobenzene	ND	0.0023	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
1,3-Dichlorobenzene	ND	0.0023	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
1,4-Dichlorobenzene	ND	0.0023	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
Dichlorodifluoromethane (Freon 12)	ND	0.012	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
1,1-Dichloroethane	ND	0.0023	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
1,2-Dichloroethane	ND	0.0023	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
1,1-Dichloroethylene	ND	0.0046	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
cis-1,2-Dichloroethylene	ND	0.0023	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
trans-1,2-Dichloroethylene	ND	0.0023	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
1,2-Dichloropropane	ND	0.0023	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
1,3-Dichloropropane	ND	0.0012	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
2,2-Dichloropropane	ND	0.0023	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
1,1-Dichloropropene	ND	0.0023	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
cis-1,3-Dichloropropene	ND	0.0012	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
trans-1,3-Dichloropropene	ND	0.0012	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
Diethyl Ether	ND	0.012	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
Diisopropyl Ether (DIPE)	ND	0.0012	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
1,4-Dioxane	ND	0.12	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
Ethylbenzene	ND	0.0046	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0471

Date Received: 9/9/2021

Field Sample #: 1543210907-04 | Sampled: 9/7/2021 11:23

Sample ID: 21I0471-04

Sample Matrix: Soil

Volatile Organic Compounds by GC/MS

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Hexachlorobutadiene	ND	0.0023	mg/Kg dry	1	V-05	SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
2-Hexanone (MBK)	ND	0.023	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
Isopropylbenzene (Cumene)	ND	0.0023	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
p-Isopropyltoluene (p-Cymene)	ND	0.0023	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
Methyl tert-Butyl Ether (MTBE)	ND	0.0046	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
Methylene Chloride	ND	0.012	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
4-Methyl-2-pentanone (MIBK)	ND	0.023	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
Naphthalene	ND	0.0046	mg/Kg dry	1	V-05	SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
n-Propylbenzene	ND	0.0023	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
Styrene	ND	0.0023	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
1,1,1,2-Tetrachloroethane	ND	0.0023	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
1,1,2,2-Tetrachloroethane	ND	0.0012	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
Tetrachloroethylene	ND	0.0023	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
Tetrahydrofuran	ND	0.012	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
Toluene	ND	0.0046	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
1,2,3-Trichlorobenzene	ND	0.0023	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
1,2,4-Trichlorobenzene	ND	0.0023	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
1,1,1-Trichloroethane	ND	0.0023	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
1,1,2-Trichloroethane	ND	0.0023	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
Trichloroethylene	ND	0.0023	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
Trichlorofluoromethane (Freon 11)	ND	0.012	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
1,2,3-Trichloropropane	ND	0.0023	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
1,2,4-Trimethylbenzene	ND	0.0023	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
1,3,5-Trimethylbenzene	ND	0.0023	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
Vinyl Chloride	ND	0.012	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
m+p Xylene	ND	0.0093	mg/Kg dry	1	V-05	SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF
o-Xylene	ND	0.0046	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 13:58	MFF

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
1,2-Dichloroethane-d4	113	70-130		9/10/21 13:58
Toluene-d8	102	70-130		9/10/21 13:58
4-Bromofluorobenzene	91.5	70-130		9/10/21 13:58

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0471

Date Received: 9/9/2021

Field Sample #: 1543210907-04 | Sampled: 9/7/2021 11:23

Sample ID: 21I0471-04

Sample Matrix: Soil

Semivolatile Organic Compounds by GC/MS

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Acenaphthene	ND	0.27	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 18:38	IMR
Acenaphthylene	ND	0.27	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 18:38	IMR
Anthracene	ND	0.27	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 18:38	IMR
Benzo(a)anthracene	0.55	0.27	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 18:38	IMR
Benzo(a)pyrene	0.62	0.27	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 18:38	IMR
Benzo(b)fluoranthene	0.81	0.27	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 18:38	IMR
Benzo(g,h,i)perylene	0.50	0.27	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 18:38	IMR
Benzo(k)fluoranthene	0.30	0.27	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 18:38	IMR
Chrysene	0.69	0.27	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 18:38	IMR
Dibenz(a,h)anthracene	ND	0.27	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 18:38	IMR
Fluoranthene	1.2	0.27	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 18:38	IMR
Fluorene	ND	0.27	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 18:38	IMR
Indeno(1,2,3-cd)pyrene	0.51	0.27	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 18:38	IMR
2-Methylnaphthalene	ND	0.27	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 18:38	IMR
Naphthalene	ND	0.27	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 18:38	IMR
Phenanthrene	0.82	0.27	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 18:38	IMR
Pyrene	1.4	0.27	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 18:38	IMR

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Nitrobenzene-d5	55.6	30-130		9/13/21 18:38
2-Fluorobiphenyl	59.7	30-130		9/13/21 18:38
p-Terphenyl-d14	81.2	30-130		9/13/21 18:38

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0471

Date Received: 9/9/2021

Field Sample #: 1543210907-04 | Sampled: 9/7/2021 11:23

Sample ID: 21I0471-04

Sample Matrix: Soil

Sample Flags: DL-03

Organochloride Pesticides by GC/ECD

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Aldrin [1]	ND	0.16	mg/Kg dry	20		SW-846 8081B	9/10/21	9/17/21 11:47	TG
alpha-BHC [1]	ND	0.16	mg/Kg dry	20		SW-846 8081B	9/10/21	9/17/21 11:47	TG
beta-BHC [1]	ND	0.16	mg/Kg dry	20		SW-846 8081B	9/10/21	9/17/21 11:47	TG
delta-BHC [1]	ND	0.16	mg/Kg dry	20		SW-846 8081B	9/10/21	9/17/21 11:47	TG
gamma-BHC (Lindane) [1]	ND	0.063	mg/Kg dry	20		SW-846 8081B	9/10/21	9/17/21 11:47	TG
Chlordane [1]	ND	0.63	mg/Kg dry	20		SW-846 8081B	9/10/21	9/17/21 11:47	TG
4,4'-DDD [1]	ND	0.13	mg/Kg dry	20		SW-846 8081B	9/10/21	9/17/21 11:47	TG
4,4'-DDE [1]	ND	0.13	mg/Kg dry	20		SW-846 8081B	9/10/21	9/17/21 11:47	TG
4,4'-DDT [1]	ND	0.13	mg/Kg dry	20		SW-846 8081B	9/10/21	9/17/21 11:47	TG
Dieldrin [1]	ND	0.13	mg/Kg dry	20		SW-846 8081B	9/10/21	9/17/21 11:47	TG
Endosulfan I [1]	ND	0.16	mg/Kg dry	20		SW-846 8081B	9/10/21	9/17/21 11:47	TG
Endosulfan II [1]	ND	0.25	mg/Kg dry	20		SW-846 8081B	9/10/21	9/17/21 11:47	TG
Endosulfan sulfate [1]	ND	0.25	mg/Kg dry	20		SW-846 8081B	9/10/21	9/17/21 11:47	TG
Endrin [1]	ND	0.25	mg/Kg dry	20		SW-846 8081B	9/10/21	9/17/21 11:47	TG
Endrin ketone [1]	ND	0.25	mg/Kg dry	20		SW-846 8081B	9/10/21	9/17/21 11:47	TG
Heptachlor [1]	ND	0.16	mg/Kg dry	20		SW-846 8081B	9/10/21	9/17/21 11:47	TG
Heptachlor epoxide [1]	ND	0.16	mg/Kg dry	20		SW-846 8081B	9/10/21	9/17/21 11:47	TG
Hexachlorobenzene [1]	ND	0.19	mg/Kg dry	20		SW-846 8081B	9/10/21	9/17/21 11:47	TG
Methoxychlor [1]	ND	1.6	mg/Kg dry	20		SW-846 8081B	9/10/21	9/17/21 11:47	TG

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Decachlorobiphenyl [1]	77.6	30-150		9/17/21 11:47
Decachlorobiphenyl [2]	81.3	30-150		9/17/21 11:47
Tetrachloro-m-xylene [1]	68.0	30-150		9/17/21 11:47
Tetrachloro-m-xylene [2]	71.5	30-150		9/17/21 11:47

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0471

Date Received: 9/9/2021

Field Sample #: 1543210907-04 | Sampled: 9/7/2021 11:23

Sample ID: 21I0471-04

Sample Matrix: Soil

Sample Flags: O-32

Polychlorinated Biphenyls By GC/ECD

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Aroclor-1016 [1]	ND	0.13	mg/Kg dry	4		SW-846 8082A	9/10/21	9/15/21 22:12	TG
Aroclor-1221 [1]	ND	0.13	mg/Kg dry	4		SW-846 8082A	9/10/21	9/15/21 22:12	TG
Aroclor-1232 [1]	ND	0.13	mg/Kg dry	4		SW-846 8082A	9/10/21	9/15/21 22:12	TG
Aroclor-1242 [1]	ND	0.13	mg/Kg dry	4		SW-846 8082A	9/10/21	9/15/21 22:12	TG
Aroclor-1248 [1]	ND	0.13	mg/Kg dry	4		SW-846 8082A	9/10/21	9/15/21 22:12	TG
Aroclor-1254 [2]	ND	0.13	mg/Kg dry	4		SW-846 8082A	9/10/21	9/15/21 22:12	TG
Aroclor-1260 [1]	ND	0.13	mg/Kg dry	4		SW-846 8082A	9/10/21	9/15/21 22:12	TG
Aroclor-1262 [1]	ND	0.13	mg/Kg dry	4		SW-846 8082A	9/10/21	9/15/21 22:12	TG
Aroclor-1268 [1]	ND	0.13	mg/Kg dry	4		SW-846 8082A	9/10/21	9/15/21 22:12	TG

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Decachlorobiphenyl [1]	75.8	30-150		9/15/21 22:12
Decachlorobiphenyl [2]	78.6	30-150		9/15/21 22:12
Tetrachloro-m-xylene [1]	77.6	30-150		9/15/21 22:12
Tetrachloro-m-xylene [2]	80.9	30-150		9/15/21 22:12

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0471

Date Received: 9/9/2021

Field Sample #: 1543210907-04 | Sampled: 9/7/2021 11:23

Sample ID: 21I0471-04

Sample Matrix: Soil

Herbicides by GC/ECD

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
2,4-D [1]	ND	160	µg/kg dry	4		SW-846 8151A	9/13/21	9/17/21 21:20	JMB
2,4-DB [1]	ND	160	µg/kg dry	4		SW-846 8151A	9/13/21	9/17/21 21:20	JMB
2,4,5-TP (Silvex) [1]	ND	16	µg/kg dry	4		SW-846 8151A	9/13/21	9/17/21 21:20	JMB
2,4,5-T [1]	ND	16	µg/kg dry	4		SW-846 8151A	9/13/21	9/17/21 21:20	JMB
Dalalpon [1]	ND	390	µg/kg dry	4	V-20	SW-846 8151A	9/13/21	9/17/21 21:20	JMB
Dicamba [1]	ND	16	µg/kg dry	4		SW-846 8151A	9/13/21	9/17/21 21:20	JMB
Dichloroprop [1]	ND	160	µg/kg dry	4		SW-846 8151A	9/13/21	9/17/21 21:20	JMB
Dinoseb [1]	ND	78	µg/kg dry	4		SW-846 8151A	9/13/21	9/17/21 21:20	JMB
MCPA [1]	ND	16000	µg/kg dry	4		SW-846 8151A	9/13/21	9/17/21 21:20	JMB
MCPP [1]	ND	16000	µg/kg dry	4		SW-846 8151A	9/13/21	9/17/21 21:20	JMB

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
2,4-Dichlorophenylacetic acid [1]	103	30-150		9/17/21 21:20
2,4-Dichlorophenylacetic acid [2]	86.7	30-150		9/17/21 21:20

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0471

Date Received: 9/9/2021

Field Sample #: 1543210907-04 | Sampled: 9/7/2021 11:23

Sample ID: 21I0471-04

Sample Matrix: Soil

Petroleum Hydrocarbons Analyses - EPH

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
C9-C18 Aliphatics	24	16	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 19:47	AYH
C19-C36 Aliphatics	96	16	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 19:47	AYH
Unadjusted C11-C22 Aromatics	78	16	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 19:47	AYH
C11-C22 Aromatics	65	16	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 19:47	AYH
Acenaphthene	ND	0.16	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 19:47	AYH
Acenaphthylene	ND	0.16	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 19:47	AYH
Anthracene	0.21	0.16	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 19:47	AYH
Benzo(a)anthracene	0.90	0.16	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 19:47	AYH
Benzo(a)pyrene	1.7	0.16	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 19:47	AYH
Benzo(b)fluoranthene	1.2	0.16	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 19:47	AYH
Benzo(g,h,i)perylene	0.96	0.16	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 19:47	AYH
Benzo(k)fluoranthene	0.44	0.16	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 19:47	AYH
Chrysene	1.9	0.16	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 19:47	AYH
Dibenz(a,h)anthracene	ND	0.16	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 19:47	AYH
Fluoranthene	1.8	0.16	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 19:47	AYH
Fluorene	ND	0.16	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 19:47	AYH
Indeno(1,2,3-cd)pyrene	0.69	0.16	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 19:47	AYH
2-Methylnaphthalene	ND	0.16	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 19:47	AYH
Naphthalene	0.19	0.16	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 19:47	AYH
Phenanthrene	1.1	0.16	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 19:47	AYH
Pyrene	1.8	0.16	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 19:47	AYH

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Chlorooctadecane (COD)	66.5	40-140		9/17/21 19:47
o-Terphenyl (OTP)	84.7	40-140		9/17/21 19:47
2-Bromonaphthalene	127	40-140		9/17/21 19:47
2-Fluorobiphenyl	125	40-140		9/17/21 19:47

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0471

Date Received: 9/9/2021

Field Sample #: 1543210907-04 | Sampled: 9/7/2021 11:23

Sample ID: 21I0471-04

Sample Matrix: Soil

Metals Analyses (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Arsenic	5.8	5.1	mg/Kg dry	1		SW-846 6010D	9/15/21	9/15/21 16:08	QNW
Cadmium	ND	0.51	mg/Kg dry	1		SW-846 6010D	9/15/21	9/15/21 16:08	QNW
Chromium	25	1.0	mg/Kg dry	1		SW-846 6010D	9/15/21	9/15/21 16:08	QNW
Copper	13	1.0	mg/Kg dry	1		SW-846 6010D	9/15/21	9/15/21 16:08	QNW
Lead	32	0.77	mg/Kg dry	1		SW-846 6010D	9/15/21	9/15/21 16:08	QNW
Mercury	0.072	0.041	mg/Kg dry	1		SW-846 7471B	9/10/21	9/13/21 14:53	DRL
Nickel	15	1.0	mg/Kg dry	1		SW-846 6010D	9/15/21	9/15/21 16:08	QNW
Zinc	42	1.0	mg/Kg dry	1		SW-846 6010D	9/15/21	9/15/21 16:08	QNW

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0471

Date Received: 9/9/2021

Field Sample #: 1543210907-04 | Sampled: 9/7/2021 11:23

Sample ID: 21I0471-04

Sample Matrix: Soil

Conventional Chemistry Parameters by EPA/APHA/SW-846 Methods (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
% Solids	63.8		% Wt	1		SM 2540G	9/10/21	9/13/21 9:51	CJV
Total Organic Carbon	14000	100	mg/Kg	1		SW 846 9060A	9/13/21	9/13/21 22:50	DJM

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0471

Date Received: 9/9/2021

Field Sample #: 1543210907-05 | Sampled: 9/7/2021 13:05

Sample ID: 21I0471-05

Sample Matrix: Soil

Volatile Organic Compounds by GC/MS

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Acetone	ND	0.10	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
tert-Amyl Methyl Ether (TAME)	ND	0.0010	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
Benzene	ND	0.0020	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
Bromobenzene	ND	0.0020	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
Bromochloromethane	ND	0.0020	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
Bromodichloromethane	ND	0.0020	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
Bromoform	ND	0.0020	mg/Kg dry	1	V-05	SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
Bromomethane	ND	0.010	mg/Kg dry	1	V-34	SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
2-Butanone (MEK)	ND	0.040	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
n-Butylbenzene	ND	0.0020	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
sec-Butylbenzene	ND	0.0020	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
tert-Butylbenzene	ND	0.0020	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
tert-Butyl Ethyl Ether (TBEE)	ND	0.0010	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
Carbon Disulfide	ND	0.0060	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
Carbon Tetrachloride	ND	0.0020	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
Chlorobenzene	ND	0.0020	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
Chlorodibromomethane	ND	0.0010	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
Chloroethane	ND	0.010	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
Chloroform	ND	0.0040	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
Chloromethane	ND	0.010	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
2-Chlorotoluene	ND	0.0020	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
4-Chlorotoluene	ND	0.0020	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
1,2-Dibromo-3-chloropropane (DBCP)	ND	0.0040	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
1,2-Dibromoethane (EDB)	ND	0.0010	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
Dibromomethane	ND	0.0020	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
1,2-Dichlorobenzene	ND	0.0020	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
1,3-Dichlorobenzene	ND	0.0020	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
1,4-Dichlorobenzene	ND	0.0020	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
Dichlorodifluoromethane (Freon 12)	ND	0.010	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
1,1-Dichloroethane	ND	0.0020	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
1,2-Dichloroethane	ND	0.0020	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
1,1-Dichloroethylene	ND	0.0040	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
cis-1,2-Dichloroethylene	ND	0.0020	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
trans-1,2-Dichloroethylene	ND	0.0020	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
1,2-Dichloropropane	ND	0.0020	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
1,3-Dichloropropane	ND	0.0010	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
2,2-Dichloropropane	ND	0.0020	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
1,1-Dichloropropene	ND	0.0020	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
cis-1,3-Dichloropropene	ND	0.0010	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
trans-1,3-Dichloropropene	ND	0.0010	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
Diethyl Ether	ND	0.010	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
Diisopropyl Ether (DIPE)	ND	0.0010	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
1,4-Dioxane	ND	0.10	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
Ethylbenzene	ND	0.0040	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0471

Date Received: 9/9/2021

Field Sample #: 1543210907-05 | Sampled: 9/7/2021 13:05

Sample ID: 21I0471-05

Sample Matrix: Soil

Volatile Organic Compounds by GC/MS

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Hexachlorobutadiene	ND	0.0020	mg/Kg dry	1	V-05	SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
2-Hexanone (MBK)	ND	0.020	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
Isopropylbenzene (Cumene)	ND	0.0020	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
p-Isopropyltoluene (p-Cymene)	ND	0.0020	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
Methyl tert-Butyl Ether (MTBE)	ND	0.0040	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
Methylene Chloride	ND	0.010	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
4-Methyl-2-pentanone (MIBK)	ND	0.020	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
Naphthalene	ND	0.0040	mg/Kg dry	1	V-05	SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
n-Propylbenzene	ND	0.0020	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
Styrene	ND	0.0020	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
1,1,1,2-Tetrachloroethane	ND	0.0020	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
1,1,2,2-Tetrachloroethane	ND	0.0010	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
Tetrachloroethylene	ND	0.0020	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
Tetrahydrofuran	ND	0.010	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
Toluene	ND	0.0040	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
1,2,3-Trichlorobenzene	ND	0.0020	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
1,2,4-Trichlorobenzene	ND	0.0020	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
1,1,1-Trichloroethane	ND	0.0020	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
1,1,2-Trichloroethane	ND	0.0020	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
Trichloroethylene	ND	0.0020	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
Trichlorofluoromethane (Freon 11)	ND	0.010	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
1,2,3-Trichloropropane	ND	0.0020	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
1,2,4-Trimethylbenzene	ND	0.0020	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
1,3,5-Trimethylbenzene	ND	0.0020	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
Vinyl Chloride	ND	0.010	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
m+p Xylene	ND	0.0080	mg/Kg dry	1	V-05	SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF
o-Xylene	ND	0.0040	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 14:23	MFF

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
1,2-Dichloroethane-d4	111	70-130		9/10/21 14:23
Toluene-d8	102	70-130		9/10/21 14:23
4-Bromofluorobenzene	101	70-130		9/10/21 14:23

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0471

Date Received: 9/9/2021

Field Sample #: 1543210907-05 | Sampled: 9/7/2021 13:05

Sample ID: 21I0471-05

Sample Matrix: Soil

Semivolatile Organic Compounds by GC/MS

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Acenaphthene	ND	0.26	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 19:01	IMR
Acenaphthylene	ND	0.26	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 19:01	IMR
Anthracene	2.3	0.26	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 19:01	IMR
Benzo(a)anthracene	6.2	0.26	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 19:01	IMR
Benzo(a)pyrene	2.0	0.26	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 19:01	IMR
Benzo(b)fluoranthene	4.7	0.26	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 19:01	IMR
Benzo(g,h,i)perylene	0.80	0.26	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 19:01	IMR
Benzo(k)fluoranthene	1.9	0.26	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 19:01	IMR
Chrysene	8.5	2.6	mg/Kg dry	10		SW-846 8270D-E	9/10/21	9/14/21 22:09	BGL
Dibenz(a,h)anthracene	ND	0.26	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 19:01	IMR
Fluoranthene	49	2.6	mg/Kg dry	10		SW-846 8270D-E	9/10/21	9/14/21 22:09	BGL
Fluorene	0.64	0.26	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 19:01	IMR
Indeno(1,2,3-cd)pyrene	1.0	0.26	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 19:01	IMR
2-Methylnaphthalene	ND	0.26	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 19:01	IMR
Naphthalene	ND	0.26	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 19:01	IMR
Phenanthrene	25	2.6	mg/Kg dry	10		SW-846 8270D-E	9/10/21	9/14/21 22:09	BGL
Pyrene	31	2.6	mg/Kg dry	10		SW-846 8270D-E	9/10/21	9/14/21 22:09	BGL

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Nitrobenzene-d5	50.1	30-130		9/13/21 19:01
Nitrobenzene-d5	50.0	30-130		9/14/21 22:09
2-Fluorobiphenyl	56.4	30-130		9/13/21 19:01
2-Fluorobiphenyl	51.4	30-130		9/14/21 22:09
p-Terphenyl-d14	81.8	30-130		9/13/21 19:01
p-Terphenyl-d14	56.7	30-130		9/14/21 22:09

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0471

Date Received: 9/9/2021

Field Sample #: 1543210907-05 | Sampled: 9/7/2021 13:05

Sample ID: 21I0471-05

Sample Matrix: Soil

Sample Flags: DL-03

Organochloride Pesticides by GC/ECD

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Aldrin [1]	ND	0.078	mg/Kg dry	10		SW-846 8081B	9/10/21	9/17/21 12:15	TG
alpha-BHC [1]	ND	0.078	mg/Kg dry	10		SW-846 8081B	9/10/21	9/17/21 12:15	TG
beta-BHC [1]	ND	0.078	mg/Kg dry	10		SW-846 8081B	9/10/21	9/17/21 12:15	TG
delta-BHC [1]	ND	0.078	mg/Kg dry	10		SW-846 8081B	9/10/21	9/17/21 12:15	TG
gamma-BHC (Lindane) [1]	ND	0.031	mg/Kg dry	10		SW-846 8081B	9/10/21	9/17/21 12:15	TG
Chlordane [1]	ND	0.31	mg/Kg dry	10		SW-846 8081B	9/10/21	9/17/21 12:15	TG
4,4'-DDD [1]	ND	0.062	mg/Kg dry	10		SW-846 8081B	9/10/21	9/17/21 12:15	TG
4,4'-DDE [1]	ND	0.062	mg/Kg dry	10		SW-846 8081B	9/10/21	9/17/21 12:15	TG
4,4'-DDT [1]	ND	0.062	mg/Kg dry	10		SW-846 8081B	9/10/21	9/17/21 12:15	TG
Dieldrin [1]	ND	0.062	mg/Kg dry	10		SW-846 8081B	9/10/21	9/17/21 12:15	TG
Endosulfan I [1]	ND	0.078	mg/Kg dry	10		SW-846 8081B	9/10/21	9/17/21 12:15	TG
Endosulfan II [1]	ND	0.12	mg/Kg dry	10		SW-846 8081B	9/10/21	9/17/21 12:15	TG
Endosulfan sulfate [1]	ND	0.12	mg/Kg dry	10		SW-846 8081B	9/10/21	9/17/21 12:15	TG
Endrin [1]	ND	0.12	mg/Kg dry	10		SW-846 8081B	9/10/21	9/17/21 12:15	TG
Endrin ketone [1]	ND	0.12	mg/Kg dry	10		SW-846 8081B	9/10/21	9/17/21 12:15	TG
Heptachlor [1]	ND	0.078	mg/Kg dry	10		SW-846 8081B	9/10/21	9/17/21 12:15	TG
Heptachlor epoxide [1]	ND	0.078	mg/Kg dry	10		SW-846 8081B	9/10/21	9/17/21 12:15	TG
Hexachlorobenzene [1]	ND	0.093	mg/Kg dry	10		SW-846 8081B	9/10/21	9/17/21 12:15	TG
Methoxychlor [1]	ND	0.78	mg/Kg dry	10		SW-846 8081B	9/10/21	9/17/21 12:15	TG

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Decachlorobiphenyl [1]	69.0	30-150		9/17/21 12:15
Decachlorobiphenyl [2]	77.2	30-150		9/17/21 12:15
Tetrachloro-m-xylene [1]	62.7	30-150		9/17/21 12:15
Tetrachloro-m-xylene [2]	64.5	30-150		9/17/21 12:15

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0471

Date Received: 9/9/2021

Field Sample #: 1543210907-05 | Sampled: 9/7/2021 13:05

Sample ID: 21I0471-05

Sample Matrix: Soil

Sample Flags: O-32

Polychlorinated Biphenyls By GC/ECD

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Aroclor-1016 [1]	ND	0.12	mg/Kg dry	4		SW-846 8082A	9/10/21	9/15/21 22:31	TG
Aroclor-1221 [1]	ND	0.12	mg/Kg dry	4		SW-846 8082A	9/10/21	9/15/21 22:31	TG
Aroclor-1232 [1]	ND	0.12	mg/Kg dry	4		SW-846 8082A	9/10/21	9/15/21 22:31	TG
Aroclor-1242 [1]	ND	0.12	mg/Kg dry	4		SW-846 8082A	9/10/21	9/15/21 22:31	TG
Aroclor-1248 [1]	ND	0.12	mg/Kg dry	4		SW-846 8082A	9/10/21	9/15/21 22:31	TG
Aroclor-1254 [1]	ND	0.12	mg/Kg dry	4		SW-846 8082A	9/10/21	9/15/21 22:31	TG
Aroclor-1260 [1]	ND	0.12	mg/Kg dry	4		SW-846 8082A	9/10/21	9/15/21 22:31	TG
Aroclor-1262 [1]	ND	0.12	mg/Kg dry	4		SW-846 8082A	9/10/21	9/15/21 22:31	TG
Aroclor-1268 [1]	ND	0.12	mg/Kg dry	4		SW-846 8082A	9/10/21	9/15/21 22:31	TG

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Decachlorobiphenyl [1]	76.1	30-150		9/15/21 22:31
Decachlorobiphenyl [2]	79.4	30-150		9/15/21 22:31
Tetrachloro-m-xylene [1]	77.0	30-150		9/15/21 22:31
Tetrachloro-m-xylene [2]	80.8	30-150		9/15/21 22:31

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0471

Date Received: 9/9/2021

Field Sample #: 1543210907-05 | Sampled: 9/7/2021 13:05

Sample ID: 21I0471-05

Sample Matrix: Soil

Herbicides by GC/ECD

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
2,4-D [1]	ND	160	µg/kg dry	4		SW-846 8151A	9/13/21	9/17/21 22:00	JMB
2,4-DB [1]	ND	160	µg/kg dry	4		SW-846 8151A	9/13/21	9/17/21 22:00	JMB
2,4,5-TP (Silvex) [1]	ND	16	µg/kg dry	4		SW-846 8151A	9/13/21	9/17/21 22:00	JMB
2,4,5-T [1]	ND	16	µg/kg dry	4		SW-846 8151A	9/13/21	9/17/21 22:00	JMB
Dalalpon [1]	ND	390	µg/kg dry	4	V-20	SW-846 8151A	9/13/21	9/17/21 22:00	JMB
Dicamba [1]	ND	16	µg/kg dry	4		SW-846 8151A	9/13/21	9/17/21 22:00	JMB
Dichloroprop [1]	ND	160	µg/kg dry	4		SW-846 8151A	9/13/21	9/17/21 22:00	JMB
Dinoseb [1]	ND	78	µg/kg dry	4		SW-846 8151A	9/13/21	9/17/21 22:00	JMB
MCPA [1]	ND	16000	µg/kg dry	4		SW-846 8151A	9/13/21	9/17/21 22:00	JMB
MCPP [1]	ND	16000	µg/kg dry	4		SW-846 8151A	9/13/21	9/17/21 22:00	JMB

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
2,4-Dichlorophenylacetic acid [1]	109	30-150		9/17/21 22:00
2,4-Dichlorophenylacetic acid [2]	80.6	30-150		9/17/21 22:00

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0471

Date Received: 9/9/2021

Field Sample #: 1543210907-05 | Sampled: 9/7/2021 13:05

Sample ID: 21I0471-05

Sample Matrix: Soil

Petroleum Hydrocarbons Analyses - EPH

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
C9-C18 Aliphatics	ND	16	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 20:06	AYH
C19-C36 Aliphatics	92	16	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 20:06	AYH
Unadjusted C11-C22 Aromatics	53	16	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 20:06	AYH
C11-C22 Aromatics	44	16	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 20:06	AYH
Acenaphthene	ND	0.16	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 20:06	AYH
Acenaphthylene	ND	0.16	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 20:06	AYH
Anthracene	ND	0.16	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 20:06	AYH
Benzo(a)anthracene	2.2	0.16	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 20:06	AYH
Benzo(a)pyrene	2.2	0.16	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 20:06	AYH
Benzo(b)fluoranthene	0.42	0.16	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 20:06	AYH
Benzo(g,h,i)perylene	ND	0.16	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 20:06	AYH
Benzo(k)fluoranthene	ND	0.16	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 20:06	AYH
Chrysene	1.4	0.16	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 20:06	AYH
Dibenz(a,h)anthracene	ND	0.16	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 20:06	AYH
Fluoranthene	0.94	0.16	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 20:06	AYH
Fluorene	ND	0.16	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 20:06	AYH
Indeno(1,2,3-cd)pyrene	ND	0.16	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 20:06	AYH
2-Methylnaphthalene	ND	0.16	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 20:06	AYH
Naphthalene	ND	0.16	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 20:06	AYH
Phenanthrene	0.46	0.16	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 20:06	AYH
Pyrene	0.84	0.16	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 20:06	AYH

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Chlorooctadecane (COD)	65.3	40-140		9/17/21 20:06
o-Terphenyl (OTP)	80.9	40-140		9/17/21 20:06
2-Bromonaphthalene	131	40-140		9/17/21 20:06
2-Fluorobiphenyl	133	40-140		9/17/21 20:06

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0471

Date Received: 9/9/2021

Field Sample #: 1543210907-05 | Sampled: 9/7/2021 13:05

Sample ID: 21I0471-05

Sample Matrix: Soil

Metals Analyses (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Arsenic	7.4	5.2	mg/Kg dry	1		SW-846 6010D	9/15/21	9/15/21 16:15	QNW
Cadmium	ND	0.52	mg/Kg dry	1		SW-846 6010D	9/15/21	9/15/21 16:15	QNW
Chromium	39	1.0	mg/Kg dry	1		SW-846 6010D	9/15/21	9/15/21 16:15	QNW
Copper	23	1.0	mg/Kg dry	1		SW-846 6010D	9/15/21	9/15/21 16:15	QNW
Lead	17	0.77	mg/Kg dry	1		SW-846 6010D	9/15/21	9/15/21 16:15	QNW
Mercury	ND	0.043	mg/Kg dry	1		SW-846 7471B	9/10/21	9/13/21 14:55	DRL
Nickel	25	1.0	mg/Kg dry	1		SW-846 6010D	9/15/21	9/15/21 16:15	QNW
Zinc	78	1.0	mg/Kg dry	1		SW-846 6010D	9/15/21	9/15/21 16:15	QNW

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0471

Date Received: 9/9/2021

Field Sample #: 1543210907-05 | Sampled: 9/7/2021 13:05

Sample ID: 21I0471-05

Sample Matrix: Soil

Conventional Chemistry Parameters by EPA/APHA/SW-846 Methods (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
% Solids	64.3		% Wt	1		SM 2540G	9/10/21	9/13/21 9:51	CJV
Total Organic Carbon	4300	100	mg/Kg	1		SW 846 9060A	9/13/21	9/13/21 23:13	DJM

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0471

Date Received: 9/9/2021

Field Sample #: 1543210908-06 | Sampled: 9/8/2021 09:50

Sample ID: 21I0471-06

Sample Matrix: Soil

Volatile Organic Compounds by GC/MS

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Acetone	ND	0.10	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
tert-Amyl Methyl Ether (TAME)	ND	0.0010	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
Benzene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
Bromobenzene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
Bromochloromethane	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
Bromodichloromethane	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
Bromoform	ND	0.0020	mg/Kg wet	1	V-05	SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
Bromomethane	ND	0.010	mg/Kg wet	1	V-34	SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
2-Butanone (MEK)	ND	0.040	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
n-Butylbenzene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
sec-Butylbenzene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
tert-Butylbenzene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
tert-Butyl Ethyl Ether (TBEE)	ND	0.0010	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
Carbon Disulfide	ND	0.0060	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
Carbon Tetrachloride	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
Chlorobenzene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
Chlorodibromomethane	ND	0.0010	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
Chloroethane	ND	0.010	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
Chloroform	ND	0.0040	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
Chloromethane	ND	0.010	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
2-Chlorotoluene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
4-Chlorotoluene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
1,2-Dibromo-3-chloropropane (DBCP)	ND	0.0040	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
1,2-Dibromoethane (EDB)	ND	0.0010	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
Dibromomethane	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
1,2-Dichlorobenzene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
1,3-Dichlorobenzene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
1,4-Dichlorobenzene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
Dichlorodifluoromethane (Freon 12)	ND	0.010	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
1,1-Dichloroethane	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
1,2-Dichloroethane	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
1,1-Dichloroethylene	ND	0.0040	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
cis-1,2-Dichloroethylene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
trans-1,2-Dichloroethylene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
1,2-Dichloropropane	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
1,3-Dichloropropane	ND	0.0010	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
2,2-Dichloropropane	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
1,1-Dichloropropene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
cis-1,3-Dichloropropene	ND	0.0010	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
trans-1,3-Dichloropropene	ND	0.0010	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
Diethyl Ether	ND	0.010	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
Diisopropyl Ether (DIPE)	ND	0.0010	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
1,4-Dioxane	ND	0.10	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
Ethylbenzene	ND	0.0040	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0471

Date Received: 9/9/2021

Field Sample #: 1543210908-06 | Sampled: 9/8/2021 09:50

Sample ID: 21I0471-06

Sample Matrix: Soil

Volatile Organic Compounds by GC/MS

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Hexachlorobutadiene	ND	0.0020	mg/Kg wet	1	V-05	SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
2-Hexanone (MBK)	ND	0.020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
Isopropylbenzene (Cumene)	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
p-Isopropyltoluene (p-Cymene)	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
Methyl tert-Butyl Ether (MTBE)	ND	0.0040	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
Methylene Chloride	ND	0.010	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
4-Methyl-2-pentanone (MIBK)	ND	0.020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
Naphthalene	ND	0.0040	mg/Kg wet	1	V-05	SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
n-Propylbenzene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
Styrene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
1,1,1,2-Tetrachloroethane	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
1,1,2,2-Tetrachloroethane	ND	0.0010	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
Tetrachloroethylene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
Tetrahydrofuran	ND	0.010	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
Toluene	ND	0.0040	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
1,2,3-Trichlorobenzene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
1,2,4-Trichlorobenzene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
1,1,1-Trichloroethane	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
1,1,2-Trichloroethane	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
Trichloroethylene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
Trichlorofluoromethane (Freon 11)	ND	0.010	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
1,2,3-Trichloropropane	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
1,2,4-Trimethylbenzene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
1,3,5-Trimethylbenzene	ND	0.0020	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
Vinyl Chloride	ND	0.010	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
m+p Xylene	ND	0.0080	mg/Kg wet	1	V-05	SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF
o-Xylene	ND	0.0040	mg/Kg wet	1		SW-846 8260C-D	9/10/21	9/10/21 14:48	MFF

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
1,2-Dichloroethane-d4	108	70-130		9/10/21 14:48
Toluene-d8	100	70-130		9/10/21 14:48
4-Bromofluorobenzene	95.4	70-130		9/10/21 14:48

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0471

Date Received: 9/9/2021

Field Sample #: 1543210908-07 | Sampled: 9/8/2021 10:27

Sample ID: 21I0471-07

Sample Matrix: Soil

Volatile Organic Compounds by GC/MS

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Acetone	ND	0.13	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
tert-Amyl Methyl Ether (TAME)	ND	0.0013	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
Benzene	ND	0.0026	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
Bromobenzene	ND	0.0026	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
Bromochloromethane	ND	0.0026	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
Bromodichloromethane	ND	0.0026	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
Bromoform	ND	0.0026	mg/Kg dry	1	V-05	SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
Bromomethane	ND	0.013	mg/Kg dry	1	V-34	SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
2-Butanone (MEK)	ND	0.052	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
n-Butylbenzene	ND	0.0026	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
sec-Butylbenzene	ND	0.0026	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
tert-Butylbenzene	ND	0.0026	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
tert-Butyl Ethyl Ether (TBEE)	ND	0.0013	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
Carbon Disulfide	ND	0.0078	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
Carbon Tetrachloride	ND	0.0026	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
Chlorobenzene	ND	0.0026	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
Chlorodibromomethane	ND	0.0013	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
Chloroethane	ND	0.013	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
Chloroform	ND	0.0052	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
Chloromethane	ND	0.013	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
2-Chlorotoluene	ND	0.0026	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
4-Chlorotoluene	ND	0.0026	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
1,2-Dibromo-3-chloropropane (DBCP)	ND	0.0052	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
1,2-Dibromoethane (EDB)	ND	0.0013	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
Dibromomethane	ND	0.0026	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
1,2-Dichlorobenzene	ND	0.0026	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
1,3-Dichlorobenzene	ND	0.0026	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
1,4-Dichlorobenzene	ND	0.0026	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
Dichlorodifluoromethane (Freon 12)	ND	0.013	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
1,1-Dichloroethane	ND	0.0026	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
1,2-Dichloroethane	ND	0.0026	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
1,1-Dichloroethylene	ND	0.0052	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
cis-1,2-Dichloroethylene	ND	0.0026	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
trans-1,2-Dichloroethylene	ND	0.0026	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
1,2-Dichloropropane	ND	0.0026	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
1,3-Dichloropropane	ND	0.0013	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
2,2-Dichloropropane	ND	0.0026	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
1,1-Dichloropropene	ND	0.0026	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
cis-1,3-Dichloropropene	ND	0.0013	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
trans-1,3-Dichloropropene	ND	0.0013	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
Diethyl Ether	ND	0.013	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
Diisopropyl Ether (DIPE)	ND	0.0013	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
1,4-Dioxane	ND	0.13	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
Ethylbenzene	ND	0.0052	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0471

Date Received: 9/9/2021

Field Sample #: 1543210908-07 | Sampled: 9/8/2021 10:27

Sample ID: 21I0471-07

Sample Matrix: Soil

Volatile Organic Compounds by GC/MS

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Hexachlorobutadiene	ND	0.0026	mg/Kg dry	1	V-05	SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
2-Hexanone (MBK)	ND	0.026	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
Isopropylbenzene (Cumene)	ND	0.0026	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
p-Isopropyltoluene (p-Cymene)	ND	0.0026	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
Methyl tert-Butyl Ether (MTBE)	ND	0.0052	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
Methylene Chloride	ND	0.013	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
4-Methyl-2-pentanone (MIBK)	ND	0.026	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
Naphthalene	ND	0.0052	mg/Kg dry	1	V-05	SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
n-Propylbenzene	ND	0.0026	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
Styrene	ND	0.0026	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
1,1,1,2-Tetrachloroethane	ND	0.0026	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
1,1,2,2-Tetrachloroethane	ND	0.0013	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
Tetrachloroethylene	ND	0.0026	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
Tetrahydrofuran	ND	0.013	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
Toluene	ND	0.0052	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
1,2,3-Trichlorobenzene	ND	0.0026	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
1,2,4-Trichlorobenzene	ND	0.0026	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
1,1,1-Trichloroethane	ND	0.0026	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
1,1,2-Trichloroethane	ND	0.0026	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
Trichloroethylene	ND	0.0026	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
Trichlorofluoromethane (Freon 11)	ND	0.013	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
1,2,3-Trichloropropane	ND	0.0026	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
1,2,4-Trimethylbenzene	ND	0.0026	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
1,3,5-Trimethylbenzene	ND	0.0026	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
Vinyl Chloride	ND	0.013	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
m+p Xylene	ND	0.010	mg/Kg dry	1	V-05	SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF
o-Xylene	ND	0.0052	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:12	MFF

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
1,2-Dichloroethane-d4	109	70-130		9/10/21 15:12
Toluene-d8	102	70-130		9/10/21 15:12
4-Bromofluorobenzene	95.0	70-130		9/10/21 15:12

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0471

Date Received: 9/9/2021

Field Sample #: 1543210908-07 | Sampled: 9/8/2021 10:27

Sample ID: 21I0471-07

Sample Matrix: Soil

Semivolatile Organic Compounds by GC/MS

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Acenaphthene	ND	0.30	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 19:24	IMR
Acenaphthylene	ND	0.30	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 19:24	IMR
Anthracene	ND	0.30	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 19:24	IMR
Benzo(a)anthracene	ND	0.30	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 19:24	IMR
Benzo(a)pyrene	ND	0.30	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 19:24	IMR
Benzo(b)fluoranthene	ND	0.30	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 19:24	IMR
Benzo(g,h,i)perylene	ND	0.30	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 19:24	IMR
Benzo(k)fluoranthene	ND	0.30	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 19:24	IMR
Chrysene	ND	0.30	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 19:24	IMR
Dibenz(a,h)anthracene	ND	0.30	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 19:24	IMR
Fluoranthene	ND	0.30	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 19:24	IMR
Fluorene	ND	0.30	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 19:24	IMR
Indeno(1,2,3-cd)pyrene	ND	0.30	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 19:24	IMR
2-Methylnaphthalene	ND	0.30	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 19:24	IMR
Naphthalene	ND	0.30	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 19:24	IMR
Phenanthrene	ND	0.30	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 19:24	IMR
Pyrene	ND	0.30	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 19:24	IMR

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Nitrobenzene-d5	64.4	30-130		9/13/21 19:24
2-Fluorobiphenyl	68.6	30-130		9/13/21 19:24
p-Terphenyl-d14	103	30-130		9/13/21 19:24

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0471

Date Received: 9/9/2021

Field Sample #: 1543210908-07 | Sampled: 9/8/2021 10:27

Sample ID: 21I0471-07

Sample Matrix: Soil

Sample Flags: DL-03

Organochloride Pesticides by GC/ECD

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Aldrin [1]	ND	0.087	mg/Kg dry	10		SW-846 8081B	9/10/21	9/17/21 12:43	TG
alpha-BHC [1]	ND	0.087	mg/Kg dry	10		SW-846 8081B	9/10/21	9/17/21 12:43	TG
beta-BHC [1]	ND	0.087	mg/Kg dry	10		SW-846 8081B	9/10/21	9/17/21 12:43	TG
delta-BHC [1]	ND	0.087	mg/Kg dry	10		SW-846 8081B	9/10/21	9/17/21 12:43	TG
gamma-BHC (Lindane) [1]	ND	0.035	mg/Kg dry	10		SW-846 8081B	9/10/21	9/17/21 12:43	TG
Chlordane [1]	ND	0.35	mg/Kg dry	10		SW-846 8081B	9/10/21	9/17/21 12:43	TG
4,4'-DDD [1]	ND	0.070	mg/Kg dry	10		SW-846 8081B	9/10/21	9/17/21 12:43	TG
4,4'-DDE [1]	ND	0.070	mg/Kg dry	10		SW-846 8081B	9/10/21	9/17/21 12:43	TG
4,4'-DDT [1]	ND	0.070	mg/Kg dry	10		SW-846 8081B	9/10/21	9/17/21 12:43	TG
Dieldrin [1]	ND	0.070	mg/Kg dry	10		SW-846 8081B	9/10/21	9/17/21 12:43	TG
Endosulfan I [1]	ND	0.087	mg/Kg dry	10		SW-846 8081B	9/10/21	9/17/21 12:43	TG
Endosulfan II [1]	ND	0.14	mg/Kg dry	10		SW-846 8081B	9/10/21	9/17/21 12:43	TG
Endosulfan sulfate [1]	ND	0.14	mg/Kg dry	10		SW-846 8081B	9/10/21	9/17/21 12:43	TG
Endrin [1]	ND	0.14	mg/Kg dry	10		SW-846 8081B	9/10/21	9/17/21 12:43	TG
Endrin ketone [1]	ND	0.14	mg/Kg dry	10		SW-846 8081B	9/10/21	9/17/21 12:43	TG
Heptachlor [1]	ND	0.087	mg/Kg dry	10		SW-846 8081B	9/10/21	9/17/21 12:43	TG
Heptachlor epoxide [1]	ND	0.087	mg/Kg dry	10		SW-846 8081B	9/10/21	9/17/21 12:43	TG
Hexachlorobenzene [1]	ND	0.10	mg/Kg dry	10		SW-846 8081B	9/10/21	9/17/21 12:43	TG
Methoxychlor [1]	ND	0.87	mg/Kg dry	10		SW-846 8081B	9/10/21	9/17/21 12:43	TG

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Decachlorobiphenyl [1]	76.5	30-150		9/17/21 12:43
Decachlorobiphenyl [2]	85.3	30-150		9/17/21 12:43
Tetrachloro-m-xylene [1]	72.0	30-150		9/17/21 12:43
Tetrachloro-m-xylene [2]	74.5	30-150		9/17/21 12:43

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0471

Date Received: 9/9/2021

Field Sample #: 1543210908-07 | Sampled: 9/8/2021 10:27

Sample ID: 21I0471-07

Sample Matrix: Soil

Sample Flags: O-32

Polychlorinated Biphenyls By GC/ECD

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Aroclor-1016 [1]	ND	0.14	mg/Kg dry	4		SW-846 8082A	9/10/21	9/15/21 22:49	TG
Aroclor-1221 [1]	ND	0.14	mg/Kg dry	4		SW-846 8082A	9/10/21	9/15/21 22:49	TG
Aroclor-1232 [1]	ND	0.14	mg/Kg dry	4		SW-846 8082A	9/10/21	9/15/21 22:49	TG
Aroclor-1242 [1]	ND	0.14	mg/Kg dry	4		SW-846 8082A	9/10/21	9/15/21 22:49	TG
Aroclor-1248 [1]	ND	0.14	mg/Kg dry	4		SW-846 8082A	9/10/21	9/15/21 22:49	TG
Aroclor-1254 [1]	ND	0.14	mg/Kg dry	4		SW-846 8082A	9/10/21	9/15/21 22:49	TG
Aroclor-1260 [1]	ND	0.14	mg/Kg dry	4		SW-846 8082A	9/10/21	9/15/21 22:49	TG
Aroclor-1262 [1]	ND	0.14	mg/Kg dry	4		SW-846 8082A	9/10/21	9/15/21 22:49	TG
Aroclor-1268 [1]	ND	0.14	mg/Kg dry	4		SW-846 8082A	9/10/21	9/15/21 22:49	TG

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Decachlorobiphenyl [1]	83.1	30-150		9/15/21 22:49
Decachlorobiphenyl [2]	88.8	30-150		9/15/21 22:49
Tetrachloro-m-xylene [1]	83.8	30-150		9/15/21 22:49
Tetrachloro-m-xylene [2]	88.4	30-150		9/15/21 22:49

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0471

Date Received: 9/9/2021

Field Sample #: 1543210908-07 | Sampled: 9/8/2021 10:27

Sample ID: 21I0471-07

Sample Matrix: Soil

Herbicides by GC/ECD

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
2,4-D [1]	ND	170	µg/kg dry	4		SW-846 8151A	9/13/21	9/17/21 22:39	JMB
2,4-DB [1]	ND	170	µg/kg dry	4		SW-846 8151A	9/13/21	9/17/21 22:39	JMB
2,4,5-TP (Silvex) [1]	ND	17	µg/kg dry	4		SW-846 8151A	9/13/21	9/17/21 22:39	JMB
2,4,5-T [1]	ND	17	µg/kg dry	4		SW-846 8151A	9/13/21	9/17/21 22:39	JMB
Dalalpon [1]	ND	440	µg/kg dry	4	V-20	SW-846 8151A	9/13/21	9/17/21 22:39	JMB
Dicamba [1]	ND	17	µg/kg dry	4		SW-846 8151A	9/13/21	9/17/21 22:39	JMB
Dichloroprop [1]	ND	170	µg/kg dry	4		SW-846 8151A	9/13/21	9/17/21 22:39	JMB
Dinoseb [1]	ND	87	µg/kg dry	4		SW-846 8151A	9/13/21	9/17/21 22:39	JMB
MCPA [1]	ND	17000	µg/kg dry	4		SW-846 8151A	9/13/21	9/17/21 22:39	JMB
MCPP [1]	ND	17000	µg/kg dry	4		SW-846 8151A	9/13/21	9/17/21 22:39	JMB

Surrogates	% Recovery	Recovery Limits	Flag/Qual		
2,4-Dichlorophenylacetic acid [1]	94.4	30-150		9/17/21 22:39	
2,4-Dichlorophenylacetic acid [2]	76.0	30-150		9/17/21 22:39	

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0471

Date Received: 9/9/2021

Field Sample #: 1543210908-07 | Sampled: 9/8/2021 10:27

Sample ID: 21I0471-07

Sample Matrix: Soil

Petroleum Hydrocarbons Analyses - EPH

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
C9-C18 Aliphatics	ND	17	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 20:26	AYH
C19-C36 Aliphatics	31	17	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 20:26	AYH
Unadjusted C11-C22 Aromatics	41	17	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 20:26	AYH
C11-C22 Aromatics	33	17	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 20:26	AYH
Acenaphthene	ND	0.17	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 20:26	AYH
Acenaphthylene	ND	0.17	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 20:26	AYH
Anthracene	ND	0.17	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 20:26	AYH
Benzo(a)anthracene	2.8	0.17	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 20:26	AYH
Benzo(a)pyrene	1.9	0.17	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 20:26	AYH
Benzo(b)fluoranthene	0.42	0.17	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 20:26	AYH
Benzo(g,h,i)perylene	ND	0.17	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 20:26	AYH
Benzo(k)fluoranthene	ND	0.17	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 20:26	AYH
Chrysene	1.7	0.17	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 20:26	AYH
Dibenz(a,h)anthracene	ND	0.17	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 20:26	AYH
Fluoranthene	0.66	0.17	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 20:26	AYH
Fluorene	ND	0.17	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 20:26	AYH
Indeno(1,2,3-cd)pyrene	ND	0.17	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 20:26	AYH
2-Methylnaphthalene	ND	0.17	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 20:26	AYH
Naphthalene	ND	0.17	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 20:26	AYH
Phenanthrene	0.34	0.17	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 20:26	AYH
Pyrene	0.66	0.17	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 20:26	AYH

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Chlorooctadecane (COD)	76.6	40-140		9/17/21 20:26
o-Terphenyl (OTP)	93.3	40-140		9/17/21 20:26
2-Bromonaphthalene	125	40-140		9/17/21 20:26
2-Fluorobiphenyl	126	40-140		9/17/21 20:26

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0471

Date Received: 9/9/2021

Field Sample #: 1543210908-07 | Sampled: 9/8/2021 10:27

Sample ID: 21I0471-07

Sample Matrix: Soil

Metals Analyses (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Arsenic	7.5	5.7	mg/Kg dry	1		SW-846 6010D	9/15/21	9/15/21 16:21	QNW
Cadmium	ND	0.57	mg/Kg dry	1		SW-846 6010D	9/15/21	9/15/21 16:21	QNW
Chromium	24	1.1	mg/Kg dry	1		SW-846 6010D	9/15/21	9/15/21 16:21	QNW
Copper	14	1.1	mg/Kg dry	1		SW-846 6010D	9/15/21	9/15/21 16:21	QNW
Lead	26	0.86	mg/Kg dry	1		SW-846 6010D	9/15/21	9/15/21 16:21	QNW
Mercury	ND	0.044	mg/Kg dry	1		SW-846 7471B	9/10/21	9/13/21 14:57	DRL
Nickel	17	1.1	mg/Kg dry	1		SW-846 6010D	9/15/21	9/15/21 16:21	QNW
Zinc	60	1.1	mg/Kg dry	1		SW-846 6010D	9/15/21	9/15/21 16:21	QNW

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0471

Date Received: 9/9/2021

Field Sample #: 1543210908-07 | Sampled: 9/8/2021 10:27

Sample ID: 21I0471-07

Sample Matrix: Soil

Conventional Chemistry Parameters by EPA/APHA/SW-846 Methods (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
% Solids	57.2		% Wt	1	R-02	SM 2540G	9/10/21	9/13/21 9:51	CJV
Total Organic Carbon	20000	100	mg/Kg	1		SW 846 9060A	9/13/21	9/13/21 23:33	DJM

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0471

Date Received: 9/9/2021

Field Sample #: 1543210908-08 | Sampled: 9/8/2021 11:04

Sample ID: 21I0471-08

Sample Matrix: Soil

Volatile Organic Compounds by GC/MS

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Acetone	ND	0.085	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
tert-Amyl Methyl Ether (TAME)	ND	0.00085	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
Benzene	ND	0.0017	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
Bromobenzene	ND	0.0017	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
Bromochloromethane	ND	0.0017	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
Bromodichloromethane	ND	0.0017	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
Bromoform	ND	0.0017	mg/Kg dry	1	V-05	SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
Bromomethane	ND	0.0085	mg/Kg dry	1	V-34	SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
2-Butanone (MEK)	ND	0.034	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
n-Butylbenzene	ND	0.0017	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
sec-Butylbenzene	ND	0.0017	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
tert-Butylbenzene	ND	0.0017	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
tert-Butyl Ethyl Ether (TBEE)	ND	0.00085	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
Carbon Disulfide	ND	0.0051	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
Carbon Tetrachloride	ND	0.0017	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
Chlorobenzene	ND	0.0017	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
Chlorodibromomethane	ND	0.00085	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
Chloroethane	ND	0.0085	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
Chloroform	ND	0.0034	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
Chloromethane	ND	0.0085	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
2-Chlorotoluene	ND	0.0017	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
4-Chlorotoluene	ND	0.0017	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
1,2-Dibromo-3-chloropropane (DBCP)	ND	0.0034	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
1,2-Dibromoethane (EDB)	ND	0.00085	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
Dibromomethane	ND	0.0017	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
1,2-Dichlorobenzene	ND	0.0017	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
1,3-Dichlorobenzene	ND	0.0017	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
1,4-Dichlorobenzene	ND	0.0017	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
Dichlorodifluoromethane (Freon 12)	ND	0.0085	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
1,1-Dichloroethane	ND	0.0017	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
1,2-Dichloroethane	ND	0.0017	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
1,1-Dichloroethylene	ND	0.0034	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
cis-1,2-Dichloroethylene	ND	0.0017	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
trans-1,2-Dichloroethylene	ND	0.0017	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
1,2-Dichloropropane	ND	0.0017	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
1,3-Dichloropropane	ND	0.00085	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
2,2-Dichloropropane	ND	0.0017	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
1,1-Dichloropropene	ND	0.0017	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
cis-1,3-Dichloropropene	ND	0.00085	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
trans-1,3-Dichloropropene	ND	0.00085	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
Diethyl Ether	ND	0.0085	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
Diisopropyl Ether (DIPE)	ND	0.00085	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
1,4-Dioxane	ND	0.085	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
Ethylbenzene	ND	0.0034	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0471

Date Received: 9/9/2021

Field Sample #: 1543210908-08 | Sampled: 9/8/2021 11:04

Sample ID: 21I0471-08

Sample Matrix: Soil

Volatile Organic Compounds by GC/MS

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Hexachlorobutadiene	ND	0.0017	mg/Kg dry	1	V-05	SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
2-Hexanone (MBK)	ND	0.017	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
Isopropylbenzene (Cumene)	ND	0.0017	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
p-Isopropyltoluene (p-Cymene)	ND	0.0017	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
Methyl tert-Butyl Ether (MTBE)	ND	0.0034	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
Methylene Chloride	ND	0.0085	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
4-Methyl-2-pentanone (MIBK)	ND	0.017	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
Naphthalene	ND	0.0034	mg/Kg dry	1	V-05	SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
n-Propylbenzene	ND	0.0017	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
Styrene	ND	0.0017	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
1,1,1,2-Tetrachloroethane	ND	0.0017	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
1,1,2,2-Tetrachloroethane	ND	0.00085	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
Tetrachloroethylene	ND	0.0017	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
Tetrahydrofuran	ND	0.0085	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
Toluene	ND	0.0034	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
1,2,3-Trichlorobenzene	ND	0.0017	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
1,2,4-Trichlorobenzene	ND	0.0017	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
1,1,1-Trichloroethane	ND	0.0017	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
1,1,2-Trichloroethane	ND	0.0017	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
Trichloroethylene	ND	0.0017	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
Trichlorofluoromethane (Freon 11)	ND	0.0085	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
1,2,3-Trichloropropane	ND	0.0017	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
1,2,4-Trimethylbenzene	ND	0.0017	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
1,3,5-Trimethylbenzene	ND	0.0017	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
Vinyl Chloride	ND	0.0085	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
m+p Xylene	ND	0.0068	mg/Kg dry	1	V-05	SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF
o-Xylene	ND	0.0034	mg/Kg dry	1		SW-846 8260C-D	9/10/21	9/10/21 15:37	MFF

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
1,2-Dichloroethane-d4	107	70-130		9/10/21 15:37
Toluene-d8	103	70-130		9/10/21 15:37
4-Bromofluorobenzene	92.6	70-130		9/10/21 15:37

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0471

Date Received: 9/9/2021

Field Sample #: 1543210908-08 | Sampled: 9/8/2021 11:04

Sample ID: 21I0471-08

Sample Matrix: Soil

Semivolatile Organic Compounds by GC/MS

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Acenaphthene	ND	0.25	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 19:47	IMR
Acenaphthylene	ND	0.25	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 19:47	IMR
Anthracene	ND	0.25	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 19:47	IMR
Benzo(a)anthracene	ND	0.25	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 19:47	IMR
Benzo(a)pyrene	ND	0.25	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 19:47	IMR
Benzo(b)fluoranthene	ND	0.25	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 19:47	IMR
Benzo(g,h,i)perylene	ND	0.25	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 19:47	IMR
Benzo(k)fluoranthene	ND	0.25	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 19:47	IMR
Chrysene	ND	0.25	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 19:47	IMR
Dibenz(a,h)anthracene	ND	0.25	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 19:47	IMR
Fluoranthene	ND	0.25	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 19:47	IMR
Fluorene	ND	0.25	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 19:47	IMR
Indeno(1,2,3-cd)pyrene	ND	0.25	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 19:47	IMR
2-Methylnaphthalene	ND	0.25	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 19:47	IMR
Naphthalene	ND	0.25	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 19:47	IMR
Phenanthrene	ND	0.25	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 19:47	IMR
Pyrene	ND	0.25	mg/Kg dry	1		SW-846 8270D-E	9/10/21	9/13/21 19:47	IMR

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Nitrobenzene-d5	61.2	30-130		9/13/21 19:47
2-Fluorobiphenyl	62.6	30-130		9/13/21 19:47
p-Terphenyl-d14	85.1	30-130		9/13/21 19:47

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0471

Date Received: 9/9/2021

Field Sample #: 1543210908-08 | Sampled: 9/8/2021 11:04

Sample ID: 21I0471-08

Sample Matrix: Soil

Sample Flags: DL-03

Organochloride Pesticides by GC/ECD

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Aldrin [1]	ND	0.072	mg/Kg dry	10		SW-846 8081B	9/10/21	9/17/21 13:10	TG
alpha-BHC [1]	ND	0.072	mg/Kg dry	10		SW-846 8081B	9/10/21	9/17/21 13:10	TG
beta-BHC [1]	ND	0.072	mg/Kg dry	10		SW-846 8081B	9/10/21	9/17/21 13:10	TG
delta-BHC [1]	ND	0.072	mg/Kg dry	10		SW-846 8081B	9/10/21	9/17/21 13:10	TG
gamma-BHC (Lindane) [1]	ND	0.029	mg/Kg dry	10		SW-846 8081B	9/10/21	9/17/21 13:10	TG
Chlordane [1]	ND	0.29	mg/Kg dry	10		SW-846 8081B	9/10/21	9/17/21 13:10	TG
4,4'-DDD [1]	ND	0.058	mg/Kg dry	10		SW-846 8081B	9/10/21	9/17/21 13:10	TG
4,4'-DDE [1]	ND	0.058	mg/Kg dry	10		SW-846 8081B	9/10/21	9/17/21 13:10	TG
4,4'-DDT [1]	ND	0.058	mg/Kg dry	10		SW-846 8081B	9/10/21	9/17/21 13:10	TG
Dieldrin [1]	ND	0.058	mg/Kg dry	10		SW-846 8081B	9/10/21	9/17/21 13:10	TG
Endosulfan I [1]	ND	0.072	mg/Kg dry	10		SW-846 8081B	9/10/21	9/17/21 13:10	TG
Endosulfan II [1]	ND	0.12	mg/Kg dry	10		SW-846 8081B	9/10/21	9/17/21 13:10	TG
Endosulfan sulfate [1]	ND	0.12	mg/Kg dry	10		SW-846 8081B	9/10/21	9/17/21 13:10	TG
Endrin [1]	ND	0.12	mg/Kg dry	10		SW-846 8081B	9/10/21	9/17/21 13:10	TG
Endrin ketone [1]	ND	0.12	mg/Kg dry	10		SW-846 8081B	9/10/21	9/17/21 13:10	TG
Heptachlor [1]	ND	0.072	mg/Kg dry	10		SW-846 8081B	9/10/21	9/17/21 13:10	TG
Heptachlor epoxide [1]	ND	0.072	mg/Kg dry	10		SW-846 8081B	9/10/21	9/17/21 13:10	TG
Hexachlorobenzene [1]	ND	0.087	mg/Kg dry	10		SW-846 8081B	9/10/21	9/17/21 13:10	TG
Methoxychlor [1]	ND	0.72	mg/Kg dry	10		SW-846 8081B	9/10/21	9/17/21 13:10	TG

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Decachlorobiphenyl [1]	90.5	30-150		9/17/21 13:10
Decachlorobiphenyl [2]	103	30-150		9/17/21 13:10
Tetrachloro-m-xylene [1]	77.1	30-150		9/17/21 13:10
Tetrachloro-m-xylene [2]	78.6	30-150		9/17/21 13:10

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0471

Date Received: 9/9/2021

Field Sample #: 1543210908-08 | Sampled: 9/8/2021 11:04

Sample ID: 21I0471-08

Sample Matrix: Soil

Sample Flags: O-32

Polychlorinated Biphenyls By GC/ECD

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Aroclor-1016 [1]	ND	0.12	mg/Kg dry	4		SW-846 8082A	9/10/21	9/15/21 23:07	TG
Aroclor-1221 [1]	ND	0.12	mg/Kg dry	4		SW-846 8082A	9/10/21	9/15/21 23:07	TG
Aroclor-1232 [1]	ND	0.12	mg/Kg dry	4		SW-846 8082A	9/10/21	9/15/21 23:07	TG
Aroclor-1242 [1]	ND	0.12	mg/Kg dry	4		SW-846 8082A	9/10/21	9/15/21 23:07	TG
Aroclor-1248 [1]	ND	0.12	mg/Kg dry	4		SW-846 8082A	9/10/21	9/15/21 23:07	TG
Aroclor-1254 [1]	ND	0.12	mg/Kg dry	4		SW-846 8082A	9/10/21	9/15/21 23:07	TG
Aroclor-1260 [1]	ND	0.12	mg/Kg dry	4		SW-846 8082A	9/10/21	9/15/21 23:07	TG
Aroclor-1262 [1]	ND	0.12	mg/Kg dry	4		SW-846 8082A	9/10/21	9/15/21 23:07	TG
Aroclor-1268 [1]	ND	0.12	mg/Kg dry	4		SW-846 8082A	9/10/21	9/15/21 23:07	TG

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Decachlorobiphenyl [1]	95.8	30-150		9/15/21 23:07
Decachlorobiphenyl [2]	102	30-150		9/15/21 23:07
Tetrachloro-m-xylene [1]	88.8	30-150		9/15/21 23:07
Tetrachloro-m-xylene [2]	93.1	30-150		9/15/21 23:07

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0471

Date Received: 9/9/2021

Field Sample #: 1543210908-08 | Sampled: 9/8/2021 11:04

Sample ID: 21I0471-08

Sample Matrix: Soil

Herbicides by GC/ECD

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
2,4-D [1]	ND	140	µg/kg dry	4		SW-846 8151A	9/13/21	9/17/21 23:19	JMB
2,4-DB [1]	ND	140	µg/kg dry	4		SW-846 8151A	9/13/21	9/17/21 23:19	JMB
2,4,5-TP (Silvex) [1]	ND	14	µg/kg dry	4		SW-846 8151A	9/13/21	9/17/21 23:19	JMB
2,4,5-T [1]	ND	14	µg/kg dry	4		SW-846 8151A	9/13/21	9/17/21 23:19	JMB
Dalalpon [1]	ND	360	µg/kg dry	4	V-20	SW-846 8151A	9/13/21	9/17/21 23:19	JMB
Dicamba [1]	ND	14	µg/kg dry	4		SW-846 8151A	9/13/21	9/17/21 23:19	JMB
Dichloroprop [1]	ND	140	µg/kg dry	4		SW-846 8151A	9/13/21	9/17/21 23:19	JMB
Dinoseb [1]	ND	72	µg/kg dry	4		SW-846 8151A	9/13/21	9/17/21 23:19	JMB
MCPA [1]	ND	14000	µg/kg dry	4		SW-846 8151A	9/13/21	9/17/21 23:19	JMB
MCPP [1]	ND	14000	µg/kg dry	4		SW-846 8151A	9/13/21	9/17/21 23:19	JMB

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
2,4-Dichlorophenylacetic acid [1]	84.6	30-150		9/17/21 23:19
2,4-Dichlorophenylacetic acid [2]	68.2	30-150		9/17/21 23:19

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0471

Date Received: 9/9/2021

Field Sample #: 1543210908-08 | Sampled: 9/8/2021 11:04

Sample ID: 21I0471-08

Sample Matrix: Soil

Petroleum Hydrocarbons Analyses - EPH

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
C9-C18 Aliphatics	ND	14	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 20:45	AYH
C19-C36 Aliphatics	30	14	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 20:45	AYH
Unadjusted C11-C22 Aromatics	20	14	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 20:45	AYH
C11-C22 Aromatics	17	14	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 20:45	AYH
Acenaphthene	ND	0.14	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 20:45	AYH
Acenaphthylene	ND	0.14	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 20:45	AYH
Anthracene	ND	0.14	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 20:45	AYH
Benzo(a)anthracene	0.42	0.14	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 20:45	AYH
Benzo(a)pyrene	1.1	0.14	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 20:45	AYH
Benzo(b)fluoranthene	ND	0.14	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 20:45	AYH
Benzo(g,h,i)perylene	ND	0.14	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 20:45	AYH
Benzo(k)fluoranthene	ND	0.14	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 20:45	AYH
Chrysene	0.40	0.14	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 20:45	AYH
Dibenz(a,h)anthracene	ND	0.14	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 20:45	AYH
Fluoranthene	0.51	0.14	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 20:45	AYH
Fluorene	ND	0.14	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 20:45	AYH
Indeno(1,2,3-cd)pyrene	ND	0.14	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 20:45	AYH
2-Methylnaphthalene	ND	0.14	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 20:45	AYH
Naphthalene	ND	0.14	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 20:45	AYH
Phenanthrene	0.27	0.14	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 20:45	AYH
Pyrene	0.42	0.14	mg/Kg dry	1		MADEP EPH rev 2.1	9/10/21	9/17/21 20:45	AYH

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Chlorooctadecane (COD)	66.3	40-140		9/17/21 20:45
o-Terphenyl (OTP)	77.5	40-140		9/17/21 20:45
2-Bromonaphthalene	117	40-140		9/17/21 20:45
2-Fluorobiphenyl	119	40-140		9/17/21 20:45

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0471

Date Received: 9/9/2021

Field Sample #: 1543210908-08 | Sampled: 9/8/2021 11:04

Sample ID: 21I0471-08

Sample Matrix: Soil

Metals Analyses (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Arsenic	ND	4.7	mg/Kg dry	1		SW-846 6010D	9/15/21	9/15/21 16:28	QNW
Cadmium	ND	0.47	mg/Kg dry	1		SW-846 6010D	9/15/21	9/15/21 16:28	QNW
Chromium	12	0.95	mg/Kg dry	1		SW-846 6010D	9/15/21	9/15/21 16:28	QNW
Copper	5.7	0.95	mg/Kg dry	1		SW-846 6010D	9/15/21	9/15/21 16:28	QNW
Lead	11	0.71	mg/Kg dry	1		SW-846 6010D	9/15/21	9/15/21 16:28	QNW
Mercury	ND	0.038	mg/Kg dry	1		SW-846 7471B	9/10/21	9/13/21 14:58	DRL
Nickel	7.2	0.95	mg/Kg dry	1		SW-846 6010D	9/15/21	9/15/21 16:28	QNW
Zinc	31	0.95	mg/Kg dry	1		SW-846 6010D	9/15/21	9/15/21 16:28	QNW

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0471

Date Received: 9/9/2021

Field Sample #: 1543210908-08 | Sampled: 9/8/2021 11:04

Sample ID: 21I0471-08

Sample Matrix: Soil

Conventional Chemistry Parameters by EPA/APHA/SW-846 Methods (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
% Solids	69.0		% Wt	1		SM 2540G	9/10/21	9/13/21 9:51	CJV
Total Organic Carbon	9100	100	mg/Kg	1		SW 846 9060A	9/13/21	9/13/21 23:48	DJM

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Sample Extraction Data

Prep Method: SW-846 3546 **Analytical Method: MADEP EPH rev 2.1**

Lab Number [Field ID]	Batch	Initial [g]	Final [mL]	Date
21I0471-02 [1543210907-02]	B289959	20.0	2.00	09/10/21
21I0471-03 [1543210907-03]	B289959	20.0	2.00	09/10/21
21I0471-04 [1543210907-04]	B289959	20.0	2.00	09/10/21
21I0471-05 [1543210907-05]	B289959	20.0	2.00	09/10/21
21I0471-07 [1543210908-07]	B289959	20.0	2.00	09/10/21
21I0471-08 [1543210908-08]	B289959	20.0	2.00	09/10/21

Prep Method: % Solids **Analytical Method: SM 2540G**

Lab Number [Field ID]	Batch	Date
21I0471-02 [1543210907-02]	B289999	09/10/21
21I0471-03 [1543210907-03]	B289999	09/10/21
21I0471-04 [1543210907-04]	B289999	09/10/21
21I0471-05 [1543210907-05]	B289999	09/10/21
21I0471-07 [1543210908-07]	B289999	09/10/21
21I0471-08 [1543210908-08]	B289999	09/10/21

SW 846 9060A

Lab Number [Field ID]	Batch	Initial [g]	Final [mL]	Date
21I0471-02 [1543210907-02]	B290031	1.00	1.00	09/13/21
21I0471-03 [1543210907-03]	B290031	1.00	1.00	09/13/21
21I0471-04 [1543210907-04]	B290031	1.00	1.00	09/13/21
21I0471-05 [1543210907-05]	B290031	1.00	1.00	09/13/21
21I0471-07 [1543210908-07]	B290031	1.00	1.00	09/13/21
21I0471-08 [1543210908-08]	B290031	1.00	1.00	09/13/21

Prep Method: SW-846 3050B **Analytical Method: SW-846 6010D**

Lab Number [Field ID]	Batch	Initial [g]	Final [mL]	Date
21I0471-02 [1543210907-02]	B290223	1.57	50.0	09/15/21
21I0471-03 [1543210907-03]	B290223	1.51	50.0	09/15/21
21I0471-04 [1543210907-04]	B290223	1.53	50.0	09/15/21
21I0471-05 [1543210907-05]	B290223	1.51	50.0	09/15/21
21I0471-07 [1543210908-07]	B290223	1.53	50.0	09/15/21
21I0471-08 [1543210908-08]	B290223	1.52	50.0	09/15/21

Prep Method: SW-846 7471 **Analytical Method: SW-846 7471B**

Lab Number [Field ID]	Batch	Initial [g]	Final [mL]	Date
21I0471-02 [1543210907-02]	B289988	0.584	50.0	09/10/21

Prep Method: SW-846 7471 **Analytical Method: SW-846 7471B**

Lab Number [Field ID]	Batch	Initial [g]	Final [mL]	Date
21I0471-03 [1543210907-03]	B289989	0.578	50.0	09/10/21
21I0471-04 [1543210907-04]	B289989	0.567	50.0	09/10/21
21I0471-05 [1543210907-05]	B289989	0.540	50.0	09/10/21
21I0471-07 [1543210908-07]	B289989	0.600	50.0	09/10/21

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Sample Extraction Data

Prep Method: SW-846 7471 **Analytical Method: SW-846 7471B**

Lab Number [Field ID]	Batch	Initial [g]	Final [mL]	Date
21I0471-08 [1543210908-08]	B289989	0.571	50.0	09/10/21

Prep Method: SW-846 3546 **Analytical Method: SW-846 8081B**

Lab Number [Field ID]	Batch	Initial [g]	Final [mL]	Date
21I0471-02 [1543210907-02]	B289958	10.0	10.0	09/10/21
21I0471-03 [1543210907-03]	B289958	10.0	10.0	09/10/21
21I0471-04 [1543210907-04]	B289958	10.0	10.0	09/10/21
21I0471-05 [1543210907-05]	B289958	10.0	10.0	09/10/21
21I0471-07 [1543210908-07]	B289958	10.0	10.0	09/10/21
21I0471-08 [1543210908-08]	B289958	10.0	10.0	09/10/21

Prep Method: SW-846 3546 **Analytical Method: SW-846 8082A**

Lab Number [Field ID]	Batch	Initial [g]	Final [mL]	Date
21I0471-02 [1543210907-02]	B289957	10.0	10.0	09/10/21
21I0471-03 [1543210907-03]	B289957	10.0	10.0	09/10/21
21I0471-04 [1543210907-04]	B289957	10.0	10.0	09/10/21
21I0471-05 [1543210907-05]	B289957	10.0	10.0	09/10/21
21I0471-07 [1543210908-07]	B289957	10.0	10.0	09/10/21
21I0471-08 [1543210908-08]	B289957	10.0	10.0	09/10/21

Prep Method: SW-846 8151 **Analytical Method: SW-846 8151A**

Lab Number [Field ID]	Batch	Initial [g]	Final [mL]	Date
21I0471-02 [1543210907-02]	B290112	20.0	5.00	09/13/21
21I0471-03 [1543210907-03]	B290112	20.0	5.00	09/13/21
21I0471-04 [1543210907-04]	B290112	20.0	5.00	09/13/21
21I0471-05 [1543210907-05]	B290112	20.0	5.00	09/13/21
21I0471-07 [1543210908-07]	B290112	20.0	5.00	09/13/21
21I0471-08 [1543210908-08]	B290112	20.0	5.00	09/13/21

Prep Method: SW-846 5035 **Analytical Method: SW-846 8260C-D**

Lab Number [Field ID]	Batch	Sample Amount(g)	Methanol Volume(mL)	Methanol Aliquot(mL)	Final Volume(mL)	Date
21I0471-02 [1543210907-02]	B289949	6.01	8.16	1	50	09/10/21
21I0471-03 [1543210907-03]	B289949	6.66	7.37	1	50	09/10/21

Prep Method: SW-846 5035 **Analytical Method: SW-846 8260C-D**

Lab Number [Field ID]	Batch	Initial [g]	Final [mL]	Date
21I0471-01 [1543210907-01]	B289971	5.00	10.0	09/10/21
21I0471-04 [1543210907-04]	B289971	6.75	10.0	09/10/21
21I0471-05 [1543210907-05]	B289971	7.80	10.0	09/10/21
21I0471-06 [1543210908-06]	B289971	5.00	10.0	09/10/21
21I0471-07 [1543210908-07]	B289971	6.70	10.0	09/10/21
21I0471-08 [1543210908-08]	B289971	8.55	10.0	09/10/21

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Sample Extraction Data

Prep Method: SW-846 3546 **Analytical Method: SW-846 8270D-E**

Lab Number [Field ID]	Batch	Initial [g]	Final [mL]	Date
21I0471-02 [1543210907-02]	B289965	30.0	1.00	09/10/21
21I0471-03 [1543210907-03]	B289965	30.0	1.00	09/10/21
21I0471-04 [1543210907-04]	B289965	30.0	1.00	09/10/21
21I0471-05 [1543210907-05]	B289965	30.0	1.00	09/10/21
21I0471-05RE1 [1543210907-05]	B289965	30.0	1.00	09/10/21
21I0471-07 [1543210908-07]	B289965	30.0	1.00	09/10/21
21I0471-08 [1543210908-08]	B289965	30.0	1.00	09/10/21

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QUALITY CONTROL

Volatile Organic Compounds by GC/MS - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B289949 - SW-846 5035										
Blank (B289949-BLK1)				Prepared & Analyzed: 09/10/21						
Acetone	ND	2.5	mg/Kg wet							
tert-Amyl Methyl Ether (TAME)	ND	0.025	mg/Kg wet							
Benzene	ND	0.050	mg/Kg wet							
Bromobenzene	ND	0.050	mg/Kg wet							
Bromochloromethane	ND	0.050	mg/Kg wet							
Bromodichloromethane	ND	0.050	mg/Kg wet							
Bromoform	ND	0.050	mg/Kg wet							
Bromomethane	ND	0.10	mg/Kg wet							V-05
2-Butanone (MEK)	ND	1.0	mg/Kg wet							
n-Butylbenzene	ND	0.050	mg/Kg wet							
sec-Butylbenzene	ND	0.050	mg/Kg wet							
tert-Butylbenzene	ND	0.050	mg/Kg wet							
tert-Butyl Ethyl Ether (TBEE)	ND	0.025	mg/Kg wet							
Carbon Disulfide	ND	0.50	mg/Kg wet							
Carbon Tetrachloride	ND	0.050	mg/Kg wet							
Chlorobenzene	ND	0.050	mg/Kg wet							
Chlorodibromomethane	ND	0.025	mg/Kg wet							
Chloroethane	ND	0.10	mg/Kg wet							
Chloroform	ND	0.10	mg/Kg wet							
Chloromethane	ND	0.10	mg/Kg wet							
2-Chlorotoluene	ND	0.050	mg/Kg wet							
4-Chlorotoluene	ND	0.050	mg/Kg wet							
1,2-Dibromo-3-chloropropane (DBCP)	ND	0.20	mg/Kg wet							
1,2-Dibromoethane (EDB)	ND	0.025	mg/Kg wet							
Dibromomethane	ND	0.050	mg/Kg wet							
1,2-Dichlorobenzene	ND	0.050	mg/Kg wet							
1,3-Dichlorobenzene	ND	0.050	mg/Kg wet							
1,4-Dichlorobenzene	ND	0.050	mg/Kg wet							
Dichlorodifluoromethane (Freon 12)	ND	0.10	mg/Kg wet							
1,1-Dichloroethane	ND	0.050	mg/Kg wet							
1,2-Dichloroethane	ND	0.050	mg/Kg wet							
1,1-Dichloroethylene	ND	0.050	mg/Kg wet							
cis-1,2-Dichloroethylene	ND	0.050	mg/Kg wet							
trans-1,2-Dichloroethylene	ND	0.050	mg/Kg wet							
1,2-Dichloropropane	ND	0.050	mg/Kg wet							
1,3-Dichloropropane	ND	0.025	mg/Kg wet							
2,2-Dichloropropane	ND	0.050	mg/Kg wet							
1,1-Dichloropropene	ND	0.10	mg/Kg wet							
cis-1,3-Dichloropropene	ND	0.025	mg/Kg wet							
trans-1,3-Dichloropropene	ND	0.025	mg/Kg wet							
Diethyl Ether	ND	0.10	mg/Kg wet							
Diisopropyl Ether (DIPE)	ND	0.025	mg/Kg wet							
1,4-Dioxane	ND	2.5	mg/Kg wet							
Ethylbenzene	ND	0.050	mg/Kg wet							
Hexachlorobutadiene	ND	0.050	mg/Kg wet							
2-Hexanone (MBK)	ND	0.50	mg/Kg wet							
Isopropylbenzene (Cumene)	ND	0.050	mg/Kg wet							
p-Isopropyltoluene (p-Cymene)	ND	0.050	mg/Kg wet							
Methyl tert-Butyl Ether (MTBE)	ND	0.050	mg/Kg wet							
Methylene Chloride	ND	0.25	mg/Kg wet							
4-Methyl-2-pentanone (MIBK)	ND	0.50	mg/Kg wet							
Naphthalene	ND	0.10	mg/Kg wet							V-05

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QUALITY CONTROL

Volatile Organic Compounds by GC/MS - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes	
Batch B289949 - SW-846 5035											
Blank (B289949-BLK1)				Prepared & Analyzed: 09/10/21							
n-Propylbenzene	ND	0.050	mg/Kg wet								
Styrene	ND	0.050	mg/Kg wet								
1,1,1,2-Tetrachloroethane	ND	0.050	mg/Kg wet								
1,1,2,2-Tetrachloroethane	ND	0.025	mg/Kg wet								
Tetrachloroethylene	ND	0.050	mg/Kg wet								
Tetrahydrofuran	ND	0.20	mg/Kg wet								
Toluene	ND	0.050	mg/Kg wet								
1,2,3-Trichlorobenzene	ND	0.20	mg/Kg wet							V-05	
1,2,4-Trichlorobenzene	ND	0.050	mg/Kg wet								
1,1,1-Trichloroethane	ND	0.050	mg/Kg wet								
1,1,2-Trichloroethane	ND	0.050	mg/Kg wet								
Trichloroethylene	ND	0.050	mg/Kg wet								
Trichlorofluoromethane (Freon 11)	ND	0.10	mg/Kg wet								
1,2,3-Trichloropropane	ND	0.10	mg/Kg wet								
1,2,4-Trimethylbenzene	ND	0.050	mg/Kg wet								
1,3,5-Trimethylbenzene	ND	0.050	mg/Kg wet								
Vinyl Chloride	ND	0.10	mg/Kg wet								
m+p Xylene	ND	0.10	mg/Kg wet								
o-Xylene	ND	0.050	mg/Kg wet								
Surrogate: 1,2-Dichloroethane-d4	*0.0268*		mg/Kg wet	0.0250		107	70-130				
Surrogate: Toluene-d8	*0.0276*		mg/Kg wet	0.0250		111	70-130				
Surrogate: 4-Bromofluorobenzene	*0.0270*		mg/Kg wet	0.0250		108	70-130				
LCS (B289949-BS1)				Prepared & Analyzed: 09/10/21							
Acetone	0.103	0.057	mg/Kg wet	0.113		90.8	40-160				†
tert-Amyl Methyl Ether (TAME)	0.0108	0.00057	mg/Kg wet	0.0113		95.4	70-130				
Benzene	0.0108	0.0011	mg/Kg wet	0.0113		95.6	70-130				
Bromobenzene	0.0113	0.0011	mg/Kg wet	0.0113		99.5	70-130				
Bromochloromethane	0.0107	0.0011	mg/Kg wet	0.0113		94.6	70-130				
Bromodichloromethane	0.0119	0.0011	mg/Kg wet	0.0113		105	70-130				
Bromoform	0.0123	0.0011	mg/Kg wet	0.0113		108	70-130				
Bromomethane	0.00957	0.0023	mg/Kg wet	0.0113		84.4	40-160			V-05	†
2-Butanone (MEK)	0.0976	0.023	mg/Kg wet	0.113		86.1	40-160				†
n-Butylbenzene	0.0106	0.0011	mg/Kg wet	0.0113		93.2	70-130				
sec-Butylbenzene	0.0113	0.0011	mg/Kg wet	0.0113		99.4	70-130				
tert-Butylbenzene	0.0117	0.0011	mg/Kg wet	0.0113		104	70-130				
tert-Butyl Ethyl Ether (TBEE)	0.0108	0.00057	mg/Kg wet	0.0113		94.9	70-130				
Carbon Disulfide	0.103	0.011	mg/Kg wet	0.113		91.1	70-130				
Carbon Tetrachloride	0.0122	0.0011	mg/Kg wet	0.0113		108	70-130				
Chlorobenzene	0.0125	0.0011	mg/Kg wet	0.0113		110	70-130				
Chlorodibromomethane	0.0125	0.00057	mg/Kg wet	0.0113		110	70-130				
Chloroethane	0.0115	0.0023	mg/Kg wet	0.0113		102	70-130				
Chloroform	0.0111	0.0023	mg/Kg wet	0.0113		97.7	70-130				
Chloromethane	0.0103	0.0023	mg/Kg wet	0.0113		90.8	40-160				†
2-Chlorotoluene	0.0118	0.0011	mg/Kg wet	0.0113		104	70-130				
4-Chlorotoluene	0.0120	0.0011	mg/Kg wet	0.0113		106	70-130				
1,2-Dibromo-3-chloropropane (DBCP)	0.00991	0.0045	mg/Kg wet	0.0113		87.4	70-130				
1,2-Dibromoethane (EDB)	0.0113	0.00057	mg/Kg wet	0.0113		100	70-130				
Dibromomethane	0.0114	0.0011	mg/Kg wet	0.0113		101	70-130				
1,2-Dichlorobenzene	0.0118	0.0011	mg/Kg wet	0.0113		104	70-130				
1,3-Dichlorobenzene	0.0116	0.0011	mg/Kg wet	0.0113		103	70-130				
1,4-Dichlorobenzene	0.0115	0.0011	mg/Kg wet	0.0113		101	70-130				

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QUALITY CONTROL

Volatile Organic Compounds by GC/MS - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes	
Batch B289949 - SW-846 5035											
LCS (B289949-BS1)				Prepared & Analyzed: 09/10/21							
Dichlorodifluoromethane (Freon 12)	0.00995	0.0023	mg/Kg wet	0.0113		87.8	40-160				†
1,1-Dichloroethane	0.0106	0.0011	mg/Kg wet	0.0113		93.4	70-130				
1,2-Dichloroethane	0.0123	0.0011	mg/Kg wet	0.0113		108	70-130				
1,1-Dichloroethylene	0.0106	0.0011	mg/Kg wet	0.0113		93.1	70-130				
cis-1,2-Dichloroethylene	0.0109	0.0011	mg/Kg wet	0.0113		96.2	70-130				
trans-1,2-Dichloroethylene	0.0104	0.0011	mg/Kg wet	0.0113		91.8	70-130				
1,2-Dichloropropane	0.0114	0.0011	mg/Kg wet	0.0113		101	70-130				
1,3-Dichloropropane	0.0114	0.00057	mg/Kg wet	0.0113		100	70-130				
2,2-Dichloropropane	0.0117	0.0011	mg/Kg wet	0.0113		103	70-130				
1,1-Dichloropropene	0.0112	0.0023	mg/Kg wet	0.0113		99.1	70-130				
cis-1,3-Dichloropropene	0.0124	0.00057	mg/Kg wet	0.0113		110	70-130				
trans-1,3-Dichloropropene	0.0122	0.00057	mg/Kg wet	0.0113		108	70-130				
Diethyl Ether	0.0102	0.0023	mg/Kg wet	0.0113		89.9	70-130				
Diisopropyl Ether (DIPE)	0.0100	0.00057	mg/Kg wet	0.0113		88.6	70-130				
1,4-Dioxane	0.118	0.057	mg/Kg wet	0.113		104	40-160				†
Ethylbenzene	0.0120	0.0011	mg/Kg wet	0.0113		106	70-130				
Hexachlorobutadiene	0.0130	0.0011	mg/Kg wet	0.0113		115	70-130				
2-Hexanone (MBK)	0.105	0.011	mg/Kg wet	0.113		92.3	40-160				†
Isopropylbenzene (Cumene)	0.0124	0.0011	mg/Kg wet	0.0113		110	70-130				
p-Isopropyltoluene (p-Cymene)	0.0115	0.0011	mg/Kg wet	0.0113		102	70-130				
Methyl tert-Butyl Ether (MTBE)	0.00997	0.0011	mg/Kg wet	0.0113		88.0	70-130				
Methylene Chloride	0.0102	0.0057	mg/Kg wet	0.0113		90.1	70-130				
4-Methyl-2-pentanone (MIBK)	0.108	0.011	mg/Kg wet	0.113		95.1	40-160				†
Naphthalene	0.00830	0.0023	mg/Kg wet	0.0113		73.2	70-130			V-05	
n-Propylbenzene	0.0118	0.0011	mg/Kg wet	0.0113		104	70-130				
Styrene	0.0128	0.0011	mg/Kg wet	0.0113		113	70-130				
1,1,1,2-Tetrachloroethane	0.0132	0.0011	mg/Kg wet	0.0113		117	70-130				
1,1,2,2-Tetrachloroethane	0.0121	0.00057	mg/Kg wet	0.0113		107	70-130				
Tetrachloroethylene	0.0133	0.0011	mg/Kg wet	0.0113		118	70-130				
Tetrahydrofuran	0.00954	0.0045	mg/Kg wet	0.0113		84.2	70-130				
Toluene	0.0120	0.0011	mg/Kg wet	0.0113		106	70-130				
1,2,3-Trichlorobenzene	0.00878	0.0045	mg/Kg wet	0.0113		77.5	70-130			V-05	
1,2,4-Trichlorobenzene	0.00967	0.0011	mg/Kg wet	0.0113		85.3	70-130				
1,1,1-Trichloroethane	0.0114	0.0011	mg/Kg wet	0.0113		101	70-130				
1,1,2-Trichloroethane	0.0119	0.0011	mg/Kg wet	0.0113		105	70-130				
Trichloroethylene	0.0113	0.0011	mg/Kg wet	0.0113		99.3	70-130				
Trichlorofluoromethane (Freon 11)	0.0112	0.0023	mg/Kg wet	0.0113		98.8	70-130				
1,2,3-Trichloropropane	0.0118	0.0023	mg/Kg wet	0.0113		104	70-130				
1,2,4-Trimethylbenzene	0.0113	0.0011	mg/Kg wet	0.0113		99.3	70-130				
1,3,5-Trimethylbenzene	0.0125	0.0011	mg/Kg wet	0.0113		110	70-130				
Vinyl Chloride	0.0110	0.0023	mg/Kg wet	0.0113		97.0	70-130				
m+p Xylene	0.0251	0.0023	mg/Kg wet	0.0227		111	70-130				
o-Xylene	0.0123	0.0011	mg/Kg wet	0.0113		108	70-130				
Surrogate: 1,2-Dichloroethane-d4	*0.0301*		mg/Kg wet	0.0283		106	70-130				
Surrogate: Toluene-d8	*0.0319*		mg/Kg wet	0.0283		113	70-130				
Surrogate: 4-Bromofluorobenzene	*0.0309*		mg/Kg wet	0.0283		109	70-130				

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QUALITY CONTROL

Volatile Organic Compounds by GC/MS - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes	
Batch B289949 - SW-846 5035											
LCS Dup (B289949-BSD1)				Prepared & Analyzed: 09/10/21							
Acetone	0.104	0.057	mg/Kg wet	0.113		91.6	40-160	0.855	20		†
tert-Amyl Methyl Ether (TAME)	0.0107	0.00057	mg/Kg wet	0.0113		94.1	70-130	1.37	20		
Benzene	0.0110	0.0011	mg/Kg wet	0.0113		97.0	70-130	1.45	20		
Bromobenzene	0.0115	0.0011	mg/Kg wet	0.0113		101	70-130	1.79	20		
Bromochloromethane	0.0109	0.0011	mg/Kg wet	0.0113		95.9	70-130	1.36	20		
Bromodichloromethane	0.0117	0.0011	mg/Kg wet	0.0113		104	70-130	1.34	20		
Bromoform	0.0129	0.0011	mg/Kg wet	0.0113		114	70-130	4.60	20		
Bromomethane	0.0104	0.0023	mg/Kg wet	0.0113		91.8	40-160	8.40	20	V-05	†
2-Butanone (MEK)	0.102	0.023	mg/Kg wet	0.113		90.3	40-160	4.73	20		†
n-Butylbenzene	0.0108	0.0011	mg/Kg wet	0.0113		94.9	70-130	1.81	20		
sec-Butylbenzene	0.0115	0.0011	mg/Kg wet	0.0113		102	70-130	2.48	20		
tert-Butylbenzene	0.0121	0.0011	mg/Kg wet	0.0113		107	70-130	2.95	20		
tert-Butyl Ethyl Ether (TBEE)	0.0107	0.00057	mg/Kg wet	0.0113		94.4	70-130	0.528	20		
Carbon Disulfide	0.104	0.011	mg/Kg wet	0.113		91.6	70-130	0.504	20		
Carbon Tetrachloride	0.0123	0.0011	mg/Kg wet	0.0113		109	70-130	1.11	20		
Chlorobenzene	0.0126	0.0011	mg/Kg wet	0.0113		111	70-130	1.08	20		
Chlorodibromomethane	0.0123	0.00057	mg/Kg wet	0.0113		108	70-130	1.83	20		
Chloroethane	0.0118	0.0023	mg/Kg wet	0.0113		104	70-130	2.34	20		
Chloroform	0.0112	0.0023	mg/Kg wet	0.0113		98.4	70-130	0.714	20		
Chloromethane	0.0107	0.0023	mg/Kg wet	0.0113		94.4	40-160	3.89	20		†
2-Chlorotoluene	0.0119	0.0011	mg/Kg wet	0.0113		105	70-130	0.574	20		
4-Chlorotoluene	0.0119	0.0011	mg/Kg wet	0.0113		105	70-130	0.757	20		
1,2-Dibromo-3-chloropropane (DBCP)	0.0109	0.0045	mg/Kg wet	0.0113		96.3	70-130	9.69	20		
1,2-Dibromoethane (EDB)	0.0118	0.00057	mg/Kg wet	0.0113		104	70-130	4.30	20		
Dibromomethane	0.0108	0.0011	mg/Kg wet	0.0113		95.7	70-130	5.39	20		
1,2-Dichlorobenzene	0.0122	0.0011	mg/Kg wet	0.0113		107	70-130	2.74	20		
1,3-Dichlorobenzene	0.0124	0.0011	mg/Kg wet	0.0113		109	70-130	6.04	20		
1,4-Dichlorobenzene	0.0122	0.0011	mg/Kg wet	0.0113		108	70-130	6.32	20		
Dichlorodifluoromethane (Freon 12)	0.0102	0.0023	mg/Kg wet	0.0113		90.4	40-160	2.92	20		†
1,1-Dichloroethane	0.0110	0.0011	mg/Kg wet	0.0113		97.3	70-130	4.09	20		
1,2-Dichloroethane	0.0122	0.0011	mg/Kg wet	0.0113		108	70-130	0.278	20		
1,1-Dichloroethylene	0.0112	0.0011	mg/Kg wet	0.0113		98.6	70-130	5.74	20		
cis-1,2-Dichloroethylene	0.0112	0.0011	mg/Kg wet	0.0113		98.5	70-130	2.36	20		
trans-1,2-Dichloroethylene	0.0100	0.0011	mg/Kg wet	0.0113		88.6	70-130	3.55	20		
1,2-Dichloropropane	0.0114	0.0011	mg/Kg wet	0.0113		101	70-130	0.0994	20		
1,3-Dichloropropane	0.0113	0.00057	mg/Kg wet	0.0113		100	70-130	0.399	20		
2,2-Dichloropropane	0.0121	0.0011	mg/Kg wet	0.0113		107	70-130	4.09	20		
1,1-Dichloropropene	0.0115	0.0023	mg/Kg wet	0.0113		101	70-130	2.10	20		
cis-1,3-Dichloropropene	0.0122	0.00057	mg/Kg wet	0.0113		108	70-130	1.47	20		
trans-1,3-Dichloropropene	0.0119	0.00057	mg/Kg wet	0.0113		105	70-130	2.63	20		
Diethyl Ether	0.0101	0.0023	mg/Kg wet	0.0113		89.2	70-130	0.782	20		
Diisopropyl Ether (DIPE)	0.0105	0.00057	mg/Kg wet	0.0113		92.3	70-130	4.09	20		
1,4-Dioxane	0.120	0.057	mg/Kg wet	0.113		106	40-160	2.20	20		†
Ethylbenzene	0.0122	0.0011	mg/Kg wet	0.0113		107	70-130	1.50	20		
Hexachlorobutadiene	0.0141	0.0011	mg/Kg wet	0.0113		125	70-130	8.36	20		
2-Hexanone (MBK)	0.108	0.011	mg/Kg wet	0.113		95.0	40-160	2.89	20		†
Isopropylbenzene (Cumene)	0.0126	0.0011	mg/Kg wet	0.0113		111	70-130	1.18	20		
p-Isopropyltoluene (p-Cymene)	0.0118	0.0011	mg/Kg wet	0.0113		104	70-130	1.85	20		
Methyl tert-Butyl Ether (MTBE)	0.0103	0.0011	mg/Kg wet	0.0113		91.1	70-130	3.46	20		
Methylene Chloride	0.0100	0.0057	mg/Kg wet	0.0113		88.3	70-130	2.02	20		
4-Methyl-2-pentanone (MIBK)	0.110	0.011	mg/Kg wet	0.113		97.1	40-160	2.02	20		†
Naphthalene	0.00831	0.0023	mg/Kg wet	0.0113		73.3	70-130	0.137	20	V-05	

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QUALITY CONTROL

Volatile Organic Compounds by GC/MS - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B289949 - SW-846 5035										
LCS Dup (B289949-BSD1)				Prepared & Analyzed: 09/10/21						
n-Propylbenzene	0.0120	0.0011	mg/Kg wet	0.0113		106	70-130	1.24	20	
Styrene	0.0128	0.0011	mg/Kg wet	0.0113		113	70-130	0.266	20	
1,1,1,2-Tetrachloroethane	0.0131	0.0011	mg/Kg wet	0.0113		116	70-130	0.947	20	
1,1,2,2-Tetrachloroethane	0.0122	0.00057	mg/Kg wet	0.0113		108	70-130	1.12	20	
Tetrachloroethylene	0.0130	0.0011	mg/Kg wet	0.0113		115	70-130	2.59	20	
Tetrahydrofuran	0.00997	0.0045	mg/Kg wet	0.0113		88.0	70-130	4.41	20	
Toluene	0.0119	0.0011	mg/Kg wet	0.0113		105	70-130	0.761	20	
1,2,3-Trichlorobenzene	0.00958	0.0045	mg/Kg wet	0.0113		84.5	70-130	8.64	20	V-05
1,2,4-Trichlorobenzene	0.0102	0.0011	mg/Kg wet	0.0113		89.8	70-130	5.14	20	
1,1,1-Trichloroethane	0.0118	0.0011	mg/Kg wet	0.0113		104	70-130	2.84	20	
1,1,2-Trichloroethane	0.0123	0.0011	mg/Kg wet	0.0113		108	70-130	3.19	20	
Trichloroethylene	0.0121	0.0011	mg/Kg wet	0.0113		107	70-130	7.28	20	
Trichlorofluoromethane (Freon 11)	0.0115	0.0023	mg/Kg wet	0.0113		102	70-130	3.09	20	
1,2,3-Trichloropropane	0.0104	0.0023	mg/Kg wet	0.0113		92.2	70-130	11.7	20	
1,2,4-Trimethylbenzene	0.0119	0.0011	mg/Kg wet	0.0113		105	70-130	5.58	20	
1,3,5-Trimethylbenzene	0.0126	0.0011	mg/Kg wet	0.0113		111	70-130	0.995	20	
Vinyl Chloride	0.0110	0.0023	mg/Kg wet	0.0113		97.3	70-130	0.309	20	
m+p Xylene	0.0252	0.0023	mg/Kg wet	0.0227		111	70-130	0.496	20	
o-Xylene	0.0123	0.0011	mg/Kg wet	0.0113		108	70-130	0.277	20	
Surrogate: 1,2-Dichloroethane-d4	*0.0307*		mg/Kg wet	0.0283		108	70-130			
Surrogate: Toluene-d8	*0.0309*		mg/Kg wet	0.0283		109	70-130			
Surrogate: 4-Bromofluorobenzene	*0.0310*		mg/Kg wet	0.0283		109	70-130			
Batch B289971 - SW-846 5035										
Blank (B289971-BLK1)				Prepared & Analyzed: 09/10/21						
Acetone	ND	0.10	mg/Kg wet							
tert-Amyl Methyl Ether (TAME)	ND	0.0010	mg/Kg wet							
Benzene	ND	0.0020	mg/Kg wet							
Bromobenzene	ND	0.0020	mg/Kg wet							
Bromochloromethane	ND	0.0020	mg/Kg wet							
Bromodichloromethane	ND	0.0020	mg/Kg wet							
Bromoform	ND	0.0020	mg/Kg wet							V-05
Bromomethane	ND	0.010	mg/Kg wet							V-34
2-Butanone (MEK)	ND	0.040	mg/Kg wet							
n-Butylbenzene	ND	0.0020	mg/Kg wet							
sec-Butylbenzene	ND	0.0020	mg/Kg wet							
tert-Butylbenzene	ND	0.0020	mg/Kg wet							
tert-Butyl Ethyl Ether (TBEE)	ND	0.0010	mg/Kg wet							
Carbon Disulfide	ND	0.0060	mg/Kg wet							
Carbon Tetrachloride	ND	0.0020	mg/Kg wet							
Chlorobenzene	ND	0.0020	mg/Kg wet							
Chlorodibromomethane	ND	0.0010	mg/Kg wet							
Chloroethane	ND	0.010	mg/Kg wet							
Chloroform	ND	0.0040	mg/Kg wet							
Chloromethane	ND	0.010	mg/Kg wet							
2-Chlorotoluene	ND	0.0020	mg/Kg wet							
4-Chlorotoluene	ND	0.0020	mg/Kg wet							
1,2-Dibromo-3-chloropropane (DBCP)	ND	0.0020	mg/Kg wet							
1,2-Dibromoethane (EDB)	ND	0.0010	mg/Kg wet							
Dibromomethane	ND	0.0020	mg/Kg wet							
1,2-Dichlorobenzene	ND	0.0020	mg/Kg wet							
1,3-Dichlorobenzene	ND	0.0020	mg/Kg wet							

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QUALITY CONTROL

Volatile Organic Compounds by GC/MS - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B289971 - SW-846 5035										
Blank (B289971-BLK1)				Prepared & Analyzed: 09/10/21						
1,4-Dichlorobenzene	ND	0.0020	mg/Kg wet							
Dichlorodifluoromethane (Freon 12)	ND	0.010	mg/Kg wet							
1,1-Dichloroethane	ND	0.0020	mg/Kg wet							
1,2-Dichloroethane	ND	0.0020	mg/Kg wet							
1,1-Dichloroethylene	ND	0.0040	mg/Kg wet							
cis-1,2-Dichloroethylene	ND	0.0020	mg/Kg wet							
trans-1,2-Dichloroethylene	ND	0.0020	mg/Kg wet							
1,2-Dichloropropane	ND	0.0020	mg/Kg wet							
1,3-Dichloropropane	ND	0.0010	mg/Kg wet							
2,2-Dichloropropane	ND	0.0020	mg/Kg wet							
1,1-Dichloropropene	ND	0.0020	mg/Kg wet							
cis-1,3-Dichloropropene	ND	0.0010	mg/Kg wet							
trans-1,3-Dichloropropene	ND	0.0010	mg/Kg wet							
Diethyl Ether	ND	0.010	mg/Kg wet							
Diisopropyl Ether (DIPE)	ND	0.0010	mg/Kg wet							
1,4-Dioxane	ND	0.10	mg/Kg wet							
Ethylbenzene	ND	0.0020	mg/Kg wet							
Hexachlorobutadiene	ND	0.0020	mg/Kg wet							V-05
2-Hexanone (MBK)	ND	0.020	mg/Kg wet							
Isopropylbenzene (Cumene)	ND	0.0020	mg/Kg wet							
p-Isopropyltoluene (p-Cymene)	ND	0.0020	mg/Kg wet							
Methyl tert-Butyl Ether (MTBE)	ND	0.0040	mg/Kg wet							
Methylene Chloride	ND	0.010	mg/Kg wet							
4-Methyl-2-pentanone (MIBK)	ND	0.020	mg/Kg wet							
Naphthalene	ND	0.0040	mg/Kg wet							V-05
n-Propylbenzene	ND	0.0020	mg/Kg wet							
Styrene	ND	0.0020	mg/Kg wet							
1,1,1,2-Tetrachloroethane	ND	0.0020	mg/Kg wet							
1,1,2,2-Tetrachloroethane	ND	0.0010	mg/Kg wet							
Tetrachloroethylene	ND	0.0020	mg/Kg wet							
Tetrahydrofuran	ND	0.010	mg/Kg wet							
Toluene	ND	0.0020	mg/Kg wet							
1,2,3-Trichlorobenzene	ND	0.0020	mg/Kg wet							
1,2,4-Trichlorobenzene	ND	0.0020	mg/Kg wet							
1,1,1-Trichloroethane	ND	0.0020	mg/Kg wet							
1,1,2-Trichloroethane	ND	0.0020	mg/Kg wet							
Trichloroethylene	ND	0.0020	mg/Kg wet							
Trichlorofluoromethane (Freon 11)	ND	0.010	mg/Kg wet							
1,2,3-Trichloropropane	ND	0.0020	mg/Kg wet							
1,2,4-Trimethylbenzene	ND	0.0020	mg/Kg wet							
1,3,5-Trimethylbenzene	ND	0.0020	mg/Kg wet							
Vinyl Chloride	ND	0.010	mg/Kg wet							
m+p Xylene	ND	0.0040	mg/Kg wet							V-05
o-Xylene	ND	0.0020	mg/Kg wet							
Surrogate: 1,2-Dichloroethane-d4	*0.0555*		mg/Kg wet	0.0500		111	70-130			
Surrogate: Toluene-d8	*0.0517*		mg/Kg wet	0.0500		103	70-130			
Surrogate: 4-Bromofluorobenzene	*0.0484*		mg/Kg wet	0.0500		96.9	70-130			

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QUALITY CONTROL

Volatile Organic Compounds by GC/MS - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes	
Batch B289971 - SW-846 5035											
LCS (B289971-BS1)				Prepared & Analyzed: 09/10/21							
Acetone	0.206	0.10	mg/Kg wet	0.200		103	40-160				†
tert-Amyl Methyl Ether (TAME)	0.0189	0.0010	mg/Kg wet	0.0200		94.7	70-130				
Benzene	0.0207	0.0020	mg/Kg wet	0.0200		103	70-130				
Bromobenzene	0.0170	0.0020	mg/Kg wet	0.0200		84.9	70-130				
Bromochloromethane	0.0229	0.0020	mg/Kg wet	0.0200		115	70-130				
Bromodichloromethane	0.0182	0.0020	mg/Kg wet	0.0200		91.2	70-130				
Bromoform	0.0159	0.0020	mg/Kg wet	0.0200		79.4	70-130			V-05	
Bromomethane	0.0200	0.010	mg/Kg wet	0.0200		100	40-160			V-34	†
2-Butanone (MEK)	0.239	0.040	mg/Kg wet	0.200		120	40-160				†
n-Butylbenzene	0.0156	0.0020	mg/Kg wet	0.0200		77.9	70-130				
sec-Butylbenzene	0.0155	0.0020	mg/Kg wet	0.0200		77.4	70-130				
tert-Butylbenzene	0.0155	0.0020	mg/Kg wet	0.0200		77.5	70-130				
tert-Butyl Ethyl Ether (TBEE)	0.0201	0.0010	mg/Kg wet	0.0200		100	70-130				
Carbon Disulfide	0.176	0.0060	mg/Kg wet	0.200		87.8	70-130				
Carbon Tetrachloride	0.0192	0.0020	mg/Kg wet	0.0200		96.1	70-130				
Chlorobenzene	0.0166	0.0020	mg/Kg wet	0.0200		82.9	70-130				
Chlorodibromomethane	0.0181	0.0010	mg/Kg wet	0.0200		90.6	70-130				
Chloroethane	0.0185	0.010	mg/Kg wet	0.0200		92.3	70-130				
Chloroform	0.0200	0.0040	mg/Kg wet	0.0200		99.9	70-130				
Chloromethane	0.0216	0.010	mg/Kg wet	0.0200		108	40-160				†
2-Chlorotoluene	0.0165	0.0020	mg/Kg wet	0.0200		82.3	70-130				
4-Chlorotoluene	0.0161	0.0020	mg/Kg wet	0.0200		80.7	70-130				
1,2-Dibromo-3-chloropropane (DBCP)	0.0170	0.0020	mg/Kg wet	0.0200		85.1	70-130				
1,2-Dibromoethane (EDB)	0.0191	0.0010	mg/Kg wet	0.0200		95.6	70-130				
Dibromomethane	0.0190	0.0020	mg/Kg wet	0.0200		95.1	70-130				
1,2-Dichlorobenzene	0.0159	0.0020	mg/Kg wet	0.0200		79.3	70-130				
1,3-Dichlorobenzene	0.0160	0.0020	mg/Kg wet	0.0200		79.9	70-130				
1,4-Dichlorobenzene	0.0164	0.0020	mg/Kg wet	0.0200		81.8	70-130				
Dichlorodifluoromethane (Freon 12)	0.0201	0.010	mg/Kg wet	0.0200		101	40-160				†
1,1-Dichloroethane	0.0212	0.0020	mg/Kg wet	0.0200		106	70-130				
1,2-Dichloroethane	0.0202	0.0020	mg/Kg wet	0.0200		101	70-130				
1,1-Dichloroethylene	0.0195	0.0040	mg/Kg wet	0.0200		97.5	70-130				
cis-1,2-Dichloroethylene	0.0211	0.0020	mg/Kg wet	0.0200		106	70-130				
trans-1,2-Dichloroethylene	0.0212	0.0020	mg/Kg wet	0.0200		106	70-130				
1,2-Dichloropropane	0.0200	0.0020	mg/Kg wet	0.0200		100	70-130				
1,3-Dichloropropane	0.0203	0.0010	mg/Kg wet	0.0200		102	70-130				
2,2-Dichloropropane	0.0193	0.0020	mg/Kg wet	0.0200		96.3	70-130				
1,1-Dichloropropene	0.0198	0.0020	mg/Kg wet	0.0200		99.0	70-130				
cis-1,3-Dichloropropene	0.0182	0.0010	mg/Kg wet	0.0200		91.0	70-130				
trans-1,3-Dichloropropene	0.0178	0.0010	mg/Kg wet	0.0200		89.1	70-130				
Diethyl Ether	0.0200	0.010	mg/Kg wet	0.0200		100	70-130				
Diisopropyl Ether (DIPE)	0.0217	0.0010	mg/Kg wet	0.0200		109	70-130				
1,4-Dioxane	0.200	0.10	mg/Kg wet	0.200		100	40-160				†
Ethylbenzene	0.0166	0.0020	mg/Kg wet	0.0200		82.8	70-130				
Hexachlorobutadiene	0.0151	0.0020	mg/Kg wet	0.0200		75.5	70-130			V-05	
2-Hexanone (MBK)	0.211	0.020	mg/Kg wet	0.200		106	40-160				†
Isopropylbenzene (Cumene)	0.0166	0.0020	mg/Kg wet	0.0200		82.8	70-130				
p-Isopropyltoluene (p-Cymene)	0.0158	0.0020	mg/Kg wet	0.0200		79.2	70-130				
Methyl tert-Butyl Ether (MTBE)	0.0194	0.0040	mg/Kg wet	0.0200		96.8	70-130				
Methylene Chloride	0.0219	0.010	mg/Kg wet	0.0200		110	70-130				
4-Methyl-2-pentanone (MIBK)	0.212	0.020	mg/Kg wet	0.200		106	40-160				†
Naphthalene	0.0150	0.0040	mg/Kg wet	0.0200		74.9	70-130			V-05	

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QUALITY CONTROL

Volatile Organic Compounds by GC/MS - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes	
Batch B289971 - SW-846 5035											
LCS (B289971-BS1)				Prepared & Analyzed: 09/10/21							
n-Propylbenzene	0.0163	0.0020	mg/Kg wet	0.0200		81.5	70-130				
Styrene	0.0162	0.0020	mg/Kg wet	0.0200		81.2	70-130				
1,1,1,2-Tetrachloroethane	0.0156	0.0020	mg/Kg wet	0.0200		78.0	70-130				
1,1,2,2-Tetrachloroethane	0.0170	0.0010	mg/Kg wet	0.0200		85.2	70-130				
Tetrachloroethylene	0.0176	0.0020	mg/Kg wet	0.0200		88.0	70-130				
Tetrahydrofuran	0.0222	0.010	mg/Kg wet	0.0200		111	70-130				
Toluene	0.0187	0.0020	mg/Kg wet	0.0200		93.4	70-130				
1,2,3-Trichlorobenzene	0.0156	0.0020	mg/Kg wet	0.0200		78.0	70-130				
1,2,4-Trichlorobenzene	0.0150	0.0020	mg/Kg wet	0.0200		75.0	70-130				
1,1,1-Trichloroethane	0.0189	0.0020	mg/Kg wet	0.0200		94.3	70-130				
1,1,2-Trichloroethane	0.0187	0.0020	mg/Kg wet	0.0200		93.5	70-130				
Trichloroethylene	0.0189	0.0020	mg/Kg wet	0.0200		94.6	70-130				
Trichlorofluoromethane (Freon 11)	0.0205	0.010	mg/Kg wet	0.0200		102	70-130				
1,2,3-Trichloropropane	0.0176	0.0020	mg/Kg wet	0.0200		87.8	70-130				
1,2,4-Trimethylbenzene	0.0156	0.0020	mg/Kg wet	0.0200		78.0	70-130				
1,3,5-Trimethylbenzene	0.0165	0.0020	mg/Kg wet	0.0200		82.6	70-130				
Vinyl Chloride	0.0211	0.010	mg/Kg wet	0.0200		105	70-130				
m+p Xylene	0.0287	0.0040	mg/Kg wet	0.0400		71.8	70-130			V-05	
o-Xylene	0.0160	0.0020	mg/Kg wet	0.0200		79.8	70-130				
Surrogate: 1,2-Dichloroethane-d4	*0.0524*		mg/Kg wet	0.0500		105	70-130				
Surrogate: Toluene-d8	*0.0517*		mg/Kg wet	0.0500		103	70-130				
Surrogate: 4-Bromofluorobenzene	*0.0494*		mg/Kg wet	0.0500		98.8	70-130				
LCS Dup (B289971-BSD1)				Prepared & Analyzed: 09/10/21							
Acetone	0.221	0.10	mg/Kg wet	0.200		110	40-160	7.01	20		†
tert-Amyl Methyl Ether (TAME)	0.0182	0.0010	mg/Kg wet	0.0200		90.8	70-130	4.15	20		
Benzene	0.0195	0.0020	mg/Kg wet	0.0200		97.4	70-130	5.86	20		
Bromobenzene	0.0164	0.0020	mg/Kg wet	0.0200		81.8	70-130	3.70	20		
Bromochloromethane	0.0232	0.0020	mg/Kg wet	0.0200		116	70-130	1.11	20		
Bromodichloromethane	0.0180	0.0020	mg/Kg wet	0.0200		90.0	70-130	1.34	20		
Bromoform	0.0149	0.0020	mg/Kg wet	0.0200		74.5	70-130	6.39	20	V-05	
Bromomethane	0.0202	0.010	mg/Kg wet	0.0200		101	40-160	0.746	20	V-34	†
2-Butanone (MEK)	0.235	0.040	mg/Kg wet	0.200		118	40-160	1.79	20		†
n-Butylbenzene	0.0154	0.0020	mg/Kg wet	0.0200		76.9	70-130	1.30	20		
sec-Butylbenzene	0.0155	0.0020	mg/Kg wet	0.0200		77.6	70-130	0.258	20		
tert-Butylbenzene	0.0154	0.0020	mg/Kg wet	0.0200		76.8	70-130	0.894	20		
tert-Butyl Ethyl Ether (TBEE)	0.0195	0.0010	mg/Kg wet	0.0200		97.4	70-130	3.12	20		
Carbon Disulfide	0.173	0.0060	mg/Kg wet	0.200		86.5	70-130	1.55	20		
Carbon Tetrachloride	0.0189	0.0020	mg/Kg wet	0.0200		94.3	70-130	1.84	20		
Chlorobenzene	0.0165	0.0020	mg/Kg wet	0.0200		82.5	70-130	0.471	20		
Chlorodibromomethane	0.0177	0.0010	mg/Kg wet	0.0200		88.4	70-130	2.41	20		
Chloroethane	0.0191	0.010	mg/Kg wet	0.0200		95.7	70-130	3.61	20		
Chloroform	0.0195	0.0040	mg/Kg wet	0.0200		97.3	70-130	2.66	20		
Chloromethane	0.0210	0.010	mg/Kg wet	0.0200		105	40-160	2.87	20		†
2-Chlorotoluene	0.0159	0.0020	mg/Kg wet	0.0200		79.3	70-130	3.75	20		
4-Chlorotoluene	0.0157	0.0020	mg/Kg wet	0.0200		78.7	70-130	2.50	20		
1,2-Dibromo-3-chloropropane (DBCP)	0.0164	0.0020	mg/Kg wet	0.0200		82.1	70-130	3.66	20		
1,2-Dibromoethane (EDB)	0.0185	0.0010	mg/Kg wet	0.0200		92.7	70-130	3.08	20		
Dibromomethane	0.0182	0.0020	mg/Kg wet	0.0200		91.0	70-130	4.40	20		
1,2-Dichlorobenzene	0.0154	0.0020	mg/Kg wet	0.0200		77.2	70-130	2.71	20		
1,3-Dichlorobenzene	0.0159	0.0020	mg/Kg wet	0.0200		79.7	70-130	0.313	20		
1,4-Dichlorobenzene	0.0154	0.0020	mg/Kg wet	0.0200		76.8	70-130	6.39	20		

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QUALITY CONTROL

Volatile Organic Compounds by GC/MS - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes	
Batch B289971 - SW-846 5035											
LCS Dup (B289971-BSD1)				Prepared & Analyzed: 09/10/21							
Dichlorodifluoromethane (Freon 12)	0.0192	0.010	mg/Kg wet	0.0200		96.0	40-160	4.78	20		†
1,1-Dichloroethane	0.0210	0.0020	mg/Kg wet	0.0200		105	70-130	0.692	20		
1,2-Dichloroethane	0.0196	0.0020	mg/Kg wet	0.0200		98.2	70-130	2.68	20		
1,1-Dichloroethylene	0.0193	0.0040	mg/Kg wet	0.0200		96.6	70-130	0.938	20		
cis-1,2-Dichloroethylene	0.0204	0.0020	mg/Kg wet	0.0200		102	70-130	3.62	20		
trans-1,2-Dichloroethylene	0.0206	0.0020	mg/Kg wet	0.0200		103	70-130	3.08	20		
1,2-Dichloropropane	0.0200	0.0020	mg/Kg wet	0.0200		100	70-130	0.100	20		
1,3-Dichloropropane	0.0200	0.0010	mg/Kg wet	0.0200		99.9	70-130	1.66	20		
2,2-Dichloropropane	0.0190	0.0020	mg/Kg wet	0.0200		95.0	70-130	1.36	20		
1,1-Dichloropropene	0.0198	0.0020	mg/Kg wet	0.0200		98.8	70-130	0.192	20		
cis-1,3-Dichloropropene	0.0184	0.0010	mg/Kg wet	0.0200		91.9	70-130	0.908	20		
trans-1,3-Dichloropropene	0.0174	0.0010	mg/Kg wet	0.0200		86.8	70-130	2.66	20		
Diethyl Ether	0.0192	0.010	mg/Kg wet	0.0200		95.8	70-130	4.34	20		
Diisopropyl Ether (DIPE)	0.0216	0.0010	mg/Kg wet	0.0200		108	70-130	0.526	20		
1,4-Dioxane	0.201	0.10	mg/Kg wet	0.200		101	40-160	0.500	20		†
Ethylbenzene	0.0163	0.0020	mg/Kg wet	0.0200		81.3	70-130	1.88	20		
Hexachlorobutadiene	0.0143	0.0020	mg/Kg wet	0.0200		71.3	70-130	5.68	20	V-05	
2-Hexanone (MBK)	0.206	0.020	mg/Kg wet	0.200		103	40-160	2.27	20		†
Isopropylbenzene (Cumene)	0.0159	0.0020	mg/Kg wet	0.0200		79.6	70-130	3.94	20		
p-Isopropyltoluene (p-Cymene)	0.0154	0.0020	mg/Kg wet	0.0200		77.1	70-130	2.66	20		
Methyl tert-Butyl Ether (MTBE)	0.0192	0.0040	mg/Kg wet	0.0200		96.1	70-130	0.716	20		
Methylene Chloride	0.0235	0.010	mg/Kg wet	0.0200		117	70-130	6.91	20		
4-Methyl-2-pentanone (MIBK)	0.207	0.020	mg/Kg wet	0.200		103	40-160	2.73	20		†
Naphthalene	0.0152	0.0040	mg/Kg wet	0.0200		75.9	70-130	1.29	20	V-05	
n-Propylbenzene	0.0158	0.0020	mg/Kg wet	0.0200		79.2	70-130	2.97	20		
Styrene	0.0160	0.0020	mg/Kg wet	0.0200		79.8	70-130	1.68	20		
1,1,1,2-Tetrachloroethane	0.0153	0.0020	mg/Kg wet	0.0200		76.4	70-130	2.01	20		
1,1,2,2-Tetrachloroethane	0.0173	0.0010	mg/Kg wet	0.0200		86.6	70-130	1.73	20		
Tetrachloroethylene	0.0172	0.0020	mg/Kg wet	0.0200		85.8	70-130	2.58	20		
Tetrahydrofuran	0.0193	0.010	mg/Kg wet	0.0200		96.5	70-130	14.2	20		
Toluene	0.0185	0.0020	mg/Kg wet	0.0200		92.5	70-130	0.990	20		
1,2,3-Trichlorobenzene	0.0143	0.0020	mg/Kg wet	0.0200		71.5	70-130	8.68	20		
1,2,4-Trichlorobenzene	0.0142	0.0020	mg/Kg wet	0.0200		70.8	70-130	5.69	20		
1,1,1-Trichloroethane	0.0185	0.0020	mg/Kg wet	0.0200		92.5	70-130	1.93	20		
1,1,2-Trichloroethane	0.0188	0.0020	mg/Kg wet	0.0200		94.2	70-130	0.831	20		
Trichloroethylene	0.0176	0.0020	mg/Kg wet	0.0200		88.0	70-130	7.14	20		
Trichlorofluoromethane (Freon 11)	0.0201	0.010	mg/Kg wet	0.0200		100	70-130	1.91	20		
1,2,3-Trichloropropane	0.0178	0.0020	mg/Kg wet	0.0200		88.9	70-130	1.27	20		
1,2,4-Trimethylbenzene	0.0155	0.0020	mg/Kg wet	0.0200		77.7	70-130	0.424	20		
1,3,5-Trimethylbenzene	0.0158	0.0020	mg/Kg wet	0.0200		78.8	70-130	4.71	20		
Vinyl Chloride	0.0206	0.010	mg/Kg wet	0.0200		103	70-130	2.30	20		
m+p Xylene	0.0287	0.0040	mg/Kg wet	0.0400		71.8	70-130	0.0488	20	V-05	
o-Xylene	0.0157	0.0020	mg/Kg wet	0.0200		78.3	70-130	1.91	20		
Surrogate: 1,2-Dichloroethane-d4	*0.0532*		mg/Kg wet	0.0500		106	70-130				
Surrogate: Toluene-d8	*0.0522*		mg/Kg wet	0.0500		104	70-130				
Surrogate: 4-Bromofluorobenzene	*0.0498*		mg/Kg wet	0.0500		99.6	70-130				

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QUALITY CONTROL

Semivolatile Organic Compounds by GC/MS - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B289965 - SW-846 3546										
Blank (B289965-BLK1)				Prepared: 09/10/21 Analyzed: 09/13/21						
Acenaphthene	ND	0.17	mg/Kg wet							
Acenaphthylene	ND	0.17	mg/Kg wet							
Anthracene	ND	0.17	mg/Kg wet							
Benzo(a)anthracene	ND	0.17	mg/Kg wet							
Benzo(a)pyrene	ND	0.17	mg/Kg wet							
Benzo(b)fluoranthene	ND	0.17	mg/Kg wet							
Benzo(g,h,i)perylene	ND	0.17	mg/Kg wet							
Benzo(k)fluoranthene	ND	0.17	mg/Kg wet							
Chrysene	ND	0.17	mg/Kg wet							
Dibenz(a,h)anthracene	ND	0.17	mg/Kg wet							
Fluoranthene	ND	0.17	mg/Kg wet							
Fluorene	ND	0.17	mg/Kg wet							
Indeno(1,2,3-cd)pyrene	ND	0.17	mg/Kg wet							
2-Methylnaphthalene	ND	0.17	mg/Kg wet							
Naphthalene	ND	0.17	mg/Kg wet							
Phenanthrene	ND	0.17	mg/Kg wet							
Pyrene	ND	0.17	mg/Kg wet							
Surrogate: Nitrobenzene-d5	*2.77*		mg/Kg wet	3.33		83.2	30-130			
Surrogate: 2-Fluorobiphenyl	*2.73*		mg/Kg wet	3.33		81.9	30-130			
Surrogate: p-Terphenyl-d14	*2.89*		mg/Kg wet	3.33		86.8	30-130			
LCS (B289965-BS1)				Prepared: 09/10/21 Analyzed: 09/13/21						
Acenaphthene	1.17	0.17	mg/Kg wet	1.67		70.2	40-140			
Acenaphthylene	1.17	0.17	mg/Kg wet	1.67		70.3	40-140			
Anthracene	1.23	0.17	mg/Kg wet	1.67		73.6	40-140			
Benzo(a)anthracene	1.17	0.17	mg/Kg wet	1.67		70.3	40-140			
Benzo(a)pyrene	1.28	0.17	mg/Kg wet	1.67		76.9	40-140			
Benzo(b)fluoranthene	1.19	0.17	mg/Kg wet	1.67		71.3	40-140			
Benzo(g,h,i)perylene	1.28	0.17	mg/Kg wet	1.67		77.1	40-140			
Benzo(k)fluoranthene	1.19	0.17	mg/Kg wet	1.67		71.2	40-140			
Chrysene	1.13	0.17	mg/Kg wet	1.67		68.1	40-140			
Dibenz(a,h)anthracene	1.32	0.17	mg/Kg wet	1.67		79.1	40-140			
Fluoranthene	1.19	0.17	mg/Kg wet	1.67		71.6	40-140			
Fluorene	1.23	0.17	mg/Kg wet	1.67		73.8	40-140			
Indeno(1,2,3-cd)pyrene	1.41	0.17	mg/Kg wet	1.67		84.9	40-140			
2-Methylnaphthalene	1.21	0.17	mg/Kg wet	1.67		72.7	40-140			
Naphthalene	1.10	0.17	mg/Kg wet	1.67		66.2	40-140			
Phenanthrene	1.20	0.17	mg/Kg wet	1.67		72.0	40-140			
Pyrene	1.23	0.17	mg/Kg wet	1.67		73.5	40-140			
Surrogate: Nitrobenzene-d5	*2.62*		mg/Kg wet	3.33		78.5	30-130			
Surrogate: 2-Fluorobiphenyl	*2.51*		mg/Kg wet	3.33		75.2	30-130			
Surrogate: p-Terphenyl-d14	*2.60*		mg/Kg wet	3.33		78.1	30-130			

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QUALITY CONTROL

Semivolatile Organic Compounds by GC/MS - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B289965 - SW-846 3546										
LCS Dup (B289965-BSD1)				Prepared: 09/10/21 Analyzed: 09/13/21						
Acenaphthene	1.25	0.17	mg/Kg wet	1.67		75.2	40-140	6.82	30	
Acenaphthylene	1.28	0.17	mg/Kg wet	1.67		77.1	40-140	9.20	30	
Anthracene	1.28	0.17	mg/Kg wet	1.67		76.6	40-140	3.92	30	
Benzo(a)anthracene	1.22	0.17	mg/Kg wet	1.67		73.0	40-140	3.79	30	
Benzo(a)pyrene	1.38	0.17	mg/Kg wet	1.67		82.6	40-140	7.18	30	
Benzo(b)fluoranthene	1.28	0.17	mg/Kg wet	1.67		76.7	40-140	7.33	30	
Benzo(g,h,i)perylene	1.36	0.17	mg/Kg wet	1.67		81.4	40-140	5.43	30	
Benzo(k)fluoranthene	1.26	0.17	mg/Kg wet	1.67		75.7	40-140	6.13	30	
Chrysene	1.21	0.17	mg/Kg wet	1.67		72.7	40-140	6.56	30	
Dibenz(a,h)anthracene	1.40	0.17	mg/Kg wet	1.67		83.7	40-140	5.75	30	
Fluoranthene	1.29	0.17	mg/Kg wet	1.67		77.4	40-140	7.76	30	
Fluorene	1.30	0.17	mg/Kg wet	1.67		78.2	40-140	5.82	30	
Indeno(1,2,3-cd)pyrene	1.51	0.17	mg/Kg wet	1.67		90.9	40-140	6.83	30	
2-Methylnaphthalene	1.24	0.17	mg/Kg wet	1.67		74.7	40-140	2.66	30	
Naphthalene	1.15	0.17	mg/Kg wet	1.67		69.0	40-140	4.14	30	
Phenanthrene	1.27	0.17	mg/Kg wet	1.67		76.1	40-140	5.56	30	
Pyrene	1.28	0.17	mg/Kg wet	1.67		76.8	40-140	4.36	30	
Surrogate: Nitrobenzene-d5	*2.58*		mg/Kg wet	3.33		77.3	30-130			
Surrogate: 2-Fluorobiphenyl	*2.65*		mg/Kg wet	3.33		79.6	30-130			
Surrogate: p-Terphenyl-d14	*2.66*		mg/Kg wet	3.33		79.8	30-130			

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QUALITY CONTROL

Organochloride Pesticides by GC/ECD - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B289958 - SW-846 3546										
Blank (B289958-BLK1)				Prepared: 09/10/21 Analyzed: 09/16/21						
Aldrin	ND	0.0010	mg/Kg wet							
Aldrin [2C]	ND	0.0010	mg/Kg wet							
alpha-BHC	ND	0.0010	mg/Kg wet							
alpha-BHC [2C]	ND	0.0010	mg/Kg wet							
beta-BHC	ND	0.0010	mg/Kg wet							
beta-BHC [2C]	ND	0.0010	mg/Kg wet							
delta-BHC	ND	0.0010	mg/Kg wet							
delta-BHC [2C]	ND	0.0010	mg/Kg wet							
gamma-BHC (Lindane)	ND	0.00040	mg/Kg wet							
gamma-BHC (Lindane) [2C]	ND	0.00040	mg/Kg wet							
Chlordane	ND	0.0040	mg/Kg wet							
Chlordane [2C]	ND	0.0040	mg/Kg wet							
4,4'-DDD	ND	0.00080	mg/Kg wet							
4,4'-DDD [2C]	ND	0.00080	mg/Kg wet							
4,4'-DDE	ND	0.00080	mg/Kg wet							
4,4'-DDE [2C]	ND	0.00080	mg/Kg wet							
4,4'-DDT	ND	0.00080	mg/Kg wet							
4,4'-DDT [2C]	ND	0.00080	mg/Kg wet							
Dieldrin	ND	0.00080	mg/Kg wet							
Dieldrin [2C]	ND	0.00080	mg/Kg wet							
Endosulfan I	ND	0.0010	mg/Kg wet							
Endosulfan I [2C]	ND	0.0010	mg/Kg wet							
Endosulfan II	ND	0.0016	mg/Kg wet							
Endosulfan II [2C]	ND	0.0016	mg/Kg wet							
Endosulfan Sulfate	ND	0.0016	mg/Kg wet							
Endosulfan Sulfate [2C]	ND	0.0016	mg/Kg wet							
Endrin	ND	0.0016	mg/Kg wet							
Endrin [2C]	ND	0.0016	mg/Kg wet							
Endrin Aldehyde	ND	0.0016	mg/Kg wet							
Endrin Aldehyde [2C]	ND	0.0016	mg/Kg wet							
Endrin Ketone	ND	0.0016	mg/Kg wet							
Endrin Ketone [2C]	ND	0.0016	mg/Kg wet							
Heptachlor	ND	0.0010	mg/Kg wet							
Heptachlor [2C]	ND	0.0010	mg/Kg wet							
Heptachlor Epoxide	ND	0.0010	mg/Kg wet							
Heptachlor Epoxide [2C]	ND	0.0010	mg/Kg wet							
Hexachlorobenzene	ND	0.0012	mg/Kg wet							
Hexachlorobenzene [2C]	ND	0.0012	mg/Kg wet							
Methoxychlor	ND	0.010	mg/Kg wet							
Methoxychlor [2C]	ND	0.010	mg/Kg wet							
Toxaphene	ND	0.020	mg/Kg wet							
Toxaphene [2C]	ND	0.020	mg/Kg wet							
Surrogate: Decachlorobiphenyl	*0.0344*		mg/Kg wet	0.0400		86.0	30-150			
Surrogate: Decachlorobiphenyl [2C]	*0.0394*		mg/Kg wet	0.0400		98.6	30-150			
Surrogate: Tetrachloro-m-xylene	*0.0284*		mg/Kg wet	0.0400		70.9	30-150			
Surrogate: Tetrachloro-m-xylene [2C]	*0.0287*		mg/Kg wet	0.0400		71.8	30-150			

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QUALITY CONTROL

Organochloride Pesticides by GC/ECD - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B289958 - SW-846 3546										
LCS (B289958-BS1)				Prepared: 09/10/21 Analyzed: 09/16/21						
Aldrin	0.079	0.0050	mg/Kg wet	0.100		78.8	40-140			
Aldrin [2C]	0.085	0.0050	mg/Kg wet	0.100		85.0	40-140			
alpha-BHC	0.061	0.0050	mg/Kg wet	0.100		60.7	40-140			
alpha-BHC [2C]	0.065	0.0050	mg/Kg wet	0.100		65.4	40-140			
beta-BHC	0.070	0.0050	mg/Kg wet	0.100		70.1	40-140			
beta-BHC [2C]	0.077	0.0050	mg/Kg wet	0.100		77.1	40-140			
delta-BHC	0.064	0.0050	mg/Kg wet	0.100		64.2	40-140			
delta-BHC [2C]	0.071	0.0050	mg/Kg wet	0.100		70.9	40-140			
gamma-BHC (Lindane)	0.066	0.0020	mg/Kg wet	0.100		66.4	40-140			
gamma-BHC (Lindane) [2C]	0.070	0.0020	mg/Kg wet	0.100		70.2	40-140			
4,4'-DDD	0.093	0.0040	mg/Kg wet	0.100		93.2	40-140			
4,4'-DDD [2C]	0.10	0.0040	mg/Kg wet	0.100		102	40-140			
4,4'-DDE	0.092	0.0040	mg/Kg wet	0.100		91.9	40-140			
4,4'-DDE [2C]	0.097	0.0040	mg/Kg wet	0.100		97.0	40-140			
4,4'-DDT	0.092	0.0040	mg/Kg wet	0.100		92.3	40-140			
4,4'-DDT [2C]	0.097	0.0040	mg/Kg wet	0.100		96.7	40-140			
Dieldrin	0.086	0.0040	mg/Kg wet	0.100		86.0	40-140			
Dieldrin [2C]	0.094	0.0040	mg/Kg wet	0.100		93.6	40-140			
Endosulfan I	0.080	0.0050	mg/Kg wet	0.100		79.6	40-140			
Endosulfan I [2C]	0.094	0.0050	mg/Kg wet	0.100		93.6	40-140			
Endosulfan II	0.085	0.0080	mg/Kg wet	0.100		84.9	40-140			
Endosulfan II [2C]	0.094	0.0080	mg/Kg wet	0.100		94.3	40-140			
Endosulfan Sulfate	0.079	0.0080	mg/Kg wet	0.100		79.3	40-140			
Endosulfan Sulfate [2C]	0.096	0.0080	mg/Kg wet	0.100		95.5	40-140			
Endrin	0.088	0.0080	mg/Kg wet	0.100		87.6	40-140			
Endrin [2C]	0.097	0.0080	mg/Kg wet	0.100		97.2	40-140			
Endrin Ketone	0.092	0.0080	mg/Kg wet	0.100		91.9	40-140			
Endrin Ketone [2C]	0.098	0.0080	mg/Kg wet	0.100		97.7	40-140			
Heptachlor	0.070	0.0050	mg/Kg wet	0.100		69.6	40-140			
Heptachlor [2C]	0.081	0.0050	mg/Kg wet	0.100		81.2	40-140			
Heptachlor Epoxide	0.080	0.0050	mg/Kg wet	0.100		80.5	40-140			
Heptachlor Epoxide [2C]	0.088	0.0050	mg/Kg wet	0.100		88.0	40-140			
Hexachlorobenzene	0.074	0.0060	mg/Kg wet	0.100		74.0	40-140			
Hexachlorobenzene [2C]	0.079	0.0060	mg/Kg wet	0.100		79.4	40-140			
Methoxychlor	0.092	0.050	mg/Kg wet	0.100		92.0	40-140			
Methoxychlor [2C]	0.098	0.050	mg/Kg wet	0.100		97.6	40-140			
Surrogate: Decachlorobiphenyl	*0.162*		mg/Kg wet	0.200		81.0	30-150			
Surrogate: Decachlorobiphenyl [2C]	*0.185*		mg/Kg wet	0.200		92.4	30-150			
Surrogate: Tetrachloro-m-xylene	*0.136*		mg/Kg wet	0.200		68.0	30-150			
Surrogate: Tetrachloro-m-xylene [2C]	*0.136*		mg/Kg wet	0.200		68.2	30-150			

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QUALITY CONTROL

Polychlorinated Biphenyls By GC/ECD - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B289957 - SW-846 3546										
Blank (B289957-BLK1)				Prepared: 09/10/21 Analyzed: 09/14/21						
Aroclor-1016	ND	0.0040	mg/Kg wet							
Aroclor-1016 [2C]	ND	0.0040	mg/Kg wet							
Aroclor-1221	ND	0.0040	mg/Kg wet							
Aroclor-1221 [2C]	ND	0.0040	mg/Kg wet							
Aroclor-1232	ND	0.0040	mg/Kg wet							
Aroclor-1232 [2C]	ND	0.0040	mg/Kg wet							
Aroclor-1242	ND	0.0040	mg/Kg wet							
Aroclor-1242 [2C]	ND	0.0040	mg/Kg wet							
Aroclor-1248	ND	0.0040	mg/Kg wet							
Aroclor-1248 [2C]	ND	0.0040	mg/Kg wet							
Aroclor-1254	ND	0.0040	mg/Kg wet							
Aroclor-1254 [2C]	ND	0.0040	mg/Kg wet							
Aroclor-1260	ND	0.0040	mg/Kg wet							
Aroclor-1260 [2C]	ND	0.0040	mg/Kg wet							
Aroclor-1262	ND	0.0040	mg/Kg wet							
Aroclor-1262 [2C]	ND	0.0040	mg/Kg wet							
Aroclor-1268	ND	0.0040	mg/Kg wet							
Aroclor-1268 [2C]	ND	0.0040	mg/Kg wet							
Surrogate: Decachlorobiphenyl	*0.0413*		mg/Kg wet	0.0400		103	30-150			
Surrogate: Decachlorobiphenyl [2C]	*0.0423*		mg/Kg wet	0.0400		106	30-150			
Surrogate: Tetrachloro-m-xylene	*0.0356*		mg/Kg wet	0.0400		88.9	30-150			
Surrogate: Tetrachloro-m-xylene [2C]	*0.0352*		mg/Kg wet	0.0400		88.1	30-150			
LCS (B289957-BS1)				Prepared: 09/10/21 Analyzed: 09/14/21						
Aroclor-1016	0.16	0.020	mg/Kg wet	0.200		80.7	40-140			
Aroclor-1016 [2C]	0.16	0.020	mg/Kg wet	0.200		80.7	40-140			
Aroclor-1260	0.15	0.020	mg/Kg wet	0.200		76.8	40-140			
Aroclor-1260 [2C]	0.15	0.020	mg/Kg wet	0.200		75.5	40-140			
Surrogate: Decachlorobiphenyl	*0.171*		mg/Kg wet	0.200		85.4	30-150			
Surrogate: Decachlorobiphenyl [2C]	*0.177*		mg/Kg wet	0.200		88.5	30-150			
Surrogate: Tetrachloro-m-xylene	*0.154*		mg/Kg wet	0.200		77.2	30-150			
Surrogate: Tetrachloro-m-xylene [2C]	*0.158*		mg/Kg wet	0.200		79.0	30-150			
LCS Dup (B289957-BSD1)				Prepared: 09/10/21 Analyzed: 09/14/21						
Aroclor-1016	0.17	0.020	mg/Kg wet	0.200		86.4	40-140	6.82	30	
Aroclor-1016 [2C]	0.17	0.020	mg/Kg wet	0.200		84.7	40-140	4.93	30	
Aroclor-1260	0.16	0.020	mg/Kg wet	0.200		81.7	40-140	6.27	30	
Aroclor-1260 [2C]	0.16	0.020	mg/Kg wet	0.200		79.3	40-140	4.97	30	
Surrogate: Decachlorobiphenyl	*0.185*		mg/Kg wet	0.200		92.6	30-150			
Surrogate: Decachlorobiphenyl [2C]	*0.189*		mg/Kg wet	0.200		94.5	30-150			
Surrogate: Tetrachloro-m-xylene	*0.172*		mg/Kg wet	0.200		86.2	30-150			
Surrogate: Tetrachloro-m-xylene [2C]	*0.173*		mg/Kg wet	0.200		86.6	30-150			

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QUALITY CONTROL

Herbicides by GC/ECD - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B290112 - SW-846 8151										
Blank (B290112-BLK1)				Prepared: 09/13/21 Analyzed: 09/16/21						
2,4-D	ND	24	µg/kg wet							
2,4-D [2C]	ND	24	µg/kg wet							
2,4-DB	ND	24	µg/kg wet							
2,4-DB [2C]	ND	24	µg/kg wet							
2,4,5-TP (Silvex)	ND	2.4	µg/kg wet							
2,4,5-TP (Silvex) [2C]	ND	2.4	µg/kg wet							
2,4,5-T	ND	2.4	µg/kg wet							
2,4,5-T [2C]	ND	2.4	µg/kg wet							
Dalapon	ND	60	µg/kg wet							V-20
Dalapon [2C]	ND	60	µg/kg wet							V-20
Dicamba	ND	2.4	µg/kg wet							
Dicamba [2C]	ND	2.4	µg/kg wet							
Dichloroprop	ND	24	µg/kg wet							
Dichloroprop [2C]	ND	24	µg/kg wet							
Dinoseb	ND	12	µg/kg wet							
Dinoseb [2C]	ND	12	µg/kg wet							
Surrogate: 2,4-Dichlorophenylacetic acid	*63.3*		µg/kg wet	95.2		66.5	30-150			
Surrogate: 2,4-Dichlorophenylacetic acid [2C]	*63.3*		µg/kg wet	95.2		66.5	30-150			
LCS (B290112-BS1)				Prepared: 09/13/21 Analyzed: 09/16/21						
2,4-D	86.1	25	µg/kg wet	125		68.9	40-140			
2,4-D [2C]	91.8	25	µg/kg wet	125		73.4	40-140			
2,4-DB	82.8	25	µg/kg wet	125		66.3	40-140			
2,4-DB [2C]	84.1	25	µg/kg wet	125		67.3	40-140			
2,4,5-TP (Silvex)	8.95	2.5	µg/kg wet	12.5		71.6	40-140			
2,4,5-TP (Silvex) [2C]	9.39	2.5	µg/kg wet	12.5		75.2	40-140			
2,4,5-T	8.56	2.5	µg/kg wet	12.5		68.5	40-140			
2,4,5-T [2C]	9.42	2.5	µg/kg wet	12.5		75.4	40-140			V-06
Dalapon	136	62	µg/kg wet	312		43.6	40-140			
Dalapon [2C]	145	62	µg/kg wet	312		46.5	40-140			
Dicamba	8.67	2.5	µg/kg wet	12.5		69.3	40-140			
Dicamba [2C]	8.94	2.5	µg/kg wet	12.5		71.5	40-140			
Dichloroprop	91.1	25	µg/kg wet	125		72.9	40-140			
Dichloroprop [2C]	94.8	25	µg/kg wet	125		75.9	40-140			
Dinoseb	10.8	12	µg/kg wet	62.5		17.2	2.28-30.2			V-06
Dinoseb [2C]	11.3	12	µg/kg wet	62.5		18.1	2.56-33.2			V-06
Surrogate: 2,4-Dichlorophenylacetic acid	*69.1*		µg/kg wet	100		69.1	30-150			
Surrogate: 2,4-Dichlorophenylacetic acid [2C]	*71.0*		µg/kg wet	100		71.0	30-150			
LCS Dup (B290112-BSD1)				Prepared: 09/13/21 Analyzed: 09/16/21						
2,4-D	87.9	25	µg/kg wet	125		70.3	40-140	2.04	30	
2,4-D [2C]	94.9	25	µg/kg wet	125		75.9	40-140	3.35	30	
2,4-DB	81.8	25	µg/kg wet	125		65.5	40-140	1.20	30	
2,4-DB [2C]	84.3	25	µg/kg wet	125		67.4	40-140	0.256	30	
2,4,5-TP (Silvex)	9.08	2.5	µg/kg wet	12.5		72.6	40-140	1.44	30	
2,4,5-TP (Silvex) [2C]	9.70	2.5	µg/kg wet	12.5		77.6	40-140	3.19	30	
2,4,5-T	8.80	2.5	µg/kg wet	12.5		70.4	40-140	2.75	30	
2,4,5-T [2C]	9.81	2.5	µg/kg wet	12.5		78.5	40-140	4.10	30	V-06
Dalapon	144	62	µg/kg wet	312		46.0	40-140	5.40	30	
Dalapon [2C]	155	62	µg/kg wet	312		49.7	40-140	6.64	30	
Dicamba	8.91	2.5	µg/kg wet	12.5		71.3	40-140	2.80	30	

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QUALITY CONTROL

Herbicides by GC/ECD - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B290112 - SW-846 8151										
LCS Dup (B290112-BSD1)				Prepared: 09/13/21 Analyzed: 09/16/21						
Dicamba [2C]	9.03	2.5	µg/kg wet	12.5		72.2	40-140	0.957	30	
Dichloroprop	93.6	25	µg/kg wet	125		74.9	40-140	2.70	30	
Dichloroprop [2C]	97.4	25	µg/kg wet	125		77.9	40-140	2.72	30	
Dinoseb	9.68	12	µg/kg wet	62.5		15.5	2.28-30.2	10.8	30	V-06
Dinoseb [2C]	10.3	12	µg/kg wet	62.5		16.5	2.56-33.2	9.43	30	V-06
Surrogate: 2,4-Dichlorophenylacetic acid	*69.5*		µg/kg wet	100		69.5	30-150			
Surrogate: 2,4-Dichlorophenylacetic acid [2C]	*71.2*		µg/kg wet	100		71.2	30-150			

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QUALITY CONTROL

Petroleum Hydrocarbons Analyses - EPH - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B289959 - SW-846 3546										
Blank (B289959-BLK1)				Prepared: 09/10/21 Analyzed: 09/17/21						
C9-C18 Aliphatics	ND	10	mg/Kg wet							
C19-C36 Aliphatics	ND	10	mg/Kg wet							
Unadjusted C11-C22 Aromatics	ND	10	mg/Kg wet							
C11-C22 Aromatics	ND	10	mg/Kg wet							
Acenaphthene	ND	0.10	mg/Kg wet							
Acenaphthylene	ND	0.10	mg/Kg wet							
Anthracene	ND	0.10	mg/Kg wet							
Benzo(a)anthracene	ND	0.10	mg/Kg wet							
Benzo(a)pyrene	ND	0.10	mg/Kg wet							
Benzo(b)fluoranthene	ND	0.10	mg/Kg wet							
Benzo(g,h,i)perylene	ND	0.10	mg/Kg wet							
Benzo(k)fluoranthene	ND	0.10	mg/Kg wet							
Chrysene	ND	0.10	mg/Kg wet							
Dibenz(a,h)anthracene	ND	0.10	mg/Kg wet							
Fluoranthene	ND	0.10	mg/Kg wet							
Fluorene	ND	0.10	mg/Kg wet							
Indeno(1,2,3-cd)pyrene	ND	0.10	mg/Kg wet							
2-Methylnaphthalene	ND	0.10	mg/Kg wet							
Naphthalene	ND	0.10	mg/Kg wet							
Phenanthrene	ND	0.10	mg/Kg wet							
Pyrene	ND	0.10	mg/Kg wet							
Naphthalene-aliphatic fraction	ND	0.10	mg/Kg wet							
2-Methylnaphthalene-aliphatic fraction	ND	0.10	mg/Kg wet							
Surrogate: Chlorooctadecane (COD)	*4.06*		mg/Kg wet	5.00		81.3	40-140			
Surrogate: o-Terphenyl (OTP)	*4.14*		mg/Kg wet	5.00		82.8	40-140			
Surrogate: 2-Bromonaphthalene	*5.83*		mg/Kg wet	5.00		117	40-140			
Surrogate: 2-Fluorobiphenyl	*5.91*		mg/Kg wet	5.00		118	40-140			
LCS (B289959-BS1)				Prepared: 09/10/21 Analyzed: 09/17/21						
C9-C18 Aliphatics	23.0	10	mg/Kg wet	30.0		76.8	40-140			
C19-C36 Aliphatics	42.6	10	mg/Kg wet	40.0		107	40-140			
Unadjusted C11-C22 Aromatics	89.8	10	mg/Kg wet	85.0		106	40-140			
Acenaphthene	4.44	0.10	mg/Kg wet	5.00		88.9	40-140			
Acenaphthylene	4.16	0.10	mg/Kg wet	5.00		83.1	40-140			
Anthracene	5.05	0.10	mg/Kg wet	5.00		101	40-140			
Benzo(a)anthracene	5.39	0.10	mg/Kg wet	5.00		108	40-140			
Benzo(a)pyrene	5.08	0.10	mg/Kg wet	5.00		102	40-140			
Benzo(b)fluoranthene	4.86	0.10	mg/Kg wet	5.00		97.2	40-140			
Benzo(g,h,i)perylene	4.54	0.10	mg/Kg wet	5.00		90.8	40-140			
Benzo(k)fluoranthene	4.64	0.10	mg/Kg wet	5.00		92.8	40-140			
Chrysene	4.88	0.10	mg/Kg wet	5.00		97.7	40-140			
Dibenz(a,h)anthracene	4.81	0.10	mg/Kg wet	5.00		96.1	40-140			
Fluoranthene	5.00	0.10	mg/Kg wet	5.00		100	40-140			
Fluorene	4.66	0.10	mg/Kg wet	5.00		93.2	40-140			
Indeno(1,2,3-cd)pyrene	4.54	0.10	mg/Kg wet	5.00		90.9	40-140			
2-Methylnaphthalene	4.01	0.10	mg/Kg wet	5.00		80.2	40-140			
Naphthalene	3.78	0.10	mg/Kg wet	5.00		75.7	40-140			
Phenanthrene	5.11	0.10	mg/Kg wet	5.00		102	40-140			
Pyrene	5.11	0.10	mg/Kg wet	5.00		102	40-140			
Naphthalene-aliphatic fraction	ND	0.10	mg/Kg wet	5.00			0-5			
2-Methylnaphthalene-aliphatic fraction	ND	0.10	mg/Kg wet	5.00			0-5			
Surrogate: Chlorooctadecane (COD)	*4.21*		mg/Kg wet	5.00		84.3	40-140			

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QUALITY CONTROL

Petroleum Hydrocarbons Analyses - EPH - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B289959 - SW-846 3546										
LCS (B289959-BS1)				Prepared: 09/10/21 Analyzed: 09/17/21						
Surrogate: o-Terphenyl (OTP)	*4.55*		mg/Kg wet	5.00		91.1	40-140			
Surrogate: 2-Bromonaphthalene	*6.12*		mg/Kg wet	5.00		122	40-140			
Surrogate: 2-Fluorobiphenyl	*6.04*		mg/Kg wet	5.00		121	40-140			
LCS Dup (B289959-BSD1)				Prepared: 09/10/21 Analyzed: 09/17/21						
C9-C18 Aliphatics	22.3	10	mg/Kg wet	30.0		74.4	40-140	3.18	25	
C19-C36 Aliphatics	40.3	10	mg/Kg wet	40.0		101	40-140	5.48	25	
Unadjusted C11-C22 Aromatics	89.8	10	mg/Kg wet	85.0		106	40-140	0.0181	25	
Acenaphthene	4.45	0.10	mg/Kg wet	5.00		89.0	40-140	0.169	25	
Acenaphthylene	4.14	0.10	mg/Kg wet	5.00		82.8	40-140	0.400	25	
Anthracene	5.14	0.10	mg/Kg wet	5.00		103	40-140	1.77	25	
Benzo(a)anthracene	5.44	0.10	mg/Kg wet	5.00		109	40-140	0.916	25	
Benzo(a)pyrene	5.10	0.10	mg/Kg wet	5.00		102	40-140	0.432	25	
Benzo(b)fluoranthene	4.89	0.10	mg/Kg wet	5.00		97.9	40-140	0.742	25	
Benzo(g,h,i)perylene	4.61	0.10	mg/Kg wet	5.00		92.3	40-140	1.62	25	
Benzo(k)fluoranthene	4.66	0.10	mg/Kg wet	5.00		93.2	40-140	0.351	25	
Chrysene	4.93	0.10	mg/Kg wet	5.00		98.5	40-140	0.870	25	
Dibenz(a,h)anthracene	4.86	0.10	mg/Kg wet	5.00		97.1	40-140	1.05	25	
Fluoranthene	5.08	0.10	mg/Kg wet	5.00		102	40-140	1.53	25	
Fluorene	4.73	0.10	mg/Kg wet	5.00		94.6	40-140	1.59	25	
Indeno(1,2,3-cd)pyrene	4.56	0.10	mg/Kg wet	5.00		91.2	40-140	0.299	25	
2-Methylnaphthalene	3.90	0.10	mg/Kg wet	5.00		77.9	40-140	2.84	25	
Naphthalene	3.64	0.10	mg/Kg wet	5.00		72.8	40-140	3.80	25	
Phenanthrene	5.20	0.10	mg/Kg wet	5.00		104	40-140	1.64	25	
Pyrene	5.18	0.10	mg/Kg wet	5.00		104	40-140	1.23	25	
Naphthalene-aliphatic fraction	ND	0.10	mg/Kg wet	5.00			0-5			
2-Methylnaphthalene-aliphatic fraction	ND	0.10	mg/Kg wet	5.00			0-5			
Surrogate: Chlorooctadecane (COD)	*4.02*		mg/Kg wet	5.00		80.5	40-140			
Surrogate: o-Terphenyl (OTP)	*4.63*		mg/Kg wet	5.00		92.5	40-140			
Surrogate: 2-Bromonaphthalene	*6.19*		mg/Kg wet	5.00		124	40-140			
Surrogate: 2-Fluorobiphenyl	*6.02*		mg/Kg wet	5.00		120	40-140			

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QUALITY CONTROL

Metals Analyses (Total) - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B289988 - SW-846 7471										
Blank (B289988-BLK1)				Prepared: 09/10/21 Analyzed: 09/13/21						
Mercury	ND	0.025	mg/Kg wet							
LCS (B289988-BS1)				Prepared: 09/10/21 Analyzed: 09/13/21						
Mercury	13.5	0.75	mg/Kg wet	15.6		86.3	59.3-140.4			
LCS Dup (B289988-BSD1)				Prepared: 09/10/21 Analyzed: 09/13/21						
Mercury	13.3	0.74	mg/Kg wet	15.6		85.5	59.3-140.4	0.952	20	
Batch B289989 - SW-846 7471										
Blank (B289989-BLK1)				Prepared: 09/10/21 Analyzed: 09/13/21						
Mercury	ND	0.025	mg/Kg wet							
LCS (B289989-BS1)				Prepared: 09/10/21 Analyzed: 09/13/21						
Mercury	15.8	0.74	mg/Kg wet	15.6		102	59.3-140.4			
LCS Dup (B289989-BSD1)				Prepared: 09/10/21 Analyzed: 09/13/21						
Mercury	14.6	0.75	mg/Kg wet	15.6		93.5	59.3-140.4	8.25	20	
Batch B290223 - SW-846 3050B										
Blank (B290223-BLK1)				Prepared & Analyzed: 09/15/21						
Arsenic	ND	3.3	mg/Kg wet							
Cadmium	ND	0.33	mg/Kg wet							
Chromium	ND	0.67	mg/Kg wet							
Copper	ND	0.67	mg/Kg wet							
Lead	ND	0.50	mg/Kg wet							
Nickel	ND	0.67	mg/Kg wet							
Zinc	ND	0.67	mg/Kg wet							
LCS (B290223-BS1)				Prepared & Analyzed: 09/15/21						
Arsenic	156	9.9	mg/Kg wet	170		91.9	82.9-117.6			
Cadmium	91.9	0.99	mg/Kg wet	89.5		103	82.8-117.3			
Chromium	97.5	2.0	mg/Kg wet	101		96.5	82.1-117.8			
Copper	151	2.0	mg/Kg wet	149		101	83.9-116.1			
Lead	133	1.5	mg/Kg wet	140		94.7	82.9-117.1			
Nickel	69.6	2.0	mg/Kg wet	68.3		102	82.1-117.7			
Zinc	221	2.0	mg/Kg wet	228		96.8	80.7-118.9			
LCS Dup (B290223-BSD1)				Prepared & Analyzed: 09/15/21						
Arsenic	150	9.5	mg/Kg wet	170		88.3	82.9-117.6	4.00	30	
Cadmium	88.0	0.95	mg/Kg wet	89.5		98.3	82.8-117.3	4.40	20	
Chromium	97.2	1.9	mg/Kg wet	101		96.2	82.1-117.8	0.295	30	
Copper	145	1.9	mg/Kg wet	149		97.4	83.9-116.1	3.82	30	
Lead	126	1.4	mg/Kg wet	140		90.1	82.9-117.1	4.92	30	
Nickel	66.7	1.9	mg/Kg wet	68.3		97.6	82.1-117.7	4.36	30	
Zinc	213	1.9	mg/Kg wet	228		93.6	80.7-118.9	3.40	30	

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QUALITY CONTROL

Metals Analyses (Total) - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B290223 - SW-846 3050B										
Reference (B290223-SRM1) MRL Check				Prepared & Analyzed: 09/15/21						
Lead	0.421	0.50	mg/Kg wet	0.501		84.1	80-120			

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QUALITY CONTROL

Conventional Chemistry Parameters by EPA/APHA/SW-846 Methods (Total) - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC		%REC Limits	RPD		RPD Limit	Notes
Batch B289999 - % Solids												
Duplicate (B289999-DUP2)	**Source: 21I0471-02**			Prepared: 09/10/21 Analyzed: 09/13/21								
% Solids	52.0		% Wt		47.4				**9.35**	*	5	R-02
Duplicate (B289999-DUP3)	**Source: 21I0471-03**			Prepared: 09/10/21 Analyzed: 09/13/21								
% Solids	63.5		% Wt		64.4				1.40		5	
Duplicate (B289999-DUP4)	**Source: 21I0471-04**			Prepared: 09/10/21 Analyzed: 09/13/21								
% Solids	62.5		% Wt		63.8				2.10		5	
Duplicate (B289999-DUP5)	**Source: 21I0471-05**			Prepared: 09/10/21 Analyzed: 09/13/21								
% Solids	66.5		% Wt		64.3				3.33		5	
Duplicate (B289999-DUP6)	**Source: 21I0471-07**			Prepared: 09/10/21 Analyzed: 09/13/21								
% Solids	60.5		% Wt		57.2				**5.59**	*	5	R-02
Duplicate (B289999-DUP7)	**Source: 21I0471-08**			Prepared: 09/10/21 Analyzed: 09/13/21								
% Solids	67.0		% Wt		69.0				3.00		5	
Batch B290031 - SW 846 9060A												
Blank (B290031-BLK1)				Prepared & Analyzed: 09/13/21								
Total Organic Carbon	ND	100	mg/Kg									
LCS (B290031-BS1)				Prepared & Analyzed: 09/13/21								
Total Organic Carbon	727	100	mg/Kg	750		96.9		64.9-118				
LCS Dup (B290031-BSD1)				Prepared & Analyzed: 09/13/21								
Total Organic Carbon	763	100	mg/Kg	750		102		64.9-118	4.89		16.9	
Duplicate (B290031-DUP1)	**Source: 21I0471-02**			Prepared & Analyzed: 09/13/21								
Total Organic Carbon	63700	100	mg/Kg		66000				3.64		49.1	Z-01
Matrix Spike (B290031-MS1)	**Source: 21I0471-02**			Prepared & Analyzed: 09/13/21								
Total Organic Carbon	37800	100	mg/Kg	750	66000	**-3760**	*	85-115				MS-07

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BREAKDOWN REPORT

Lab Sample ID:	S063354-PEM1	Analyzed:	09/16/2021

Column Number: 1

Analyte	% Breakdown
4,4'-DDT [1]	1.03
Endrin [1]	1.58

Column Number: 2

Analyte	% Breakdown
4,4'-DDT [2]	1.12
Endrin [2]	2.43

BREAKDOWN REPORT

Lab Sample ID:	S063354-PEM2	Analyzed:	09/16/2021

Column Number: 1

Analyte	% Breakdown
4,4'-DDT [1]	1.65
Endrin [1]	2.73

Column Number: 2

Analyte	% Breakdown
4,4'-DDT [2]	1.77
Endrin [2]	2.49

BREAKDOWN REPORT

Lab Sample ID:	S063354-PEM3	Analyzed:	09/17/2021

Column Number: 1

Analyte	% Breakdown
4,4'-DDT [1]	1.77
Endrin [1]	2.98

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BREAKDOWN REPORT

Lab Sample ID:	S063354-PEM3	Analyzed:	09/17/2021

Column Number: 2

Analyte	% Breakdown
4,4'-DDT [2]	1.90
Endrin [2]	2.68

BREAKDOWN REPORT

Lab Sample ID:	S063354-PEM4	Analyzed:	09/17/2021

Column Number: 1

Analyte	% Breakdown
4,4'-DDT [1]	2.33
Endrin [1]	3.01

Column Number: 2

Analyte	% Breakdown
4,4'-DDT [2]	2.49
Endrin [2]	2.80

BREAKDOWN REPORT

Lab Sample ID:	S063354-PEM5	Analyzed:	09/17/2021

Column Number: 1

Analyte	% Breakdown
4,4'-DDT [1]	3.41
Endrin [1]	3.25

Column Number: 2

Analyte	% Breakdown
4,4'-DDT [2]	3.42
Endrin [2]	3.32

BREAKDOWN REPORT

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BREAKDOWN REPORT

Lab Sample ID:	S063354-PEM6	Analyzed:	09/18/2021

Column Number: 1

Analyte	% Breakdown
4,4'-DDT [1]	5.86
Endrin [1]	3.75

Column Number: 2

Analyte	% Breakdown
4,4'-DDT [2]	6.07
Endrin [2]	3.58

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IDENTIFICATION SUMMARY FOR SINGLE COMPONENT ANALYTES

SW-846 8082A

1543210907-02

Lab Sample ID: 21I0471-02 Date(s) Analyzed: 09/15/2021 09/15/2021

Instrument ID (1): ECD1 Instrument ID (2): ECD1

GC Column (1): ID: (mm) GC Column (2): ID: (mm)

ANALYTE	COL	RT	RT WINDOW		CONCENTRATION	%RPD
			FROM	TO		
Aroclor-1254	1	0.000	0.000	0.000	0.33	
	2	0.000	0.000	0.000	0.29	12.9

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IDENTIFICATION SUMMARY FOR SINGLE COMPONENT ANALYTES

SW-846 8082A

LCS

Lab Sample ID: B289957-BS1

Date(s) Analyzed: 09/14/2021 09/14/2021

Instrument ID (1): ECD1

Instrument ID (2): ECD1

GC Column (1): ID: (mm)

GC Column (2): ID: (mm)

ANALYTE	COL	RT	RT WINDOW		CONCENTRATION	%RPD
			FROM	TO		
Aroclor-1016	1	0.000	0.000	0.000	0.16	
	2	0.000	0.000	0.000	0.16	0.0
Aroclor-1260	1	0.000	0.000	0.000	0.15	
	2	0.000	0.000	0.000	0.15	0.0

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IDENTIFICATION SUMMARY FOR SINGLE COMPONENT ANALYTES

SW-846 8082A

LCS Dup

Lab Sample ID: B289957-BSD1 Date(s) Analyzed: 09/14/2021 09/14/2021

Instrument ID (1): ECD1 Instrument ID (2): ECD1

GC Column (1): ID: (mm) GC Column (2): ID: (mm)

ANALYTE	COL	RT	RT WINDOW		CONCENTRATION	%RPD
			FROM	TO		
Aroclor-1016	1	0.000	0.000	0.000	0.17	
	2	0.000	0.000	0.000	0.17	0.0
Aroclor-1260	1	0.000	0.000	0.000	0.16	
	2	0.000	0.000	0.000	0.16	0.0

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IDENTIFICATION SUMMARY FOR SINGLE COMPONENT ANALYTES

SW-846 8081B

LCS

Lab Sample ID: B289958-BS1 Date(s) Analyzed: 09/16/2021 09/16/2021

Instrument ID (1): ECD2 Instrument ID (2): ECD2

GC Column (1): ID: (mm) GC Column (2): ID: (mm)

ANALYTE	COL	RT	RT WINDOW		CONCENTRATION	%RPD
			FROM	TO		
4,4'-DDD	1	6.638	0.000	0.000	0.093	
	2	6.658	0.000	0.000	0.10	7.3
4,4'-DDE	1	6.231	0.000	0.000	0.092	
	2	6.258	0.000	0.000	0.097	5.3
4,4'-DDT	1	6.836	0.000	0.000	0.092	
	2	6.881	0.000	0.000	0.097	5.3
Aldrin	1	5.621	0.000	0.000	0.079	
	2	5.565	0.000	0.000	0.085	7.3
alpha-BHC	1	5.016	0.000	0.000	0.061	
	2	4.978	0.000	0.000	0.065	6.4
beta-BHC	1	5.236	0.000	0.000	0.070	
	2	5.209	0.000	0.000	0.077	9.5
delta-BHC	1	5.331	0.000	0.000	0.064	
	2	5.363	0.000	0.000	0.071	10.4
Dieldrin	1	6.410	0.000	0.000	0.086	
	2	6.339	0.000	0.000	0.094	8.9
Endosulfan I	1	6.248	0.000	0.000	0.080	
	2	6.157	0.000	0.000	0.094	16.1
Endosulfan II	1	6.723	0.000	0.000	0.085	
	2	6.697	0.000	0.000	0.094	10.1
Endosulfan Sulfate	1	7.348	0.000	0.000	0.079	
	2	7.149	0.000	0.000	0.096	19.4
Endrin	1	6.565	0.000	0.000	0.088	
	2	6.543	0.000	0.000	0.097	9.7
Endrin Ketone	1	7.551	0.000	0.000	0.092	
	2	7.540	0.000	0.000	0.098	6.3
gamma-BHC (Lindane)	1	5.184	0.000	0.000	0.066	
	2	5.158	0.000	0.000	0.070	5.9
Heptachlor	1	5.448	0.000	0.000	0.070	
	2	5.386	0.000	0.000	0.081	14.6
Heptachlor Epoxide	1	5.997	0.000	0.000	0.080	

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IDENTIFICATION SUMMARY FOR SINGLE COMPONENT ANALYTES

SW-846 8081B

LCS

Lab Sample ID: B289958-BS1 Date(s) Analyzed: 09/16/2021 09/16/2021

Instrument ID (1): ECD2 Instrument ID (2): ECD2

GC Column (1): ID: (mm) GC Column (2): ID: (mm)

ANALYTE	COL	RT	RT WINDOW		CONCENTRATION	%RPD
			FROM	TO		
	2	5.912	0.000	0.000	0.088	8.3
Hexachlorobenzene	1	4.925	0.000	0.000	0.074	
	2	4.904	0.000	0.000	0.079	6.5
Methoxychlor	1	7.216	0.000	0.000	0.092	
	2	7.422	0.000	0.000	0.098	6.3

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IDENTIFICATION SUMMARY FOR SINGLE COMPONENT ANALYTES

SW-846 8151A

LCS

Lab Sample ID: B290112-BS1 Date(s) Analyzed: 09/16/2021 09/16/2021

Instrument ID (1): ECD 8 Instrument ID (2): ECD 8

GC Column (1): ID: (mm) GC Column (2): ID: (mm)

ANALYTE	COL	RT	RT WINDOW		CONCENTRATION	%RPD
			FROM	TO		
2,4,5-T	1	17.129	0.000	0.000	8.56	
	2	17.090	0.000	0.000	9.42	9.1
2,4,5-TP (Silvex)	1	16.870	0.000	0.000	8.95	
	2	16.706	0.000	0.000	9.39	4.2
2,4-D	1	15.163	0.000	0.000	86.1	
	2	14.953	0.000	0.000	91.8	6.5
2,4-DB	1	17.510	0.000	0.000	82.8	
	2	17.443	0.000	0.000	84.1	1.3
Dalapon	1	5.251	0.000	0.000	136	
	2	4.856	0.000	0.000	145	3.5
Dicamba	1	12.928	0.000	0.000	8.67	
	2	12.623	0.000	0.000	8.94	2.7
Dichloroprop	1	14.630	0.000	0.000	91.1	
	2	14.239	0.000	0.000	94.8	4.1
Dinoseb	1	18.054	0.000	0.000	10.8	
	2	17.616	0.000	0.000	11.3	2.7

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IDENTIFICATION SUMMARY FOR SINGLE COMPONENT ANALYTES

SW-846 8151A

LCS Dup

Lab Sample ID: B290112-BSD1 Date(s) Analyzed: 09/16/2021 09/16/2021

Instrument ID (1): ECD 8 Instrument ID (2): ECD 8

GC Column (1): ID: (mm) GC Column (2): ID: (mm)

ANALYTE	COL	RT	RT WINDOW		CONCENTRATION	%RPD
			FROM	TO		
2,4,5-T	1	17.130	0.000	0.000	8.80	
	2	17.090	0.000	0.000	9.81	10.9
2,4,5-TP (Silvex)	1	16.870	0.000	0.000	9.08	
	2	16.706	0.000	0.000	9.70	6.4
2,4-D	1	15.164	0.000	0.000	87.9	
	2	14.953	0.000	0.000	94.9	7.6
2,4-DB	1	17.510	0.000	0.000	81.8	
	2	17.443	0.000	0.000	84.3	2.8
Dalapon	1	5.252	0.000	0.000	144	
	2	4.858	0.000	0.000	155	10.2
Dicamba	1	12.927	0.000	0.000	8.91	
	2	12.623	0.000	0.000	9.03	1.5
Dichloroprop	1	14.630	0.000	0.000	93.6	
	2	14.240	0.000	0.000	97.4	3.6
Dinoseb	1	18.053	0.000	0.000	9.68	
	2	17.616	0.000	0.000	10.3	6.0

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FLAG/QUALIFIER SUMMARY

*	QC result is outside of established limits.
†	Wide recovery limits established for difficult compound.
‡	Wide RPD limits established for difficult compound.
#	Data exceeded client recommended or regulatory level
ND	Not Detected
RL	Reporting Limit is at the level of quantitation (LOQ)
DL	Detection Limit is the lower limit of detection determined by the MDL study
MCL	Maximum Contaminant Level
	Percent recoveries and relative percent differences (RPDs) are determined by the software using values in the calculation which have not been rounded.
	No results have been blank subtracted unless specified in the case narrative section.
DL-03	Elevated reporting limit due to matrix interference.
MS-07	Matrix spike recovery is outside of control limits. Analysis is in control based on laboratory fortified blank recovery.Possibility of sample matrix effects that lead to low bias for reported result or non-homogeneous sample aliquot cannot be eliminated.
O-32	A dilution was performed as part of the standard analytical procedure.
R-02	Duplicate RPD is outside of control limits. Outlier can be attributed to sample non-homogeneity encountered during sample prep.
RL-07	Elevated reporting limit based on lowest point in calibration. MA CAM reporting limit not met.
V-05	Continuing calibration verification (CCV) did not meet method specifications and was biased on the low side for this compound.
V-06	Continuing calibration verification (CCV) did not meet method specifications and was biased on the high side for this compound.
V-16	Response factor is less than method specified minimum acceptable value. Reduced precision and accuracy may be associated with reported result.
V-20	Continuing calibration verification (CCV) did not meet method specifications and was biased on the high side. Data validation is not affected since sample result was "not detected" for this compound.
V-34	Initial calibration verification (ICV) did not meet method specifications and was biased on the low side for this compound. Reported result is estimated.
Z-01	Results over calibration curve. Results are estimitated due to method limitations.

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CERTIFICATIONS

Certified Analyses included in this Report

Analyte	Certifications
MADEP EPH rev 2.1 in Soil	
C9-C18 Aliphatics	CT,NC,ME,NH-P
C19-C36 Aliphatics	CT,NC,ME,NH-P
Unadjusted C11-C22 Aromatics	CT,NC,ME,NH-P
C11-C22 Aromatics	CT,NC,ME,NH-P
Acenaphthene	CT,NC,ME,NH-P
Acenaphthylene	CT,NC,ME,NH-P
Anthracene	CT,NC,ME,NH-P
Benzo(a)anthracene	CT,NC,ME,NH-P
Benzo(a)pyrene	CT,NC,ME,NH-P
Benzo(b)fluoranthene	CT,NC,ME,NH-P
Benzo(g,h,i)perylene	CT,NC,ME,NH-P
Benzo(k)fluoranthene	CT,NC,ME,NH-P
Chrysene	CT,NC,ME,NH-P
Dibenz(a,h)anthracene	CT,NC,ME,NH-P
Fluoranthene	CT,NC,ME,NH-P
Fluorene	CT,NC,ME
Indeno(1,2,3-cd)pyrene	CT,NC,ME,NH-P
2-Methylnaphthalene	CT,NC
Naphthalene	CT,NC,ME,NH-P
Phenanthrene	CT,NC,ME,NH-P
Pyrene	CT,NC,ME,NH-P
SW 846 9060A in Soil	
Total Organic Carbon	NY,CT,ME,VA,NH
SW-846 6010D in Soil	
Arsenic	CT,NH,NY,ME,VA,NC
Cadmium	CT,NH,NY,ME,VA,NC
Chromium	CT,NH,NY,ME,VA,NC
Copper	CT,NH,NY,ME,VA,NC
Lead	CT,NH,NY,AIHA,ME,VA,NC
Nickel	CT,NH,NY,ME,VA,NC
Zinc	CT,NH,NY,ME,VA,NC
SW-846 7471B in Soil	
Mercury	CT,NH,NY,NC,ME,VA
SW-846 8081B in Soil	
Aldrin	CT,NC,NH,NY,ME,VA
Aldrin [2C]	CT,NC,NH,NY,ME,VA
alpha-BHC	CT,NC,NH,NY,ME,VA
alpha-BHC [2C]	CT,NC,NH,NY,ME,VA
beta-BHC	CT,NC,NH,NY,ME,VA
beta-BHC [2C]	CT,NC,NH,NY,ME,VA
delta-BHC	CT,NC,NH,NY,ME,VA
delta-BHC [2C]	CT,NC,NH,NY,ME,VA
gamma-BHC (Lindane)	CT,NC,NH,NY,ME,VA
gamma-BHC (Lindane) [2C]	CT,NC,NH,NY,ME,VA
Chlordane	CT,NC,NH,NY,ME,VA

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CERTIFICATIONS

Certified Analyses included in this Report

Analyte	Certifications
SW-846 8081B in Soil	
Chlordane [2C]	CT,NC,NH,NY,ME,VA
4,4'-DDD	CT,NC,NH,NY,ME,VA
4,4'-DDD [2C]	CT,NC,NH,NY,ME,VA
4,4'-DDE	CT,NC,NH,NY,ME,VA
4,4'-DDE [2C]	CT,NC,NH,NY,ME,VA
4,4'-DDT	CT,NC,NH,NY,ME,VA
4,4'-DDT [2C]	CT,NC,NH,NY,ME,VA
Dieldrin	CT,NC,NH,NY,ME,VA
Dieldrin [2C]	CT,NC,NH,NY,ME,VA
Endosulfan I	CT,NC,NH,NY,ME,VA
Endosulfan I [2C]	CT,NC,NH,NY,ME,VA
Endosulfan II	CT,NC,NH,NY,ME,VA
Endosulfan II [2C]	CT,NC,NH,NY,ME,VA
Endosulfan Sulfate	CT,NC,NH,NY,ME,VA
Endosulfan Sulfate [2C]	CT,NC,NH,NY,ME,VA
Endrin	CT,NC,NH,NY,ME,VA
Endrin [2C]	CT,NC,NH,NY,ME,VA
Endrin Ketone	NC
Endrin Ketone [2C]	NC
Heptachlor	CT,NC,NH,NY,ME,VA
Heptachlor [2C]	CT,NC,NH,NY,ME,VA
Heptachlor Epoxide	CT,NC,NH,NY,ME,VA
Heptachlor Epoxide [2C]	CT,NC,NH,NY,ME,VA
Hexachlorobenzene	NC
Hexachlorobenzene [2C]	NC
Methoxychlor	CT,NC,NH,NY,ME,VA
Methoxychlor [2C]	CT,NC,NH,NY,ME,VA
SW-846 8081B in Water	
Aldrin	CT,NC,NH,NY,ME,VA
Aldrin [2C]	CT,NC,NH,NY,ME,VA
alpha-BHC	CT,NC,NH,NY,ME,VA
alpha-BHC [2C]	CT,NC,NH,NY,ME,VA
beta-BHC	CT,NC,NH,NY,ME,VA
beta-BHC [2C]	CT,NC,NH,NY,ME,VA
delta-BHC	CT,NC,NH,NY,ME,VA
delta-BHC [2C]	CT,NC,NH,NY,ME,VA
gamma-BHC (Lindane)	CT,NC,NH,NY,ME,VA
gamma-BHC (Lindane) [2C]	CT,NC,NH,NY,ME,VA
Chlordane	CT,NC,NH,NY,ME,VA
Chlordane [2C]	CT,NC,NH,NY,ME,VA
4,4'-DDD	CT,NC,NH,NY,ME,VA
4,4'-DDD [2C]	CT,NC,NH,NY,ME,VA
4,4'-DDE	CT,NC,NH,NY,ME,VA
4,4'-DDE [2C]	CT,NC,NH,NY,ME,VA
4,4'-DDT	CT,NC,NH,NY,ME,VA
4,4'-DDT [2C]	CT,NC,NH,NY,ME,VA

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CERTIFICATIONS

Certified Analyses included in this Report

Analyte	Certifications
SW-846 8081B in Water	
Dieldrin	CT,NC,NH,NY,ME,VA
Dieldrin [2C]	CT,NC,NH,NY,ME,VA
Endosulfan I	CT,NC,NH,NY,ME,VA
Endosulfan I [2C]	CT,NC,NH,NY,ME,VA
Endosulfan II	CT,NC,NH,NY,ME,VA
Endosulfan II [2C]	CT,NC,NH,NY,ME,VA
Endosulfan Sulfate	CT,NC,NH,NY,ME,VA
Endosulfan Sulfate [2C]	CT,NC,NH,NY,ME,VA
Endrin	CT,NC,NH,NY,ME,VA
Endrin [2C]	CT,NC,NH,NY,ME,VA
Endrin Ketone	NC
Endrin Ketone [2C]	NC
Heptachlor	CT,NC,NH,NY,ME,VA
Heptachlor [2C]	CT,NC,NH,NY,ME,VA
Heptachlor Epoxide	CT,NC,NH,NY,ME,VA
Heptachlor Epoxide [2C]	CT,NC,NH,NY,ME,VA
Hexachlorobenzene	NC
Hexachlorobenzene [2C]	NC
Methoxychlor	CT,NC,NH,NY,ME,VA
Methoxychlor [2C]	CT,NC,NH,NY,ME,VA
SW-846 8082A in Soil	
Aroclor-1016	CT,NH,NY,NC,ME,VA,PA
Aroclor-1016 [2C]	CT,NH,NY,NC,ME,VA,PA
Aroclor-1221	CT,NH,NY,NC,ME,VA,PA
Aroclor-1221 [2C]	CT,NH,NY,NC,ME,VA,PA
Aroclor-1232	CT,NH,NY,NC,ME,VA,PA
Aroclor-1232 [2C]	CT,NH,NY,NC,ME,VA,PA
Aroclor-1242	CT,NH,NY,NC,ME,VA,PA
Aroclor-1242 [2C]	CT,NH,NY,NC,ME,VA,PA
Aroclor-1248	CT,NH,NY,NC,ME,VA,PA
Aroclor-1248 [2C]	CT,NH,NY,NC,ME,VA,PA
Aroclor-1254	CT,NH,NY,NC,ME,VA,PA
Aroclor-1254 [2C]	CT,NH,NY,NC,ME,VA,PA
Aroclor-1260	CT,NH,NY,NC,ME,VA,PA
Aroclor-1260 [2C]	CT,NH,NY,NC,ME,VA,PA
Aroclor-1262	NH,NY,NC,ME,VA,PA
Aroclor-1262 [2C]	NH,NY,NC,ME,VA,PA
Aroclor-1268	NH,NY,NC,ME,VA,PA
Aroclor-1268 [2C]	NH,NY,NC,ME,VA,PA
SW-846 8151A in Soil	
2,4-D	NY,ME,NC,NH,VA,CT
2,4-D [2C]	NY,ME,NC,NH,VA,CT
2,4-DB	NY,ME,NC,NH,VA,CT
2,4-DB [2C]	NY,ME,NC,NH,VA,CT
2,4,5-TP (Silvex)	NY,ME,NC,NH,VA,CT
2,4,5-TP (Silvex) [2C]	NY,ME,NC,NH,VA,CT

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CERTIFICATIONS

Certified Analyses included in this Report

Analyte	Certifications
SW-846 8151A in Soil	
2,4,5-T	NY,ME,NC,NH,VA,CT
2,4,5-T [2C]	NY,ME,NC,NH,VA,CT
Dalapon	NY,ME,NC,NH,VA,CT
Dalapon [2C]	NY,ME,NC,NH,VA,CT
Dicamba	NY,ME,NC,NH,VA,CT
Dicamba [2C]	NY,ME,NC,NH,VA,CT
Dichloroprop	NY,ME,NC,NH,VA,CT
Dichloroprop [2C]	NY,ME,NC,NH,VA,CT
Dinoseb	NY,ME,NC,NH,VA,CT
Dinoseb [2C]	NY,ME,NC,NH,VA,CT
MCPA	NY,ME,NC,NH,VA,CT
MCPA [2C]	NY,ME,NC,NH,VA,CT
MCPP	NY,ME,NC,NH,VA,CT
MCPP [2C]	NY,ME,NC,NH,VA,CT
SW-846 8151A in Water	
2,4-D	ME,NC,NH,CT,NY,VA
2,4-D [2C]	ME,NC,NH,CT,NY,VA
2,4-DB	ME,NC,NH,CT,NY,VA
2,4-DB [2C]	ME,NC,NH,CT,NY,VA
2,4,5-TP (Silvex)	ME,NC,NH,CT,NY,VA
2,4,5-TP (Silvex) [2C]	ME,NC,NH,CT,NY,VA
2,4,5-T	ME,NC,NH,CT,NY,VA
2,4,5-T [2C]	ME,NC,NH,CT,NY,VA
Dalapon	ME,NC,NH,CT,NY,VA
Dalapon [2C]	ME,NC,NH,CT,NY,VA
Dicamba	ME,NC,NH,CT,NY,VA
Dicamba [2C]	ME,NC,NH,CT,NY,VA
Dichloroprop	ME,NC,NH,CT,NY,VA
Dichloroprop [2C]	ME,NC,NH,CT,NY,VA
Dinoseb	ME,NC,NH,CT,NY,VA
Dinoseb [2C]	ME,NC,NH,CT,NY,VA
MCPA	NC,CT
MCPA [2C]	NC,CT
MCPP	NC,CT
MCPP [2C]	NC,CT
SW-846 8260C-D in Soil	
Acetone	CT,NH,NY,ME
Acetone	CT,NH,NY,ME
Benzene	CT,NH,NY,ME
Benzene	CT,NH,NY,ME
Bromobenzene	NH,NY,ME
Bromobenzene	NH,NY,ME
Bromochloromethane	NH,NY,ME
Bromochloromethane	NH,NY,ME
Bromodichloromethane	CT,NH,NY,ME
Bromodichloromethane	CT,NH,NY,ME

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CERTIFICATIONS

Certified Analyses included in this Report

Analyte	Certifications
SW-846 8260C-D in Soil	
Bromoform	CT,NH,NY,ME
Bromoform	CT,NH,NY,ME
Bromomethane	CT,NH,NY,ME
Bromomethane	CT,NH,NY,ME
2-Butanone (MEK)	CT,NH,NY,ME
2-Butanone (MEK)	CT,NH,NY,ME
n-Butylbenzene	CT,NH,NY,ME
n-Butylbenzene	CT,NH,NY,ME
sec-Butylbenzene	CT,NH,NY,ME
sec-Butylbenzene	CT,NH,NY,ME
tert-Butylbenzene	CT,NH,NY,ME
tert-Butylbenzene	CT,NH,NY,ME
Carbon Disulfide	CT,NH,NY,ME
Carbon Disulfide	CT,NH,NY,ME
Carbon Tetrachloride	CT,NH,NY,ME
Carbon Tetrachloride	CT,NH,NY,ME
Chlorobenzene	CT,NH,NY,ME
Chlorobenzene	CT,NH,NY,ME
Chlorodibromomethane	CT,NH,NY,ME
Chlorodibromomethane	CT,NH,NY,ME
Chloroethane	CT,NH,NY,ME
Chloroethane	CT,NH,NY,ME
Chloroform	CT,NH,NY,ME
Chloroform	CT,NH,NY,ME
Chloromethane	CT,NH,NY,ME
Chloromethane	CT,NH,NY,ME
2-Chlorotoluene	CT,NH,NY,ME
2-Chlorotoluene	CT,NH,NY,ME
4-Chlorotoluene	CT,NH,NY,ME
4-Chlorotoluene	CT,NH,NY,ME
1,2-Dibromo-3-chloropropane (DBCP)	NY
1,2-Dibromo-3-chloropropane (DBCP)	NY
1,2-Dibromoethane (EDB)	NY
1,2-Dibromoethane (EDB)	NY
Dibromomethane	NH,NY,ME
Dibromomethane	NH,NY,ME
1,2-Dichlorobenzene	CT,NH,NY,ME
1,2-Dichlorobenzene	CT,NH,NY,ME
1,3-Dichlorobenzene	CT,NH,NY,ME
1,3-Dichlorobenzene	CT,NH,NY,ME
1,4-Dichlorobenzene	CT,NH,NY,ME
1,4-Dichlorobenzene	CT,NH,NY,ME
Dichlorodifluoromethane (Freon 12)	NY,ME
Dichlorodifluoromethane (Freon 12)	NY,ME
1,1-Dichloroethane	CT,NH,NY,ME
1,1-Dichloroethane	CT,NH,NY,ME
1,2-Dichloroethane	CT,NH,NY,ME

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CERTIFICATIONS

Certified Analyses included in this Report

Analyte	Certifications
SW-846 8260C-D in Soil	
1,2-Dichloroethane	CT,NH,NY,ME
1,1-Dichloroethylene	CT,NH,NY,ME
1,1-Dichloroethylene	CT,NH,NY,ME
cis-1,2-Dichloroethylene	CT,NH,NY,ME
cis-1,2-Dichloroethylene	CT,NH,NY,ME
trans-1,2-Dichloroethylene	CT,NH,NY,ME
trans-1,2-Dichloroethylene	CT,NH,NY,ME
1,2-Dichloropropane	CT,NH,NY,ME
1,2-Dichloropropane	CT,NH,NY,ME
1,3-Dichloropropane	NH,NY,ME
1,3-Dichloropropane	NH,NY,ME
2,2-Dichloropropane	NH,NY,ME
2,2-Dichloropropane	NH,NY,ME
1,1-Dichloropropene	NH,NY,ME
1,1-Dichloropropene	NH,NY,ME
cis-1,3-Dichloropropene	CT,NH,NY,ME
cis-1,3-Dichloropropene	CT,NH,NY,ME
trans-1,3-Dichloropropene	CT,NH,NY,ME
trans-1,3-Dichloropropene	CT,NH,NY,ME
1,4-Dioxane	NY
Ethylbenzene	CT,NH,NY,ME
Ethylbenzene	CT,NH,NY,ME
Hexachlorobutadiene	NH,NY,ME
Hexachlorobutadiene	NH,NY,ME
2-Hexanone (MBK)	CT,NH,NY,ME
2-Hexanone (MBK)	CT,NH,NY,ME
Isopropylbenzene (Cumene)	CT,NH,NY,ME
Isopropylbenzene (Cumene)	CT,NH,NY,ME
p-Isopropyltoluene (p-Cymene)	NH,NY
p-Isopropyltoluene (p-Cymene)	NH,NY
Methyl tert-Butyl Ether (MTBE)	NH,NY
Methyl tert-Butyl Ether (MTBE)	NY
Methylene Chloride	CT,NH,NY,ME
Methylene Chloride	CT,NH,NY,ME
4-Methyl-2-pentanone (MIBK)	CT,NH,NY
4-Methyl-2-pentanone (MIBK)	CT,NH,NY
Naphthalene	NH,NY,ME
Naphthalene	NH,NY,ME
n-Propylbenzene	NH,NY
n-Propylbenzene	NH,NY
Styrene	CT,NH,NY,ME
Styrene	CT,NH,NY,ME
1,1,1,2-Tetrachloroethane	CT,NH,NY,ME
1,1,1,2-Tetrachloroethane	CT,NH,NY,ME
1,1,2,2-Tetrachloroethane	CT,NH,NY,ME
1,1,2,2-Tetrachloroethane	CT,NH,NY,ME
Tetrachloroethylene	CT,NH,NY,ME

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CERTIFICATIONS

Certified Analyses included in this Report

Analyte	Certifications
SW-846 8260C-D in Soil	
Tetrachloroethylene	CT,NH,NY,ME
Toluene	CT,NH,NY,ME
Toluene	CT,NH,NY,ME
1,2,3-Trichlorobenzene	ME
1,2,3-Trichlorobenzene	NY
1,2,4-Trichlorobenzene	NH,NY,ME
1,2,4-Trichlorobenzene	NH,NY,ME
1,1,1-Trichloroethane	CT,NH,NY,ME
1,1,1-Trichloroethane	CT,NH,NY,ME
1,1,2-Trichloroethane	CT,NH,NY,ME
1,1,2-Trichloroethane	CT,NH,NY,ME
Trichloroethylene	CT,NH,NY,ME
Trichloroethylene	CT,NH,NY,ME
Trichlorofluoromethane (Freon 11)	CT,NH,NY,ME
Trichlorofluoromethane (Freon 11)	CT,NH,NY,ME
1,2,3-Trichloropropane	NH,NY,ME
1,2,3-Trichloropropane	NH,NY,ME
1,2,4-Trimethylbenzene	CT,NH,NY,ME
1,2,4-Trimethylbenzene	CT,NH,NY,ME
1,3,5-Trimethylbenzene	CT,NH,NY,ME
1,3,5-Trimethylbenzene	CT,NH,NY,ME
Vinyl Chloride	CT,NH,NY,ME
Vinyl Chloride	CT,NH,NY,ME
m+p Xylene	CT,NH,NY,ME
m+p Xylene	CT,NH,NY,ME
o-Xylene	CT,NH,NY,ME
o-Xylene	CT,NH,NY,ME
SW-846 8270D-E in Soil	
Acenaphthene	CT,NY,NH,ME,NC,VA
Acenaphthylene	CT,NY,NH,ME,NC,VA
Anthracene	CT,NY,NH,ME,NC,VA
Benzo(a)anthracene	CT,NY,NH,ME,NC,VA
Benzo(a)pyrene	CT,NY,NH,ME,NC,VA
Benzo(b)fluoranthene	CT,NY,NH,ME,NC,VA
Benzo(g,h,i)perylene	CT,NY,NH,ME,NC,VA
Benzo(k)fluoranthene	CT,NY,NH,ME,NC,VA
Chrysene	CT,NY,NH,ME,NC,VA
Dibenz(a,h)anthracene	CT,NY,NH,ME,NC,VA
Fluoranthene	CT,NY,NH,ME,NC,VA
Fluorene	CT,NY,NH,ME,NC,VA
Indeno(1,2,3-cd)pyrene	CT,NY,NH,ME,NC,VA
2-Methylnaphthalene	CT,NY,NH,ME,NC,VA
Naphthalene	CT,NY,NH,ME,NC,VA
Phenanthrene	CT,NY,NH,ME,NC,VA
Pyrene	CT,NY,NH,ME,NC,VA
SW-846 8270D-E in Water	

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CERTIFICATIONS

Certified Analyses included in this Report

Analyte	Certifications
SW-846 8270D-E in Water	
Acenaphthene	CT,NY,NH,ME,NC,VA
Acenaphthylene	CT,NY,NH,ME,NC,VA
Anthracene	CT,NY,NH,ME,NC,VA
Benzo(a)anthracene	CT,NY,NH,ME,NC,VA
Benzo(a)pyrene	CT,NY,NH,ME,NC,VA
Benzo(b)fluoranthene	CT,NY,NH,ME,NC,VA
Benzo(g,h,i)perylene	CT,NY,NH,ME,NC,VA
Benzo(k)fluoranthene	CT,NY,NH,ME,NC,VA
Chrysene	CT,NY,NH,ME,NC,VA
Dibenz(a,h)anthracene	CT,NY,NH,ME,NC,VA
Fluoranthene	CT,NY,NH,ME,NC,VA
Fluorene	CT,NY,NH,ME,NC,VA
Indeno(1,2,3-cd)pyrene	CT,NY,NH,ME,NC,VA
2-Methylnaphthalene	CT,NY,NH,ME,NC,VA
Naphthalene	CT,NY,NH,ME,NC,VA
Phenanthrene	CT,NY,NH,ME,NC,VA
Pyrene	CT,NY,NH,ME,NC,VA

Con-Test, a Pace Environmental Laboratory, operates under the following certifications and accreditations:

Code	Description	Number	Expires
AIHA	AIHA-LAP, LLC - ISO17025:2017	100033	03/1/2022
MA	Massachusetts DEP	M-MA100	06/30/2022
CT	Connecticut Department of Publilc Health	PH-0165	12/31/2022
NY	New York State Department of Health	10899 NELAP	04/1/2022
NH-S	New Hampshire Environmental Lab	2516 NELAP	02/5/2022
RI	Rhode Island Department of Health	LAO00112	12/30/2021
NC	North Carolina Div. of Water Quality	652	12/31/2021
NJ	New Jersey DEP	MA007 NELAP	06/30/2022
FL	Florida Department of Health	E871027 NELAP	06/30/2022
VT	Vermont Department of Health Lead Laboratory	LL720741	07/30/2022
ME	State of Maine	MA00100	06/9/2023
VA	Commonwealth of Virginia	460217	12/14/2021
NH-P	New Hampshire Environmental Lab	2557 NELAP	09/6/2022
VT-DW	Vermont Department of Health Drinking Water	VT-255716	06/12/2022
NC-DW	North Carolina Department of Health	25703	07/31/2022
PA	Commonwealth of Pennsylvania DEP	68-05812	06/30/2022
MI	Dept. of Env, Great Lakes, and Energy	9100	09/6/2021

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☐ 56 Quarry Road, Trumbull, CT 06611
☐ 1419 Richland Street, Columbia, SC 29201
☐ 78 Interstate Drive, West Springfield, MA 01089
☒ 108 Myrtle Street, #502, North Quincy, MA 02171
☐ 317 Iron Horse Way, Suite 204, Providence, RI 02908
☐ 80 Washington Street, Suite 301, Poughkeepsie, NY
☐ Other _____

21I0421

CHAIN-OF-CUSTODY RECORD

41951

Turnaround: Due 9/16/21
☐ 24-Hour* ☐ 72-Hour* ☐ Other _____ (days)
☐ 48-Hour* ☐ Standard (____ days) *Surcharge Applies

Project Name	Project Location	Project Number	Laboratory
MVP Grant FY 22/23	Haverhill, MA	20170390.030	Pace Labs

Report To: Matt Krissake (MKrissane@fando.com)
Invoice To:
P.O. No.: 1543 20170390.030
Sampler's Signature: _____ Date: 9/9/21

Source Codes:
MW=Monitoring Well PW=Potable Water T=Treatment Facility S=Soil B=Sediment
SW=Surface Water ST=Stormwater W=Waste A=Air C=Concrete
X=Other TRIP BLANK

Analysis Request / Containers

Item No.	Transfer Check 1 2 3 4	Sample Number	Source Code	Date Sampled	Time Sampled	Total Metals *	PAH-only (8270D-E)	VOCs (8260D-E)	Pesticides + Herbicides	TCLP *	Total Organic Carbon	Soil VOA Vial, ☐ methanol	Soil VOA Vial, ☐ water ✱ $Na(SO_4)_2$	Glass Soil Container (16) oz	Other	Other	Water VOA Vial, ☐ As is ☐ HCl	Glass Amber (____) ml ☐ As is ☐ H_2SO_4	Plastic - As is, ☐ 250 ml ☐ 500 ☐ 1000 ml	Plastic - H_2SO_4, ☐ 250 ml ☐ 500 ml	Plastic - HNO_3, 250 ml ☐ Filtered ☐ 0.45μ ☐ 10μ	Plastic - NaOH, 250 ml	Comments
1	1 X	1543210907-01	X	9/7/21	0842					X			1	2									
2	2 X	-02	B	↓	0941	X	X	X	X	X	X	X	X	1	2	1	1	1					
3	3 X	-03	↓		1057	X	X	X	X	X	X	X	X	1	2	1	1	1					
4	4 X	-04			1125	X	X	X	X	X	X	X	X	1	2	1	1	1					
5	5 X	-05	↓	↓	1305	X	X	X	X	X	X	X	X	1	2	1	1	1					
6	6 X	1543210908-06	X	9/8/21	0954					X			1	2									
7	7 X	-07	B	↓	1027	X	X	X	X	X	X	X	X	1	2	1	1	1					
8	8 X	~~-08~~	B	↓	1104	X	X	X	X	X	X	X	X										

Transfer Number	Relinquished By	Accepted By	Date	Time
1		FED Fridge	9/9/21	
2		Paul Chalkley	9-9-21	1125
3	Paul Chalkley		9-9-21	1455
4		17:15 5.2	9/9/21	1900

Charge Exceptions: ☐ CT Tax Exempt ☐ QA/QC ☐ Other _____
____ Duplicates ☒ Blanks (Item Nos: 1 + 6)
Reporting and Detection Limit Requirements: ☐ RCP Deliverables ☐ MCP CAM Cert.
Additional Comments: * As, Cd, Cr, Cu, Pb, Hg, Ni, Zn
Hold Samples for TCLP

Table of Contents

I Have Not Confirmed Sample Container Numbers With Lab Staff Before Relinquishing Over Samples_____

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Doc# 277 Rev 5 2017

Login Sample Receipt Checklist - (Rejection Criteria Listing - Using Acceptance Policy) Any False Statement will be brought to the attention of the Client - State True or False

Client Fuss O'Neill

Received By [signature] Date 9/4/21 Time 1900

How were the samples received? In Cooler T No Cooler _____ On Ice T No Ice _____ Direct from Sampling _____ Ambient _____ Melted Ice _____

Were samples within Temperature? 2-6°C T By Gun # 3 Actual Temp - 5.2 By Blank # _____ Actual Temp - _____

Was Custody Seal Intact? n/a Were Samples Tampered with? n/a

Was COC Relinquished ? T Does Chain Agree With Samples? T

Are there broken/leaking/loose caps on any samples? F

Is COC in ink/ Legible? T Were samples received within holding time? _____

Did COC include all pertinent Information? Client T Analysis T Sampler Name _____ Project T ID's T Collection Dates/Times _____

Are Sample labels filled out and legible? T

Are there Lab to Filters? F Who was notified? _____

Are there Rushes? F Who was notified? _____

Are there Short Holds? F Who was notified? _____

Is there enough Volume? T

Is there Headspace where applicable? n/a MS/MSD? F

Proper Media/Containers Used? T Is splitting samples required? F

Were trip blanks received? T On COC? T

Do all samples have the proper pH? Acid n/a Base n/a

Vials	#	Containers:	#		#		#
Unp-		1 Liter Amb.		1 Liter Plastic		16 oz Amb.	6
HCL-		500 mL Amb.		500 mL Plastic		8oz Amb/Clear	6
Meoh-	8	250 mL Amb.		250 mL Plastic		4oz Amb/Clear	
Bisulfate-	16	Flashpoint		Col./Bacteria		2oz Amb/Clear	6
DI-		Other Glass		Other Plastic		Encore	
Thiosulfate-		SOC Kit		Plastic Bag		Frozen:	
Sulfuric-		Perchlorate		Ziplock			

Unused Media

Vials	#	Containers:	#		#		#
Unp-		1 Liter Amb.		1 Liter Plastic		16 oz Amb.	
HCL-		500 mL Amb.		500 mL Plastic		8oz Amb/Clear	
Meoh-		250 mL Amb.		250 mL Plastic		4oz Amb/Clear	
Bisulfate-		Col./Bacteria		Flashpoint		2oz Amb/Clear	
DI-		Other Plastic		Other Glass		Encore	
Thiosulfate-		SOC Kit		Plastic Bag		Frozen:	
Sulfuric-		Perchlorate		Ziplock			

Comments:

MADEP MCP Analytical Method Report Certification Form

Laboratory Name: Con-Test, a Pace Analytical Laboratory	Project #: 21I0471
Project Location: Haverhill, MA	RTN:

This Form provides certifications for the following data set: [list Laboratory Sample ID Number(s)]

21I0471-01 thru 21I0471-08

Matrices: Soil

CAM Protocol (check all that below)

8260 VOC CAM II A (X)	7470/7471 Hg CAM IIIB (X)	MassDEP VPH CAM IV A ( )	8082 PCB CAM V A (X)	9014 Total Cyanide/PAC CAM VI A ( )	6860 Perchlorate CAM VIII B ( )
8270 SVOC CAM II B (X)	7010 Metals CAM III C ( )	MassDEP VPH CAM IV C ( )	8081 Pesticides CAM V B (X)	7196 Hex Cr CAM VI B ( )	MassDEP APH CAM IX A ( )
6010 Metals CAM III A (X)	6020 Metals CAM III D ( )	MassDEP EPH CAM IV B (X)	8151 Herbicides CAM V C (X)	8330 Explosives CAM VIII A ( )	TO-15 VOC CAM IX B ( )

Affirmative response to Questions A throughF is required for "Presumptive Certainty" status

A	Were all samples received in a condition consistent with those described on the Chain-of-Custody, properly preserved (including temperature) in the field or laboratory, and prepared/analyzed within method holding times?	☑ Yes	☐ No[1]
B	Were the analytical method(s) and all associated QC requirements specificed in the selected CAM protocol(s) followed?	☑ Yes	☐ No[1]
C	Were all required corrective actions and analytical response actions specified in the selected CAM protocol(s) implemented for all identified performance standard non-conformances?	☑ Yes	☐ No[1]
D	Does the laboratory report comply with all the reporting requirements specified in CAM VII A, Quality Assurance and Quality Control Guidlines for the Acquisition and Reporting of Analytical Data?	☑ Yes	☐ No[1]
E a	VPH, EPH, and APH Methods only: Was each method conducted without significant modification(s)? (Refer to the individual method(s) for a list of significant modifications).	☑ Yes	☐ No[1]
E b	APH and TO-15 Methods only: Was the complete analyte list reported for each method?	☐ Yes	☐ No[1]
F	Were all applicable CAM protocol QC and performance standard non-conformances identified and evaluated in a laboratory narrative (including all No responses to Qestions A through E)?	☑ Yes	☐ No[1]

A response to questions G, H and I below is required for "Presumptive Certainty" status

G	Were the reporting limits at or below all CAM reporting limits specified in the selected CAM protocol(s)?	☑ Yes	☐ No[1]

***Data User Note:* Data that achieve "Presumptive Certainty" status may not necessarily meet the data usability and representativeness requirements described in 310 CMR 40. 1056 (2)(k) and WSC-07-350.**

H	Were all QC perfomance standards specified in the CAM protocol(s) achieved?	☐ Yes	☑ No[1]
I	Were results reported for the complete analyte list specified in the selected CAM protocol(s)?	☐ Yes	☑ No[1]

[1] *All Negative responses must be addressed in an attached Environmental Laboratory case narrative.*

I, the undersigned, attest under the pains and penalties of perjury that, based upon my personal inquiry of those responsible for obtaining the information, the material contained in this analytical report is, to the best of my knowledge and belief, accurate and complete.

Signature: Lisa Worthington Position: Technical Representative

Printed Name: Lisa A. Worthington Date: 09/20/21

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September 27, 2021

Matt Kissane
Fuss & O'Neill EnviroScience, LLC - MA
108 Myrtle St,
Quincy, MA 02171

Project Location: Haverhill, MA
Client Job Number:
Project Number: 20170390.U30
Laboratory Work Order Number: 21I0997

Enclosed are results of analyses for samples received by the laboratory on September 20, 2021. If you have any questions concerning this report, please feel free to contact me.

Sincerely,

Jessica L. Hoffman
Project Manager

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39 Spruce Street * East Longmeadow, MA 01028 * FAX 413/525-6405 * TEL. 413/525-2332

Fuss & O'Neill EnviroScience, LLC - MA
108 Myrtle St,
Quincy, MA 02171
ATTN: Matt Kissane

REPORT DATE: 9/27/2021

PURCHASE ORDER NUMBER:

PROJECT NUMBER: 20170390.U30

ANALYTICAL SUMMARY

WORK ORDER NUMBER: 21I0997

The results of analyses performed on the following samples submitted to CON-TEST, a Pace Analytical Laboratory, are found in this report.

PROJECT LOCATION: Haverhill, MA

FIELD SAMPLE #	LAB ID:	MATRIX	SAMPLE DESCRIPTION	TEST	SUB LAB
1543210917-01	21I0997-01	Soil		SM 2540G	
				SW-846 6010D	
				SW-846 8082A	
1543210917-02	21I0997-02	Soil		SM 2540G	
				SW-846 6010D	
				SW-846 8082A	
1543210917-03	21I0997-03	Soil		SM 2540G	
				SW-846 6010D	
				SW-846 8082A	
1543210917-04	21I0997-04	Soil		MADEP EPH rev 2.1	
				SM 2540G	
				SW-846 6010D	
				SW-846 8082A	
				SW-846 8270D-E	
1543210917-05	21I0997-05	Soil		MADEP EPH rev 2.1	
				SM 2540G	
				SW-846 6010D	
				SW-846 8082A	
				SW-846 8270D-E	
1543210917-06	21I0997-06	Soil		MADEP EPH rev 2.1	
				SM 2540G	
				SW-846 6010D	
				SW-846 8082A	
				SW-846 8270D-E	
1543210917-07	21I0997-07	Soil		MADEP EPH rev 2.1	
				SM 2540G	
				SW-846 6010D	
				SW-846 8082A	
				SW-846 8270D-E	
1543210917-08	21I0997-08	Soil		MADEP EPH rev 2.1	
				SM 2540G	
				SW-846 6010D	
				SW-846 8082A	
				SW-846 8270D-E	
1543210917-09	21I0997-09	Soil		MADEP EPH rev 2.1	
				SM 2540G	
				SW-846 6010D	
				SW-846 8082A	
				SW-846 8270D-E	

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Fuss & O'Neill EnviroScience, LLC - MA
108 Myrtle St,
Quincy, MA 02171
ATTN: Matt Kissane

REPORT DATE: 9/27/2021

PURCHASE ORDER NUMBER:

PROJECT NUMBER: 20170390.U30

ANALYTICAL SUMMARY

WORK ORDER NUMBER: 21I0997

The results of analyses performed on the following samples submitted to CON-TEST, a Pace Analytical Laboratory, are found in this report.

PROJECT LOCATION: Haverhill, MA

FIELD SAMPLE #	LAB ID:	MATRIX	SAMPLE DESCRIPTION	TEST	SUB LAB
1543210917-10	21I0997-10	Soil		MADEP EPH rev 2.1 SM 2540G SW-846 6010D SW-846 8082A SW-846 8270D-E	

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CASE NARRATIVE SUMMARY

All reported results are within defined laboratory quality control objectives unless listed below or otherwise qualified in this report.

For method 8270E, only PAHs were requested and reported.
For method MA EPH, only hydrocarbon ranges were requested and reported.
For Method 6010, only As and Pb were requested and reported.

SW-846 8082A

Qualifications:

O-32

A dilution was performed as part of the standard analytical procedure.

Analyte & Samples(s) Qualified:

21I0997-02[1543210917-02], 21I0997-04[1543210917-04], 21I0997-06[1543210917-06], 21I0997-07[1543210917-07], 21I0997-08[1543210917-08], 21I0997-09[1543210917-09], 21I0997-10[1543210917-10]

The results of analyses reported only relate to samples submitted to Con-Test, a Pace Analytical Laboratory, for testing.
I certify that the analyses listed above, unless specifically listed as subcontracted, if any, were performed under my direction according to the approved methodologies listed in this document, and that based upon my inquiry of those individuals immediately responsible for obtaining the information, the material contained in this report is, to the best of my knowledge and belief, accurate and complete.

Tod E. Kopyscinski
Laboratory Director

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39 Spruce Street * East Longmeadow, MA 01028 * FAX 413/525-6405 * TEL. 413/525-2332

Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0997

Date Received: 9/20/2021

Field Sample #: 1543210917-01 | Sampled: 9/17/2021 08:35

Sample ID: 21I0997-01

Sample Matrix: Soil

Polychlorinated Biphenyls By GC/ECD

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Aroclor-1016 [1]	ND	0.16	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 11:34	SFM
Aroclor-1221 [1]	ND	0.16	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 11:34	SFM
Aroclor-1232 [1]	ND	0.16	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 11:34	SFM
Aroclor-1242 [1]	ND	0.16	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 11:34	SFM
Aroclor-1248 [1]	ND	0.16	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 11:34	SFM
Aroclor-1254 [2]	0.20	0.16	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 11:34	SFM
Aroclor-1260 [1]	ND	0.16	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 11:34	SFM
Aroclor-1262 [1]	ND	0.16	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 11:34	SFM
Aroclor-1268 [1]	ND	0.16	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 11:34	SFM

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Decachlorobiphenyl [1]	79.6	30-150		9/23/21 11:34
Decachlorobiphenyl [2]	82.0	30-150		9/23/21 11:34
Tetrachloro-m-xylene [1]	74.7	30-150		9/23/21 11:34
Tetrachloro-m-xylene [2]	68.6	30-150		9/23/21 11:34

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0997

Date Received: 9/20/2021

Field Sample #: 1543210917-01 | Sampled: 9/17/2021 08:35

Sample ID: 21I0997-01

Sample Matrix: Soil

Metals Analyses (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Arsenic	12	6.2	mg/Kg dry	1		SW-846 6010D	9/24/21	9/26/21 23:37	JLC
Lead	150	0.92	mg/Kg dry	1		SW-846 6010D	9/24/21	9/26/21 23:37	JLC

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0997

Date Received: 9/20/2021

Field Sample #: 1543210917-01 | Sampled: 9/17/2021 08:35

Sample ID: 21I0997-01

Sample Matrix: Soil

Conventional Chemistry Parameters by EPA/APHA/SW-846 Methods (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
% Solids	50.8		% Wt	1		SM 2540G	9/23/21	9/24/21 12:41	BMB

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0997

Date Received: 9/20/2021

Field Sample #: 1543210917-02 | Sampled: 9/17/2021 08:55

Sample ID: 21I0997-02

Sample Matrix: Soil

Sample Flags: O-32

Polychlorinated Biphenyls By GC/ECD

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Aroclor-1016 [1]	ND	0.19	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 11:52	SFM
Aroclor-1221 [1]	ND	0.19	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 11:52	SFM
Aroclor-1232 [1]	ND	0.19	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 11:52	SFM
Aroclor-1242 [1]	ND	0.19	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 11:52	SFM
Aroclor-1248 [1]	ND	0.19	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 11:52	SFM
Aroclor-1254 [1]	ND	0.19	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 11:52	SFM
Aroclor-1260 [1]	ND	0.19	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 11:52	SFM
Aroclor-1262 [1]	ND	0.19	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 11:52	SFM
Aroclor-1268 [1]	ND	0.19	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 11:52	SFM

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Decachlorobiphenyl [1]	67.3	30-150		9/23/21 11:52
Decachlorobiphenyl [2]	69.5	30-150		9/23/21 11:52
Tetrachloro-m-xylene [1]	64.8	30-150		9/23/21 11:52
Tetrachloro-m-xylene [2]	58.9	30-150		9/23/21 11:52

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0997

Date Received: 9/20/2021

Field Sample #: 1543210917-02 | Sampled: 9/17/2021 08:55

Sample ID: 21I0997-02

Sample Matrix: Soil

Metals Analyses (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Arsenic	41	7.7	mg/Kg dry	1		SW-846 6010D	9/24/21	9/26/21 23:44	JLC
Lead	240	1.2	mg/Kg dry	1		SW-846 6010D	9/24/21	9/26/21 23:44	JLC

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0997

Date Received: 9/20/2021

Field Sample #: 1543210917-02 | Sampled: 9/17/2021 08:55

Sample ID: 21I0997-02

Sample Matrix: Soil

Conventional Chemistry Parameters by EPA/APHA/SW-846 Methods (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
% Solids	41.2		% Wt	1		SM 2540G	9/23/21	9/24/21 12:41	BMB

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0997

Date Received: 9/20/2021

Field Sample #: 1543210917-03 | Sampled: 9/17/2021 08:45

Sample ID: 21I0997-03

Sample Matrix: Soil

Polychlorinated Biphenyls By GC/ECD

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Aroclor-1016 [1]	ND	0.15	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 12:10	SFM
Aroclor-1221 [1]	ND	0.15	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 12:10	SFM
Aroclor-1232 [1]	ND	0.15	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 12:10	SFM
Aroclor-1242 [1]	ND	0.15	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 12:10	SFM
Aroclor-1248 [1]	ND	0.15	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 12:10	SFM
Aroclor-1254 [1]	0.23	0.15	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 12:10	SFM
Aroclor-1260 [1]	ND	0.15	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 12:10	SFM
Aroclor-1262 [1]	ND	0.15	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 12:10	SFM
Aroclor-1268 [1]	ND	0.15	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 12:10	SFM

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Decachlorobiphenyl [1]	72.2	30-150		9/23/21 12:10
Decachlorobiphenyl [2]	74.3	30-150		9/23/21 12:10
Tetrachloro-m-xylene [1]	68.3	30-150		9/23/21 12:10
Tetrachloro-m-xylene [2]	61.3	30-150		9/23/21 12:10

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0997

Date Received: 9/20/2021

Field Sample #: 1543210917-03 | Sampled: 9/17/2021 08:45

Sample ID: 21I0997-03

Sample Matrix: Soil

Metals Analyses (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Arsenic	13	6.0	mg/Kg dry	1		SW-846 6010D	9/24/21	9/26/21 23:51	JLC
Lead	600	0.91	mg/Kg dry	1		SW-846 6010D	9/24/21	9/26/21 23:51	JLC

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0997

Date Received: 9/20/2021

Field Sample #: 1543210917-03 | Sampled: 9/17/2021 08:45

Sample ID: 21I0997-03

Sample Matrix: Soil

Conventional Chemistry Parameters by EPA/APHA/SW-846 Methods (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
% Solids	52.0		% Wt	1		SM 2540G	9/23/21	9/24/21 12:41	BMB

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0997

Date Received: 9/20/2021

Field Sample #: 1543210917-04 | Sampled: 9/17/2021 09:40

Sample ID: 21I0997-04

Sample Matrix: Soil

Semivolatile Organic Compounds by GC/MS

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Acenaphthene	ND	0.32	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/24/21 14:30	BGL
Acenaphthylene	ND	0.32	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/24/21 14:30	BGL
Anthracene	ND	0.32	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/24/21 14:30	BGL
Benzo(a)anthracene	1.0	0.32	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/24/21 14:30	BGL
Benzo(a)pyrene	1.2	0.32	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/24/21 14:30	BGL
Benzo(b)fluoranthene	1.5	0.32	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/24/21 14:30	BGL
Benzo(g,h,i)perylene	0.65	0.32	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/24/21 14:30	BGL
Benzo(k)fluoranthene	0.58	0.32	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/24/21 14:30	BGL
Chrysene	1.1	0.32	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/24/21 14:30	BGL
Dibenz(a,h)anthracene	ND	0.32	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/24/21 14:30	BGL
Fluoranthene	2.3	0.32	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/24/21 14:30	BGL
Fluorene	ND	0.32	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/24/21 14:30	BGL
Indeno(1,2,3-cd)pyrene	0.82	0.32	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/24/21 14:30	BGL
2-Methylnaphthalene	ND	0.32	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/24/21 14:30	BGL
Naphthalene	ND	0.32	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/24/21 14:30	BGL
Phenanthrene	1.2	0.32	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/24/21 14:30	BGL
Pyrene	2.0	0.32	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/24/21 14:30	BGL

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Nitrobenzene-d5	63.3	30-130		9/24/21 14:30
2-Fluorobiphenyl	74.3	30-130		9/24/21 14:30
p-Terphenyl-d14	92.5	30-130		9/24/21 14:30

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0997

Date Received: 9/20/2021

Field Sample #: 1543210917-04 | Sampled: 9/17/2021 09:40

Sample ID: 21I0997-04

Sample Matrix: Soil

Sample Flags: O-32

Polychlorinated Biphenyls By GC/ECD

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Aroclor-1016 [1]	ND	0.15	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 12:27	SFM
Aroclor-1221 [1]	ND	0.15	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 12:27	SFM
Aroclor-1232 [1]	ND	0.15	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 12:27	SFM
Aroclor-1242 [1]	ND	0.15	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 12:27	SFM
Aroclor-1248 [1]	ND	0.15	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 12:27	SFM
Aroclor-1254 [1]	ND	0.15	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 12:27	SFM
Aroclor-1260 [1]	ND	0.15	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 12:27	SFM
Aroclor-1262 [1]	ND	0.15	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 12:27	SFM
Aroclor-1268 [1]	ND	0.15	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 12:27	SFM

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Decachlorobiphenyl [1]	68.4	30-150		9/23/21 12:27
Decachlorobiphenyl [2]	66.2	30-150		9/23/21 12:27
Tetrachloro-m-xylene [1]	66.6	30-150		9/23/21 12:27
Tetrachloro-m-xylene [2]	62.5	30-150		9/23/21 12:27

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0997

Date Received: 9/20/2021

Field Sample #: 1543210917-04 | Sampled: 9/17/2021 09:40

Sample ID: 21I0997-04

Sample Matrix: Soil

Petroleum Hydrocarbons Analyses - EPH

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
C9-C18 Aliphatics	24	19	mg/Kg dry	1		MADEP EPH rev 2.1	9/21/21	9/24/21 4:29	AYH
C19-C36 Aliphatics	150	19	mg/Kg dry	1		MADEP EPH rev 2.1	9/21/21	9/24/21 4:29	AYH
Unadjusted C11-C22 Aromatics	110	19	mg/Kg dry	1		MADEP EPH rev 2.1	9/21/21	9/24/21 4:29	AYH
C11-C22 Aromatics	98	19	mg/Kg dry	1		MADEP EPH rev 2.1	9/21/21	9/24/21 4:29	AYH

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Chlorooctadecane (COD)	70.0	40-140		9/24/21 4:29
o-Terphenyl (OTP)	74.2	40-140		9/24/21 4:29
2-Bromonaphthalene	85.1	40-140		9/24/21 4:29
2-Fluorobiphenyl	85.4	40-140		9/24/21 4:29

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0997

Date Received: 9/20/2021

Field Sample #: 1543210917-04 | Sampled: 9/17/2021 09:40

Sample ID: 21I0997-04

Sample Matrix: Soil

Metals Analyses (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Arsenic	14	6.1	mg/Kg dry	1		SW-846 6010D	9/24/21	9/26/21 23:58	JLC
Lead	79	0.91	mg/Kg dry	1		SW-846 6010D	9/24/21	9/26/21 23:58	JLC

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0997

Date Received: 9/20/2021

Field Sample #: 1543210917-04 | Sampled: 9/17/2021 09:40

Sample ID: 21I0997-04

Sample Matrix: Soil

Conventional Chemistry Parameters by EPA/APHA/SW-846 Methods (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
% Solids	53.8		% Wt	1		SM 2540G	9/23/21	9/24/21 12:41	BMB

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0997

Date Received: 9/20/2021

Field Sample #: 1543210917-05 | Sampled: 9/17/2021 09:15

Sample ID: 21I0997-05

Sample Matrix: Soil

Semivolatile Organic Compounds by GC/MS

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Acenaphthene	ND	0.41	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 17:06	IMR
Acenaphthylene	ND	0.41	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 17:06	IMR
Anthracene	ND	0.41	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 17:06	IMR
Benzo(a)anthracene	1.2	0.41	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 17:06	IMR
Benzo(a)pyrene	1.4	0.41	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 17:06	IMR
Benzo(b)fluoranthene	2.0	0.41	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 17:06	IMR
Benzo(g,h,i)perylene	0.84	0.41	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 17:06	IMR
Benzo(k)fluoranthene	0.77	0.41	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 17:06	IMR
Chrysene	1.5	0.41	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 17:06	IMR
Dibenz(a,h)anthracene	ND	0.41	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 17:06	IMR
Fluoranthene	2.6	0.41	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 17:06	IMR
Fluorene	ND	0.41	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 17:06	IMR
Indeno(1,2,3-cd)pyrene	0.87	0.41	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 17:06	IMR
2-Methylnaphthalene	ND	0.41	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 17:06	IMR
Naphthalene	ND	0.41	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 17:06	IMR
Phenanthrene	1.4	0.41	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 17:06	IMR
Pyrene	2.4	0.41	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 17:06	IMR

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Nitrobenzene-d5	52.5	30-130		9/22/21 17:06
2-Fluorobiphenyl	55.7	30-130		9/22/21 17:06
p-Terphenyl-d14	55.4	30-130		9/22/21 17:06

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0997

Date Received: 9/20/2021

Field Sample #: 1543210917-05 | Sampled: 9/17/2021 09:15

Sample ID: 21I0997-05

Sample Matrix: Soil

Polychlorinated Biphenyls By GC/ECD

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Aroclor-1016 [1]	ND	0.19	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 12:45	SFM
Aroclor-1221 [1]	ND	0.19	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 12:45	SFM
Aroclor-1232 [1]	ND	0.19	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 12:45	SFM
Aroclor-1242 [1]	ND	0.19	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 12:45	SFM
Aroclor-1248 [1]	ND	0.19	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 12:45	SFM
Aroclor-1254 [2]	0.20	0.19	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 12:45	SFM
Aroclor-1260 [1]	ND	0.19	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 12:45	SFM
Aroclor-1262 [1]	ND	0.19	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 12:45	SFM
Aroclor-1268 [1]	ND	0.19	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 12:45	SFM

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Decachlorobiphenyl [1]	54.6	30-150		9/23/21 12:45
Decachlorobiphenyl [2]	54.8	30-150		9/23/21 12:45
Tetrachloro-m-xylene [1]	43.9	30-150		9/23/21 12:45
Tetrachloro-m-xylene [2]	40.4	30-150		9/23/21 12:45

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0997

Date Received: 9/20/2021

Field Sample #: 1543210917-05 | Sampled: 9/17/2021 09:15

Sample ID: 21I0997-05

Sample Matrix: Soil

Petroleum Hydrocarbons Analyses - EPH

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
C9-C18 Aliphatics	99	24	mg/Kg dry	1		MADEP EPH rev 2.1	9/21/21	9/24/21 5:10	AYH
C19-C36 Aliphatics	640	48	mg/Kg dry	2		MADEP EPH rev 2.1	9/21/21	9/24/21 14:35	AYH
Unadjusted C11-C22 Aromatics	360	24	mg/Kg dry	1		MADEP EPH rev 2.1	9/21/21	9/24/21 5:10	AYH
C11-C22 Aromatics	320	24	mg/Kg dry	1		MADEP EPH rev 2.1	9/21/21	9/24/21 5:10	AYH

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Chlorooctadecane (COD)	48.1	40-140		9/24/21 5:10
Chlorooctadecane (COD)	60.0	40-140		9/24/21 14:35
o-Terphenyl (OTP)	56.5	40-140		9/24/21 5:10
2-Bromonaphthalene	82.4	40-140		9/24/21 5:10
2-Fluorobiphenyl	76.8	40-140		9/24/21 5:10

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Project Location: Haverhill, MA
Sample Description:
Work Order: 21I0997

Date Received: 9/20/2021

Field Sample #: 1543210917-05
Sampled: 9/17/2021 09:15

Sample ID: 21I0997-05

Sample Matrix: Soil

Metals Analyses (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Arsenic	16	8.1	mg/Kg dry	1		SW-846 6010D	9/24/21	9/27/21 0:05	JLC
Lead	320	1.2	mg/Kg dry	1		SW-846 6010D	9/24/21	9/27/21 0:05	JLC

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0997

Date Received: 9/20/2021

Field Sample #: 1543210917-05 | Sampled: 9/17/2021 09:15

Sample ID: 21I0997-05

Sample Matrix: Soil

Conventional Chemistry Parameters by EPA/APHA/SW-846 Methods (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
% Solids	41.3		% Wt	1		SM 2540G	9/23/21	9/24/21 12:41	BMB

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0997

Date Received: 9/20/2021

Field Sample #: 1543210917-06 | Sampled: 9/17/2021 09:25

Sample ID: 21I0997-06

Sample Matrix: Soil

Semivolatile Organic Compounds by GC/MS

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Acenaphthene	ND	0.23	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 17:29	IMR
Acenaphthylene	ND	0.23	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 17:29	IMR
Anthracene	ND	0.23	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 17:29	IMR
Benzo(a)anthracene	ND	0.23	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 17:29	IMR
Benzo(a)pyrene	ND	0.23	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 17:29	IMR
Benzo(b)fluoranthene	ND	0.23	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 17:29	IMR
Benzo(g,h,i)perylene	ND	0.23	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 17:29	IMR
Benzo(k)fluoranthene	ND	0.23	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 17:29	IMR
Chrysene	ND	0.23	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 17:29	IMR
Dibenz(a,h)anthracene	ND	0.23	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 17:29	IMR
Fluoranthene	ND	0.23	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 17:29	IMR
Fluorene	ND	0.23	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 17:29	IMR
Indeno(1,2,3-cd)pyrene	ND	0.23	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 17:29	IMR
2-Methylnaphthalene	ND	0.23	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 17:29	IMR
Naphthalene	ND	0.23	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 17:29	IMR
Phenanthrene	ND	0.23	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 17:29	IMR
Pyrene	ND	0.23	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 17:29	IMR

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Nitrobenzene-d5	65.7	30-130		9/22/21 17:29
2-Fluorobiphenyl	56.8	30-130		9/22/21 17:29
p-Terphenyl-d14	63.8	30-130		9/22/21 17:29

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0997

Date Received: 9/20/2021

Field Sample #: 1543210917-06 | Sampled: 9/17/2021 09:25

Sample ID: 21I0997-06

Sample Matrix: Soil

Sample Flags: O-32

Polychlorinated Biphenyls By GC/ECD

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Aroclor-1016 [1]	ND	0.11	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 13:02	SFM
Aroclor-1221 [1]	ND	0.11	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 13:02	SFM
Aroclor-1232 [1]	ND	0.11	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 13:02	SFM
Aroclor-1242 [1]	ND	0.11	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 13:02	SFM
Aroclor-1248 [1]	ND	0.11	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 13:02	SFM
Aroclor-1254 [1]	ND	0.11	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 13:02	SFM
Aroclor-1260 [1]	ND	0.11	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 13:02	SFM
Aroclor-1262 [1]	ND	0.11	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 13:02	SFM
Aroclor-1268 [1]	ND	0.11	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 13:02	SFM

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Decachlorobiphenyl [1]	87.8	30-150		9/23/21 13:02
Decachlorobiphenyl [2]	85.9	30-150		9/23/21 13:02
Tetrachloro-m-xylene [1]	75.9	30-150		9/23/21 13:02
Tetrachloro-m-xylene [2]	71.9	30-150		9/23/21 13:02

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0997

Date Received: 9/20/2021

Field Sample #: 1543210917-06 | Sampled: 9/17/2021 09:25

Sample ID: 21I0997-06

Sample Matrix: Soil

Petroleum Hydrocarbons Analyses - EPH

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
C9-C18 Aliphatics	ND	14	mg/Kg dry	1		MADEP EPH rev 2.1	9/21/21	9/24/21 1:23	AYH
C19-C36 Aliphatics	ND	14	mg/Kg dry	1		MADEP EPH rev 2.1	9/21/21	9/24/21 1:23	AYH
Unadjusted C11-C22 Aromatics	ND	14	mg/Kg dry	1		MADEP EPH rev 2.1	9/21/21	9/24/21 1:23	AYH
C11-C22 Aromatics	ND	14	mg/Kg dry	1		MADEP EPH rev 2.1	9/21/21	9/24/21 1:23	AYH

Surrogates	% Recovery	Recovery Limits	Flag/Qual		
Chlorooctadecane (COD)	56.8	40-140		9/24/21	1:23
o-Terphenyl (OTP)	63.8	40-140		9/24/21	1:23
2-Bromonaphthalene	72.4	40-140		9/24/21	1:23
2-Fluorobiphenyl	72.0	40-140		9/24/21	1:23

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0997

Date Received: 9/20/2021

Field Sample #: 1543210917-06 | Sampled: 9/17/2021 09:25

Sample ID: 21I0997-06

Sample Matrix: Soil

Metals Analyses (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Arsenic	ND	4.3	mg/Kg dry	1		SW-846 6010D	9/24/21	9/27/21 0:24	JLC
Lead	3.0	0.64	mg/Kg dry	1		SW-846 6010D	9/24/21	9/27/21 0:24	JLC

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0997

Date Received: 9/20/2021

Field Sample #: 1543210917-06 | Sampled: 9/17/2021 09:25

Sample ID: 21I0997-06

Sample Matrix: Soil

Conventional Chemistry Parameters by EPA/APHA/SW-846 Methods (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
% Solids	73.9		% Wt	1		SM 2540G	9/23/21	9/24/21 12:41	BMB

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0997

Date Received: 9/20/2021

Field Sample #: 1543210917-07 | Sampled: 9/17/2021 09:35

Sample ID: 21I0997-07

Sample Matrix: Soil

Semivolatile Organic Compounds by GC/MS

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Acenaphthene	ND	0.30	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 17:52	IMR
Acenaphthylene	ND	0.30	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 17:52	IMR
Anthracene	ND	0.30	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 17:52	IMR
Benzo(a)anthracene	1.0	0.30	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 17:52	IMR
Benzo(a)pyrene	1.2	0.30	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 17:52	IMR
Benzo(b)fluoranthene	1.6	0.30	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 17:52	IMR
Benzo(g,h,i)perylene	0.89	0.30	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 17:52	IMR
Benzo(k)fluoranthene	0.66	0.30	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 17:52	IMR
Chrysene	1.3	0.30	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 17:52	IMR
Dibenz(a,h)anthracene	ND	0.30	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 17:52	IMR
Fluoranthene	2.2	0.30	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 17:52	IMR
Fluorene	ND	0.30	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 17:52	IMR
Indeno(1,2,3-cd)pyrene	0.91	0.30	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 17:52	IMR
2-Methylnaphthalene	ND	0.30	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 17:52	IMR
Naphthalene	ND	0.30	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 17:52	IMR
Phenanthrene	1.6	0.30	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 17:52	IMR
Pyrene	2.1	0.30	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 17:52	IMR

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Nitrobenzene-d5	62.2	30-130		9/22/21 17:52
2-Fluorobiphenyl	68.5	30-130		9/22/21 17:52
p-Terphenyl-d14	69.4	30-130		9/22/21 17:52

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0997

Date Received: 9/20/2021

Field Sample #: 1543210917-07 | Sampled: 9/17/2021 09:35

Sample ID: 21I0997-07

Sample Matrix: Soil

Sample Flags: O-32

Polychlorinated Biphenyls By GC/ECD

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Aroclor-1016 [1]	ND	0.14	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 13:20	SFM
Aroclor-1221 [1]	ND	0.14	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 13:20	SFM
Aroclor-1232 [1]	ND	0.14	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 13:20	SFM
Aroclor-1242 [1]	ND	0.14	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 13:20	SFM
Aroclor-1248 [1]	ND	0.14	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 13:20	SFM
Aroclor-1254 [1]	ND	0.14	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 13:20	SFM
Aroclor-1260 [1]	ND	0.14	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 13:20	SFM
Aroclor-1262 [1]	ND	0.14	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 13:20	SFM
Aroclor-1268 [1]	ND	0.14	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 13:20	SFM

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Decachlorobiphenyl [1]	78.2	30-150		9/23/21 13:20
Decachlorobiphenyl [2]	78.7	30-150		9/23/21 13:20
Tetrachloro-m-xylene [1]	74.8	30-150		9/23/21 13:20
Tetrachloro-m-xylene [2]	69.0	30-150		9/23/21 13:20

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0997

Date Received: 9/20/2021

Field Sample #: 1543210917-07 | Sampled: 9/17/2021 09:35

Sample ID: 21I0997-07

Sample Matrix: Soil

Petroleum Hydrocarbons Analyses - EPH

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
C9-C18 Aliphatics	49	18	mg/Kg dry	1		MADEP EPH rev 2.1	9/21/21	9/24/21 4:50	AYH
C19-C36 Aliphatics	190	18	mg/Kg dry	1		MADEP EPH rev 2.1	9/21/21	9/24/21 4:50	AYH
Unadjusted C11-C22 Aromatics	180	18	mg/Kg dry	1		MADEP EPH rev 2.1	9/21/21	9/24/21 4:50	AYH
C11-C22 Aromatics	150	18	mg/Kg dry	1		MADEP EPH rev 2.1	9/21/21	9/24/21 4:50	AYH

Surrogates	% Recovery	Recovery Limits	Flag/Qual		
Chlorooctadecane (COD)	67.4	40-140		9/24/21 4:50	
o-Terphenyl (OTP)	60.8	40-140		9/24/21 4:50	
2-Bromonaphthalene	71.0	40-140		9/24/21 4:50	
2-Fluorobiphenyl	68.3	40-140		9/24/21 4:50	

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Project Location: Haverhill, MA
Sample Description:
Work Order: 21I0997

Date Received: 9/20/2021

Field Sample #: 1543210917-07
Sampled: 9/17/2021 09:35

Sample ID: 21I0997-07

Sample Matrix: Soil

Metals Analyses (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Arsenic	13	5.7	mg/Kg dry	1		SW-846 6010D	9/24/21	9/27/21 0:31	JLC
Lead	200	0.86	mg/Kg dry	1		SW-846 6010D	9/24/21	9/27/21 0:31	JLC

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0997

Date Received: 9/20/2021

Field Sample #: 1543210917-07 | Sampled: 9/17/2021 09:35

Sample ID: 21I0997-07

Sample Matrix: Soil

Conventional Chemistry Parameters by EPA/APHA/SW-846 Methods (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
% Solids	56.8		% Wt	1		SM 2540G	9/23/21	9/24/21 12:42	BMB

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0997

Date Received: 9/20/2021

Field Sample #: 1543210917-08 | Sampled: 9/17/2021 10:20

Sample ID: 21I0997-08

Sample Matrix: Soil

Semivolatile Organic Compounds by GC/MS

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Acenaphthene	3.2	0.40	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 18:16	IMR
Acenaphthylene	ND	0.40	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 18:16	IMR
Anthracene	3.8	0.40	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 18:16	IMR
Benzo(a)anthracene	6.5	0.40	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 18:16	IMR
Benzo(a)pyrene	5.3	0.40	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 18:16	IMR
Benzo(b)fluoranthene	5.8	0.40	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 18:16	IMR
Benzo(g,h,i)perylene	3.3	0.40	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 18:16	IMR
Benzo(k)fluoranthene	2.2	0.40	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 18:16	IMR
Chrysene	7.2	0.40	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 18:16	IMR
Dibenz(a,h)anthracene	0.73	0.40	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 18:16	IMR
Fluoranthene	12	2.0	mg/Kg dry	5		SW-846 8270D-E	9/21/21	9/23/21 18:45	IMR
Fluorene	2.7	0.40	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 18:16	IMR
Indeno(1,2,3-cd)pyrene	3.3	0.40	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 18:16	IMR
2-Methylnaphthalene	1.3	0.40	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 18:16	IMR
Naphthalene	1.7	0.40	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 18:16	IMR
Phenanthrene	21	2.0	mg/Kg dry	5		SW-846 8270D-E	9/21/21	9/23/21 18:45	IMR
Pyrene	19	2.0	mg/Kg dry	5		SW-846 8270D-E	9/21/21	9/23/21 18:45	IMR

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Nitrobenzene-d5	60.6	30-130		9/22/21 18:16
Nitrobenzene-d5	64.7	30-130		9/23/21 18:45
2-Fluorobiphenyl	62.8	30-130		9/22/21 18:16
2-Fluorobiphenyl	70.0	30-130		9/23/21 18:45
p-Terphenyl-d14	64.6	30-130		9/22/21 18:16
p-Terphenyl-d14	76.2	30-130		9/23/21 18:45

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0997

Date Received: 9/20/2021

Field Sample #: 1543210917-08 | Sampled: 9/17/2021 10:20

Sample ID: 21I0997-08

Sample Matrix: Soil

Sample Flags: O-32

Polychlorinated Biphenyls By GC/ECD

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Aroclor-1016 [1]	ND	0.19	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 13:37	SFM
Aroclor-1221 [1]	ND	0.19	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 13:37	SFM
Aroclor-1232 [1]	ND	0.19	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 13:37	SFM
Aroclor-1242 [1]	ND	0.19	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 13:37	SFM
Aroclor-1248 [1]	ND	0.19	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 13:37	SFM
Aroclor-1254 [1]	ND	0.19	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 13:37	SFM
Aroclor-1260 [1]	ND	0.19	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 13:37	SFM
Aroclor-1262 [1]	ND	0.19	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 13:37	SFM
Aroclor-1268 [1]	ND	0.19	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 13:37	SFM

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Decachlorobiphenyl [1]	67.4	30-150		9/23/21 13:37
Decachlorobiphenyl [2]	67.6	30-150		9/23/21 13:37
Tetrachloro-m-xylene [1]	69.9	30-150		9/23/21 13:37
Tetrachloro-m-xylene [2]	63.8	30-150		9/23/21 13:37

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0997

Date Received: 9/20/2021

Field Sample #: 1543210917-08 | Sampled: 9/17/2021 10:20

Sample ID: 21I0997-08

Sample Matrix: Soil

Petroleum Hydrocarbons Analyses - EPH

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
C9-C18 Aliphatics	34	23	mg/Kg dry	1		MADEP EPH rev 2.1	9/21/21	9/24/21 4:09	AYH
C19-C36 Aliphatics	400	47	mg/Kg dry	2		MADEP EPH rev 2.1	9/21/21	9/24/21 14:55	AYH
Unadjusted C11-C22 Aromatics	300	23	mg/Kg dry	1		MADEP EPH rev 2.1	9/21/21	9/24/21 4:09	AYH
C11-C22 Aromatics	260	23	mg/Kg dry	1		MADEP EPH rev 2.1	9/21/21	9/24/21 4:09	AYH

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Chlorooctadecane (COD)	56.5	40-140		9/24/21 4:09
Chlorooctadecane (COD)	55.0	40-140		9/24/21 14:55
o-Terphenyl (OTP)	59.9	40-140		9/24/21 4:09
2-Bromonaphthalene	76.2	40-140		9/24/21 4:09
2-Fluorobiphenyl	76.1	40-140		9/24/21 4:09

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0997

Date Received: 9/20/2021

Field Sample #: 1543210917-08 | Sampled: 9/17/2021 10:20

Sample ID: 21I0997-08

Sample Matrix: Soil

Metals Analyses (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Arsenic	12	7.6	mg/Kg dry	1		SW-846 6010D	9/24/21	9/27/21 0:38	JLC
Lead	160	1.1	mg/Kg dry	1		SW-846 6010D	9/24/21	9/27/21 0:38	JLC

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0997

Date Received: 9/20/2021

Field Sample #: 1543210917-08 | Sampled: 9/17/2021 10:20

Sample ID: 21I0997-08

Sample Matrix: Soil

Conventional Chemistry Parameters by EPA/APHA/SW-846 Methods (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
% Solids	42.9		% Wt	1		SM 2540G	9/23/21	9/24/21 12:42	BMB

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0997

Date Received: 9/20/2021

Field Sample #: 1543210917-09 | Sampled: 9/17/2021 10:15

Sample ID: 21I0997-09

Sample Matrix: Soil

Semivolatile Organic Compounds by GC/MS

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Acenaphthene	0.37	0.29	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 18:39	IMR
Acenaphthylene	ND	0.29	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 18:39	IMR
Anthracene	1.5	0.29	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 18:39	IMR
Benzo(a)anthracene	2.9	0.29	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 18:39	IMR
Benzo(a)pyrene	2.8	0.29	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 18:39	IMR
Benzo(b)fluoranthene	3.3	0.29	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 18:39	IMR
Benzo(g,h,i)perylene	1.8	0.29	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 18:39	IMR
Benzo(k)fluoranthene	1.2	0.29	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 18:39	IMR
Chrysene	2.9	0.29	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 18:39	IMR
Dibenz(a,h)anthracene	0.43	0.29	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 18:39	IMR
Fluoranthene	5.9	0.29	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 18:39	IMR
Fluorene	0.59	0.29	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 18:39	IMR
Indeno(1,2,3-cd)pyrene	1.9	0.29	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 18:39	IMR
2-Methylnaphthalene	ND	0.29	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 18:39	IMR
Naphthalene	ND	0.29	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 18:39	IMR
Phenanthrene	5.2	0.29	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 18:39	IMR
Pyrene	5.8	0.29	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/22/21 18:39	IMR

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Nitrobenzene-d5	62.7	30-130		9/22/21 18:39
2-Fluorobiphenyl	61.7	30-130		9/22/21 18:39
p-Terphenyl-d14	61.4	30-130		9/22/21 18:39

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0997

Date Received: 9/20/2021

Field Sample #: 1543210917-09 | Sampled: 9/17/2021 10:15

Sample ID: 21I0997-09

Sample Matrix: Soil

Sample Flags: O-32

Polychlorinated Biphenyls By GC/ECD

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Aroclor-1016 [1]	ND	0.14	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 13:55	SFM
Aroclor-1221 [1]	ND	0.14	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 13:55	SFM
Aroclor-1232 [1]	ND	0.14	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 13:55	SFM
Aroclor-1242 [1]	ND	0.14	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 13:55	SFM
Aroclor-1248 [1]	ND	0.14	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 13:55	SFM
Aroclor-1254 [1]	ND	0.14	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 13:55	SFM
Aroclor-1260 [1]	ND	0.14	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 13:55	SFM
Aroclor-1262 [1]	ND	0.14	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 13:55	SFM
Aroclor-1268 [1]	ND	0.14	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 13:55	SFM

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Decachlorobiphenyl [1]	90.5	30-150		9/23/21 13:55
Decachlorobiphenyl [2]	89.4	30-150		9/23/21 13:55
Tetrachloro-m-xylene [1]	83.6	30-150		9/23/21 13:55
Tetrachloro-m-xylene [2]	76.6	30-150		9/23/21 13:55

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0997

Date Received: 9/20/2021

Field Sample #: 1543210917-09 | Sampled: 9/17/2021 10:15

Sample ID: 21I0997-09

Sample Matrix: Soil

Petroleum Hydrocarbons Analyses - EPH

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
C9-C18 Aliphatics	51	17	mg/Kg dry	1		MADEP EPH rev 2.1	9/21/21	9/24/21 13:56	AYH
C19-C36 Aliphatics	190	35	mg/Kg dry	2		MADEP EPH rev 2.1	9/21/21	9/24/21 16:51	AYH
Unadjusted C11-C22 Aromatics	110	17	mg/Kg dry	1		MADEP EPH rev 2.1	9/21/21	9/24/21 13:56	AYH
C11-C22 Aromatics	100	17	mg/Kg dry	1		MADEP EPH rev 2.1	9/21/21	9/24/21 13:56	AYH

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Chlorooctadecane (COD)	70.8	40-140		9/24/21 13:56
Chlorooctadecane (COD)	50.8	40-140		9/24/21 16:51
o-Terphenyl (OTP)	66.7	40-140		9/24/21 13:56
2-Bromonaphthalene	75.2	40-140		9/24/21 13:56
2-Fluorobiphenyl	74.0	40-140		9/24/21 13:56

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Project Location: Haverhill, MA
Sample Description:
Work Order: 21I0997

Date Received: 9/20/2021

Field Sample #: 1543210917-09
Sampled: 9/17/2021 10:15

Sample ID: 21I0997-09

Sample Matrix: Soil

Metals Analyses (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Arsenic	11	5.8	mg/Kg dry	1		SW-846 6010D	9/24/21	9/27/21 0:45	JLC
Lead	160	0.87	mg/Kg dry	1		SW-846 6010D	9/24/21	9/27/21 0:45	JLC

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0997

Date Received: 9/20/2021

Field Sample #: 1543210917-09 | Sampled: 9/17/2021 10:15

Sample ID: 21I0997-09

Sample Matrix: Soil

Conventional Chemistry Parameters by EPA/APHA/SW-846 Methods (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
% Solids	57.6		% Wt	1		SM 2540G	9/23/21	9/24/21 12:42	BMB

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0997

Date Received: 9/20/2021

Field Sample #: 1543210917-10 | Sampled: 9/17/2021 10:05

Sample ID: 21I0997-10

Sample Matrix: Soil

Semivolatile Organic Compounds by GC/MS

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Acenaphthene	ND	0.34	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/24/21 9:44	IMR
Acenaphthylene	ND	0.34	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/24/21 9:44	IMR
Anthracene	ND	0.34	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/24/21 9:44	IMR
Benzo(a)anthracene	1.2	0.34	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/24/21 9:44	IMR
Benzo(a)pyrene	1.2	0.34	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/24/21 9:44	IMR
Benzo(b)fluoranthene	1.6	0.34	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/24/21 9:44	IMR
Benzo(g,h,i)perylene	0.57	0.34	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/24/21 9:44	IMR
Benzo(k)fluoranthene	0.52	0.34	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/24/21 9:44	IMR
Chrysene	1.3	0.34	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/24/21 9:44	IMR
Dibenz(a,h)anthracene	ND	0.34	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/24/21 9:44	IMR
Fluoranthene	2.4	0.34	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/24/21 9:44	IMR
Fluorene	ND	0.34	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/24/21 9:44	IMR
Indeno(1,2,3-cd)pyrene	0.71	0.34	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/24/21 9:44	IMR
2-Methylnaphthalene	ND	0.34	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/24/21 9:44	IMR
Naphthalene	0.89	0.34	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/24/21 9:44	IMR
Phenanthrene	0.95	0.34	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/24/21 9:44	IMR
Pyrene	2.3	0.34	mg/Kg dry	1		SW-846 8270D-E	9/21/21	9/24/21 9:44	IMR

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Nitrobenzene-d5	77.2	30-130		9/24/21 9:44
2-Fluorobiphenyl	83.0	30-130		9/24/21 9:44
p-Terphenyl-d14	84.0	30-130		9/24/21 9:44

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0997

Date Received: 9/20/2021

Field Sample #: 1543210917-10 | Sampled: 9/17/2021 10:05

Sample ID: 21I0997-10

Sample Matrix: Soil

Sample Flags: O-32

Polychlorinated Biphenyls By GC/ECD

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Aroclor-1016 [1]	ND	0.16	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 14:13	SFM
Aroclor-1221 [1]	ND	0.16	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 14:13	SFM
Aroclor-1232 [1]	ND	0.16	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 14:13	SFM
Aroclor-1242 [1]	ND	0.16	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 14:13	SFM
Aroclor-1248 [1]	ND	0.16	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 14:13	SFM
Aroclor-1254 [1]	ND	0.16	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 14:13	SFM
Aroclor-1260 [1]	ND	0.16	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 14:13	SFM
Aroclor-1262 [1]	ND	0.16	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 14:13	SFM
Aroclor-1268 [1]	ND	0.16	mg/Kg dry	4		SW-846 8082A	9/21/21	9/23/21 14:13	SFM

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Decachlorobiphenyl [1]	74.2	30-150		9/23/21 14:13
Decachlorobiphenyl [2]	73.4	30-150		9/23/21 14:13
Tetrachloro-m-xylene [1]	74.1	30-150		9/23/21 14:13
Tetrachloro-m-xylene [2]	69.0	30-150		9/23/21 14:13

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0997

Date Received: 9/20/2021

Field Sample #: 1543210917-10 | Sampled: 9/17/2021 10:05

Sample ID: 21I0997-10

Sample Matrix: Soil

Petroleum Hydrocarbons Analyses - EPH

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
C9-C18 Aliphatics	29	20	mg/Kg dry	1		MADEP EPH rev 2.1	9/21/21	9/24/21 3:48	AYH
C19-C36 Aliphatics	280	40	mg/Kg dry	2		MADEP EPH rev 2.1	9/21/21	9/24/21 15:16	AYH
Unadjusted C11-C22 Aromatics	220	20	mg/Kg dry	1		MADEP EPH rev 2.1	9/21/21	9/24/21 3:48	AYH
C11-C22 Aromatics	200	20	mg/Kg dry	1		MADEP EPH rev 2.1	9/21/21	9/24/21 3:48	AYH

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Chlorooctadecane (COD)	57.5	40-140		9/24/21 3:48
Chlorooctadecane (COD)	48.7	40-140		9/24/21 15:16
o-Terphenyl (OTP)	74.6	40-140		9/24/21 3:48
2-Bromonaphthalene	96.7	40-140		9/24/21 3:48
2-Fluorobiphenyl	100	40-140		9/24/21 3:48

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0997

Date Received: 9/20/2021

Field Sample #: 1543210917-10 | Sampled: 9/17/2021 10:05

Sample ID: 21I0997-10

Sample Matrix: Soil

Metals Analyses (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Arsenic	14	6.4	mg/Kg dry	1		SW-846 6010D	9/24/21	9/27/21 0:51	JLC
Lead	160	0.96	mg/Kg dry	1		SW-846 6010D	9/24/21	9/27/21 0:51	JLC

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21I0997

Date Received: 9/20/2021

Field Sample #: 1543210917-10 | Sampled: 9/17/2021 10:05

Sample ID: 21I0997-10

Sample Matrix: Soil

Conventional Chemistry Parameters by EPA/APHA/SW-846 Methods (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
% Solids	50.1		% Wt	1		SM 2540G	9/23/21	9/24/21 12:42	BMB

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Sample Extraction Data

Prep Method: SW-846 3546 **Analytical Method: MADEP EPH rev 2.1**

Lab Number [Field ID]	Batch	Initial [g]	Final [mL]	Date
21I0997-04 [1543210917-04]	B290670	20.0	2.00	09/21/21
21I0997-05 [1543210917-05]	B290670	20.0	2.00	09/21/21
21I0997-05RE1 [1543210917-05]	B290670	20.0	2.00	09/21/21
21I0997-06 [1543210917-06]	B290670	20.0	2.00	09/21/21
21I0997-07 [1543210917-07]	B290670	20.0	2.00	09/21/21
21I0997-08 [1543210917-08]	B290670	20.0	2.00	09/21/21
21I0997-08RE1 [1543210917-08]	B290670	20.0	2.00	09/21/21
21I0997-09 [1543210917-09]	B290670	20.0	2.00	09/21/21
21I0997-09RE1 [1543210917-09]	B290670	20.0	2.00	09/21/21
21I0997-10 [1543210917-10]	B290670	20.0	2.00	09/21/21
21I0997-10RE1 [1543210917-10]	B290670	20.0	2.00	09/21/21

Prep Method: % Solids **Analytical Method: SM 2540G**

Lab Number [Field ID]	Batch	Date
21I0997-01 [1543210917-01]	B290731	09/23/21
21I0997-02 [1543210917-02]	B290731	09/23/21
21I0997-03 [1543210917-03]	B290731	09/23/21
21I0997-04 [1543210917-04]	B290731	09/23/21
21I0997-05 [1543210917-05]	B290731	09/23/21
21I0997-06 [1543210917-06]	B290731	09/23/21
21I0997-07 [1543210917-07]	B290731	09/23/21
21I0997-08 [1543210917-08]	B290731	09/23/21
21I0997-09 [1543210917-09]	B290731	09/23/21
21I0997-10 [1543210917-10]	B290731	09/23/21

Prep Method: SW-846 3050B **Analytical Method: SW-846 6010D**

Lab Number [Field ID]	Batch	Initial [g]	Final [mL]	Date
21I0997-01 [1543210917-01]	B290882	1.60	50.0	09/24/21
21I0997-02 [1543210917-02]	B290882	1.58	50.0	09/24/21
21I0997-03 [1543210917-03]	B290882	1.59	50.0	09/24/21
21I0997-04 [1543210917-04]	B290882	1.53	50.0	09/24/21
21I0997-05 [1543210917-05]	B290882	1.50	50.0	09/24/21
21I0997-06 [1543210917-06]	B290882	1.58	50.0	09/24/21
21I0997-07 [1543210917-07]	B290882	1.54	50.0	09/24/21
21I0997-08 [1543210917-08]	B290882	1.54	50.0	09/24/21
21I0997-09 [1543210917-09]	B290882	1.50	50.0	09/24/21
21I0997-10 [1543210917-10]	B290882	1.56	50.0	09/24/21

Prep Method: SW-846 3546 **Analytical Method: SW-846 8082A**

Lab Number [Field ID]	Batch	Initial [g]	Final [mL]	Date
21I0997-01 [1543210917-01]	B290669	10.0	10.0	09/21/21
21I0997-02 [1543210917-02]	B290669	10.0	10.0	09/21/21
21I0997-03 [1543210917-03]	B290669	10.0	10.0	09/21/21
21I0997-04 [1543210917-04]	B290669	10.0	10.0	09/21/21
21I0997-05 [1543210917-05]	B290669	10.0	10.0	09/21/21
21I0997-06 [1543210917-06]	B290669	10.0	10.0	09/21/21
21I0997-07 [1543210917-07]	B290669	10.0	10.0	09/21/21
21I0997-08 [1543210917-08]	B290669	10.0	10.0	09/21/21

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Sample Extraction Data

Prep Method: SW-846 3546 **Analytical Method: SW-846 8082A**

Lab Number [Field ID]	Batch	Initial [g]	Final [mL]	Date
21I0997-09 [1543210917-09]	B290669	10.0	10.0	09/21/21
21I0997-10 [1543210917-10]	B290669	10.0	10.0	09/21/21

Prep Method: SW-846 3546 **Analytical Method: SW-846 8270D-E**

Lab Number [Field ID]	Batch	Initial [g]	Final [mL]	Date
21I0997-05 [1543210917-05]	B290653	30.0	1.00	09/21/21
21I0997-06 [1543210917-06]	B290653	30.0	1.00	09/21/21
21I0997-07 [1543210917-07]	B290653	30.0	1.00	09/21/21
21I0997-08 [1543210917-08]	B290653	30.0	1.00	09/21/21
21I0997-08RE1 [1543210917-08]	B290653	30.0	1.00	09/21/21
21I0997-09 [1543210917-09]	B290653	30.0	1.00	09/21/21
21I0997-10 [1543210917-10]	B290653	30.0	1.00	09/21/21

Prep Method: SW-846 3546 **Analytical Method: SW-846 8270D-E**

Lab Number [Field ID]	Batch	Initial [g]	Final [mL]	Date
21I0997-04 [1543210917-04]	B290671	30.0	1.00	09/21/21

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QUALITY CONTROL

Semivolatile Organic Compounds by GC/MS - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B290653 - SW-846 3546										
Blank (B290653-BLK1)				Prepared: 09/21/21 Analyzed: 09/22/21						
Acenaphthene	ND	0.17	mg/Kg wet							
Acenaphthylene	ND	0.17	mg/Kg wet							
Anthracene	ND	0.17	mg/Kg wet							
Benzo(a)anthracene	ND	0.17	mg/Kg wet							
Benzo(a)pyrene	ND	0.17	mg/Kg wet							
Benzo(b)fluoranthene	ND	0.17	mg/Kg wet							
Benzo(g,h,i)perylene	ND	0.17	mg/Kg wet							
Benzo(k)fluoranthene	ND	0.17	mg/Kg wet							
Chrysene	ND	0.17	mg/Kg wet							
Dibenz(a,h)anthracene	ND	0.17	mg/Kg wet							
Fluoranthene	ND	0.17	mg/Kg wet							
Fluorene	ND	0.17	mg/Kg wet							
Indeno(1,2,3-cd)pyrene	ND	0.17	mg/Kg wet							
2-Methylnaphthalene	ND	0.17	mg/Kg wet							
Naphthalene	ND	0.17	mg/Kg wet							
Phenanthrene	ND	0.17	mg/Kg wet							
Pyrene	ND	0.17	mg/Kg wet							
Surrogate: Nitrobenzene-d5	*1.96*		mg/Kg wet	3.33		58.9	30-130			
Surrogate: 2-Fluorobiphenyl	*2.14*		mg/Kg wet	3.33		64.1	30-130			
Surrogate: p-Terphenyl-d14	*2.43*		mg/Kg wet	3.33		73.0	30-130			
LCS (B290653-BS1)				Prepared: 09/21/21 Analyzed: 09/22/21						
Acenaphthene	1.10	0.17	mg/Kg wet	1.67		66.3	40-140			
Acenaphthylene	1.08	0.17	mg/Kg wet	1.67		65.1	40-140			
Anthracene	1.16	0.17	mg/Kg wet	1.67		69.5	40-140			
Benzo(a)anthracene	1.10	0.17	mg/Kg wet	1.67		65.8	40-140			
Benzo(a)pyrene	1.21	0.17	mg/Kg wet	1.67		72.5	40-140			
Benzo(b)fluoranthene	1.14	0.17	mg/Kg wet	1.67		68.3	40-140			
Benzo(g,h,i)perylene	1.03	0.17	mg/Kg wet	1.67		62.0	40-140			
Benzo(k)fluoranthene	1.18	0.17	mg/Kg wet	1.67		70.7	40-140			
Chrysene	1.15	0.17	mg/Kg wet	1.67		68.8	40-140			
Dibenz(a,h)anthracene	1.06	0.17	mg/Kg wet	1.67		63.8	40-140			
Fluoranthene	1.13	0.17	mg/Kg wet	1.67		67.6	40-140			
Fluorene	1.13	0.17	mg/Kg wet	1.67		67.6	40-140			
Indeno(1,2,3-cd)pyrene	1.06	0.17	mg/Kg wet	1.67		63.9	40-140			
2-Methylnaphthalene	1.16	0.17	mg/Kg wet	1.67		69.3	40-140			
Naphthalene	1.04	0.17	mg/Kg wet	1.67		62.3	40-140			
Phenanthrene	1.16	0.17	mg/Kg wet	1.67		69.3	40-140			
Pyrene	1.14	0.17	mg/Kg wet	1.67		68.2	40-140			
Surrogate: Nitrobenzene-d5	*2.27*		mg/Kg wet	3.33		68.1	30-130			
Surrogate: 2-Fluorobiphenyl	*2.33*		mg/Kg wet	3.33		69.9	30-130			
Surrogate: p-Terphenyl-d14	*2.46*		mg/Kg wet	3.33		73.8	30-130			

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QUALITY CONTROL

Semivolatile Organic Compounds by GC/MS - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B290653 - SW-846 3546										
LCS Dup (B290653-BSD1)				Prepared: 09/21/21 Analyzed: 09/22/21						
Acenaphthene	0.986	0.17	mg/Kg wet	1.67		59.1	40-140	11.4	30	
Acenaphthylene	0.954	0.17	mg/Kg wet	1.67		57.2	40-140	12.8	30	
Anthracene	1.01	0.17	mg/Kg wet	1.67		60.7	40-140	13.6	30	
Benzo(a)anthracene	0.973	0.17	mg/Kg wet	1.67		58.4	40-140	11.9	30	
Benzo(a)pyrene	1.06	0.17	mg/Kg wet	1.67		63.7	40-140	12.8	30	
Benzo(b)fluoranthene	0.996	0.17	mg/Kg wet	1.67		59.7	40-140	13.4	30	
Benzo(g,h,i)perylene	0.882	0.17	mg/Kg wet	1.67		52.9	40-140	15.8	30	
Benzo(k)fluoranthene	1.05	0.17	mg/Kg wet	1.67		63.0	40-140	11.5	30	
Chrysene	1.02	0.17	mg/Kg wet	1.67		61.1	40-140	11.8	30	
Dibenz(a,h)anthracene	0.920	0.17	mg/Kg wet	1.67		55.2	40-140	14.6	30	
Fluoranthene	1.00	0.17	mg/Kg wet	1.67		60.1	40-140	11.8	30	
Fluorene	1.00	0.17	mg/Kg wet	1.67		60.0	40-140	12.0	30	
Indeno(1,2,3-cd)pyrene	0.920	0.17	mg/Kg wet	1.67		55.2	40-140	14.6	30	
2-Methylnaphthalene	1.04	0.17	mg/Kg wet	1.67		62.3	40-140	10.6	30	
Naphthalene	0.954	0.17	mg/Kg wet	1.67		57.3	40-140	8.43	30	
Phenanthrene	1.00	0.17	mg/Kg wet	1.67		60.1	40-140	14.2	30	
Pyrene	0.994	0.17	mg/Kg wet	1.67		59.6	40-140	13.4	30	
Surrogate: Nitrobenzene-d5	*2.03*		mg/Kg wet	3.33		60.9	30-130			
Surrogate: 2-Fluorobiphenyl	*2.08*		mg/Kg wet	3.33		62.3	30-130			
Surrogate: p-Terphenyl-d14	*2.10*		mg/Kg wet	3.33		63.0	30-130			
Batch B290671 - SW-846 3546										
Blank (B290671-BLK1)				Prepared: 09/21/21 Analyzed: 09/24/21						
Acenaphthene	ND	0.17	mg/Kg wet							
Acenaphthylene	ND	0.17	mg/Kg wet							
Anthracene	ND	0.17	mg/Kg wet							
Benzo(a)anthracene	ND	0.17	mg/Kg wet							
Benzo(a)pyrene	ND	0.17	mg/Kg wet							
Benzo(b)fluoranthene	ND	0.17	mg/Kg wet							
Benzo(g,h,i)perylene	ND	0.17	mg/Kg wet							
Benzo(k)fluoranthene	ND	0.17	mg/Kg wet							
Chrysene	ND	0.17	mg/Kg wet							
Dibenz(a,h)anthracene	ND	0.17	mg/Kg wet							
Fluoranthene	ND	0.17	mg/Kg wet							
Fluorene	ND	0.17	mg/Kg wet							
Indeno(1,2,3-cd)pyrene	ND	0.17	mg/Kg wet							
2-Methylnaphthalene	ND	0.17	mg/Kg wet							
Naphthalene	ND	0.17	mg/Kg wet							
Phenanthrene	ND	0.17	mg/Kg wet							
Pyrene	ND	0.17	mg/Kg wet							
Surrogate: Nitrobenzene-d5	*1.75*		mg/Kg wet	3.33		52.5	30-130			
Surrogate: 2-Fluorobiphenyl	*1.98*		mg/Kg wet	3.33		59.5	30-130			
Surrogate: p-Terphenyl-d14	*2.96*		mg/Kg wet	3.33		88.7	30-130			

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QUALITY CONTROL

Semivolatile Organic Compounds by GC/MS - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B290671 - SW-846 3546										
LCS (B290671-BS1)				Prepared: 09/21/21 Analyzed: 09/24/21						
Acenaphthene	0.973	0.17	mg/Kg wet	1.67		58.4	40-140			
Acenaphthylene	0.996	0.17	mg/Kg wet	1.67		59.8	40-140			
Anthracene	1.07	0.17	mg/Kg wet	1.67		64.1	40-140			
Benzo(a)anthracene	1.04	0.17	mg/Kg wet	1.67		62.2	40-140			
Benzo(a)pyrene	1.15	0.17	mg/Kg wet	1.67		68.8	40-140			
Benzo(b)fluoranthene	1.08	0.17	mg/Kg wet	1.67		64.8	40-140			
Benzo(g,h,i)perylene	1.04	0.17	mg/Kg wet	1.67		62.2	40-140			
Benzo(k)fluoranthene	1.15	0.17	mg/Kg wet	1.67		69.2	40-140			
Chrysene	1.09	0.17	mg/Kg wet	1.67		65.2	40-140			
Dibenz(a,h)anthracene	1.06	0.17	mg/Kg wet	1.67		63.9	40-140			
Fluoranthene	0.994	0.17	mg/Kg wet	1.67		59.6	40-140			
Fluorene	1.05	0.17	mg/Kg wet	1.67		62.8	40-140			
Indeno(1,2,3-cd)pyrene	1.10	0.17	mg/Kg wet	1.67		66.2	40-140			
2-Methylnaphthalene	1.08	0.17	mg/Kg wet	1.67		64.8	40-140			
Naphthalene	0.977	0.17	mg/Kg wet	1.67		58.6	40-140			
Phenanthrene	1.07	0.17	mg/Kg wet	1.67		64.5	40-140			
Pyrene	1.11	0.17	mg/Kg wet	1.67		66.6	40-140			
Surrogate: Nitrobenzene-d5	*2.16*		mg/Kg wet	3.33		64.7	30-130			
Surrogate: 2-Fluorobiphenyl	*2.23*		mg/Kg wet	3.33		67.0	30-130			
Surrogate: p-Terphenyl-d14	*2.45*		mg/Kg wet	3.33		73.4	30-130			
LCS Dup (B290671-BSD1)				Prepared: 09/21/21 Analyzed: 09/24/21						
Acenaphthene	1.07	0.17	mg/Kg wet	1.67		64.0	40-140	9.22	30	
Acenaphthylene	1.09	0.17	mg/Kg wet	1.67		65.5	40-140	9.16	30	
Anthracene	1.19	0.17	mg/Kg wet	1.67		71.4	40-140	10.8	30	
Benzo(a)anthracene	1.16	0.17	mg/Kg wet	1.67		69.5	40-140	11.1	30	
Benzo(a)pyrene	1.27	0.17	mg/Kg wet	1.67		76.3	40-140	10.3	30	
Benzo(b)fluoranthene	1.20	0.17	mg/Kg wet	1.67		72.0	40-140	10.6	30	
Benzo(g,h,i)perylene	1.20	0.17	mg/Kg wet	1.67		72.0	40-140	14.5	30	
Benzo(k)fluoranthene	1.25	0.17	mg/Kg wet	1.67		75.2	40-140	8.31	30	
Chrysene	1.21	0.17	mg/Kg wet	1.67		72.4	40-140	10.3	30	
Dibenz(a,h)anthracene	1.20	0.17	mg/Kg wet	1.67		72.0	40-140	12.0	30	
Fluoranthene	1.11	0.17	mg/Kg wet	1.67		66.8	40-140	11.4	30	
Fluorene	1.18	0.17	mg/Kg wet	1.67		70.5	40-140	11.6	30	
Indeno(1,2,3-cd)pyrene	1.22	0.17	mg/Kg wet	1.67		73.1	40-140	9.97	30	
2-Methylnaphthalene	1.15	0.17	mg/Kg wet	1.67		68.8	40-140	5.99	30	
Naphthalene	1.02	0.17	mg/Kg wet	1.67		61.1	40-140	4.14	30	
Phenanthrene	1.19	0.17	mg/Kg wet	1.67		71.4	40-140	10.2	30	
Pyrene	1.23	0.17	mg/Kg wet	1.67		74.0	40-140	10.6	30	
Surrogate: Nitrobenzene-d5	*2.23*		mg/Kg wet	3.33		67.0	30-130			
Surrogate: 2-Fluorobiphenyl	*2.35*		mg/Kg wet	3.33		70.5	30-130			
Surrogate: p-Terphenyl-d14	*2.66*		mg/Kg wet	3.33		79.8	30-130			

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QUALITY CONTROL

Polychlorinated Biphenyls By GC/ECD - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B290669 - SW-846 3546										
Blank (B290669-BLK1)				Prepared: 09/21/21 Analyzed: 09/23/21						
Aroclor-1016	ND	0.020	mg/Kg wet							
Aroclor-1016 [2C]	ND	0.020	mg/Kg wet							
Aroclor-1221	ND	0.020	mg/Kg wet							
Aroclor-1221 [2C]	ND	0.020	mg/Kg wet							
Aroclor-1232	ND	0.020	mg/Kg wet							
Aroclor-1232 [2C]	ND	0.020	mg/Kg wet							
Aroclor-1242	ND	0.020	mg/Kg wet							
Aroclor-1242 [2C]	ND	0.020	mg/Kg wet							
Aroclor-1248	ND	0.020	mg/Kg wet							
Aroclor-1248 [2C]	ND	0.020	mg/Kg wet							
Aroclor-1254	ND	0.020	mg/Kg wet							
Aroclor-1254 [2C]	ND	0.020	mg/Kg wet							
Aroclor-1260	ND	0.020	mg/Kg wet							
Aroclor-1260 [2C]	ND	0.020	mg/Kg wet							
Aroclor-1262	ND	0.020	mg/Kg wet							
Aroclor-1262 [2C]	ND	0.020	mg/Kg wet							
Aroclor-1268	ND	0.020	mg/Kg wet							
Aroclor-1268 [2C]	ND	0.020	mg/Kg wet							
Surrogate: Decachlorobiphenyl	*0.202*		mg/Kg wet	0.200		101	30-150			
Surrogate: Decachlorobiphenyl [2C]	*0.179*		mg/Kg wet	0.200		89.7	30-150			
Surrogate: Tetrachloro-m-xylene	*0.174*		mg/Kg wet	0.200		87.2	30-150			
Surrogate: Tetrachloro-m-xylene [2C]	*0.143*		mg/Kg wet	0.200		71.3	30-150			
LCS (B290669-BS1)				Prepared: 09/21/21 Analyzed: 09/23/21						
Aroclor-1016	0.17	0.020	mg/Kg wet	0.200		85.6	40-140			
Aroclor-1016 [2C]	0.15	0.020	mg/Kg wet	0.200		74.2	40-140			
Aroclor-1260	0.18	0.020	mg/Kg wet	0.200		87.8	40-140			
Aroclor-1260 [2C]	0.16	0.020	mg/Kg wet	0.200		82.3	40-140			
Surrogate: Decachlorobiphenyl	*0.228*		mg/Kg wet	0.200		114	30-150			
Surrogate: Decachlorobiphenyl [2C]	*0.186*		mg/Kg wet	0.200		93.2	30-150			
Surrogate: Tetrachloro-m-xylene	*0.192*		mg/Kg wet	0.200		96.0	30-150			
Surrogate: Tetrachloro-m-xylene [2C]	*0.150*		mg/Kg wet	0.200		74.9	30-150			
LCS Dup (B290669-BSD1)				Prepared: 09/21/21 Analyzed: 09/23/21						
Aroclor-1016	0.16	0.020	mg/Kg wet	0.200		80.3	40-140	6.43	30	
Aroclor-1016 [2C]	0.14	0.020	mg/Kg wet	0.200		70.5	40-140	5.06	30	
Aroclor-1260	0.16	0.020	mg/Kg wet	0.200		80.5	40-140	8.70	30	
Aroclor-1260 [2C]	0.15	0.020	mg/Kg wet	0.200		74.7	40-140	9.67	30	
Surrogate: Decachlorobiphenyl	*0.204*		mg/Kg wet	0.200		102	30-150			
Surrogate: Decachlorobiphenyl [2C]	*0.182*		mg/Kg wet	0.200		90.9	30-150			
Surrogate: Tetrachloro-m-xylene	*0.175*		mg/Kg wet	0.200		87.6	30-150			
Surrogate: Tetrachloro-m-xylene [2C]	*0.144*		mg/Kg wet	0.200		71.8	30-150			

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QUALITY CONTROL

Polychlorinated Biphenyls By GC/ECD - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B290669 - SW-846 3546										
Matrix Spike (B290669-MS1)	**Source: 21I0997-01**			Prepared: 09/21/21 Analyzed: 09/23/21						
Aroclor-1016	0.30	0.16	mg/Kg dry	0.393	ND	75.4	40-140			
Aroclor-1016 [2C]	0.25	0.16	mg/Kg dry	0.393	ND	63.0	40-140			
Aroclor-1260	0.33	0.16	mg/Kg dry	0.393	ND	82.7	40-140			
Aroclor-1260 [2C]	0.28	0.16	mg/Kg dry	0.393	ND	70.4	40-140			
Surrogate: Decachlorobiphenyl	*0.304*		mg/Kg dry	0.393		77.2	30-150			
Surrogate: Decachlorobiphenyl [2C]	*0.306*		mg/Kg dry	0.393		77.7	30-150			
Surrogate: Tetrachloro-m-xylene	*0.285*		mg/Kg dry	0.393		72.5	30-150			
Surrogate: Tetrachloro-m-xylene [2C]	*0.254*		mg/Kg dry	0.393		64.5	30-150			
Matrix Spike Dup (B290669-MSD1)	**Source: 21I0997-01**			Prepared: 09/21/21 Analyzed: 09/23/21						
Aroclor-1016	0.30	0.16	mg/Kg dry	0.393	ND	75.5	40-140	0.196	30	
Aroclor-1016 [2C]	0.26	0.16	mg/Kg dry	0.393	ND	65.8	40-140	4.44	30	
Aroclor-1260	0.31	0.16	mg/Kg dry	0.393	ND	78.8	40-140	4.81	30	
Aroclor-1260 [2C]	0.27	0.16	mg/Kg dry	0.393	ND	69.1	40-140	1.87	30	
Surrogate: Decachlorobiphenyl	*0.288*		mg/Kg dry	0.393		73.1	30-150			
Surrogate: Decachlorobiphenyl [2C]	*0.290*		mg/Kg dry	0.393		73.8	30-150			
Surrogate: Tetrachloro-m-xylene	*0.283*		mg/Kg dry	0.393		71.8	30-150			
Surrogate: Tetrachloro-m-xylene [2C]	*0.253*		mg/Kg dry	0.393		64.2	30-150			

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QUALITY CONTROL

Petroleum Hydrocarbons Analyses - EPH - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B290670 - SW-846 3546										
Blank (B290670-BLK1)				Prepared: 09/21/21 Analyzed: 09/23/21						
C9-C18 Aliphatics	ND	10	mg/Kg wet							
C19-C36 Aliphatics	ND	10	mg/Kg wet							
Unadjusted C11-C22 Aromatics	ND	10	mg/Kg wet							
C11-C22 Aromatics	ND	10	mg/Kg wet							
Acenaphthene	ND	0.10	mg/Kg wet							
Acenaphthylene	ND	0.10	mg/Kg wet							
Anthracene	ND	0.10	mg/Kg wet							
Benzo(a)anthracene	ND	0.10	mg/Kg wet							
Benzo(a)pyrene	ND	0.10	mg/Kg wet							
Benzo(b)fluoranthene	ND	0.10	mg/Kg wet							
Benzo(g,h,i)perylene	ND	0.10	mg/Kg wet							
Benzo(k)fluoranthene	ND	0.10	mg/Kg wet							
Chrysene	ND	0.10	mg/Kg wet							
Dibenz(a,h)anthracene	ND	0.10	mg/Kg wet							
Fluoranthene	ND	0.10	mg/Kg wet							
Fluorene	ND	0.10	mg/Kg wet							
Indeno(1,2,3-cd)pyrene	ND	0.10	mg/Kg wet							
2-Methylnaphthalene	ND	0.10	mg/Kg wet							
Naphthalene	ND	0.10	mg/Kg wet							
Phenanthrene	ND	0.10	mg/Kg wet							
Pyrene	ND	0.10	mg/Kg wet							
Naphthalene-aliphatic fraction	ND	0.10	mg/Kg wet							
2-Methylnaphthalene-aliphatic fraction	ND	0.10	mg/Kg wet							
Surrogate: Chlorooctadecane (COD)	*2.90*		mg/Kg wet	5.00		58.0	40-140			
Surrogate: o-Terphenyl (OTP)	*3.54*		mg/Kg wet	5.00		70.7	40-140			
Surrogate: 2-Bromonaphthalene	*4.37*		mg/Kg wet	5.00		87.4	40-140			
Surrogate: 2-Fluorobiphenyl	*4.34*		mg/Kg wet	5.00		86.7	40-140			
LCS (B290670-BS1)				Prepared: 09/21/21 Analyzed: 09/23/21						
C9-C18 Aliphatics	21.5	10	mg/Kg wet	30.0		71.8	40-140			
C19-C36 Aliphatics	30.3	10	mg/Kg wet	40.0		75.7	40-140			
Unadjusted C11-C22 Aromatics	66.0	10	mg/Kg wet	85.0		77.7	40-140			
Acenaphthene	3.09	0.10	mg/Kg wet	5.00		61.8	40-140			
Acenaphthylene	2.92	0.10	mg/Kg wet	5.00		58.3	40-140			
Anthracene	3.34	0.10	mg/Kg wet	5.00		66.9	40-140			
Benzo(a)anthracene	4.16	0.10	mg/Kg wet	5.00		83.2	40-140			
Benzo(a)pyrene	4.24	0.10	mg/Kg wet	5.00		84.8	40-140			
Benzo(b)fluoranthene	4.64	0.10	mg/Kg wet	5.00		92.8	40-140			
Benzo(g,h,i)perylene	3.92	0.10	mg/Kg wet	5.00		78.4	40-140			
Benzo(k)fluoranthene	3.51	0.10	mg/Kg wet	5.00		70.2	40-140			
Chrysene	4.07	0.10	mg/Kg wet	5.00		81.4	40-140			
Dibenz(a,h)anthracene	4.17	0.10	mg/Kg wet	5.00		83.4	40-140			
Fluoranthene	3.65	0.10	mg/Kg wet	5.00		72.9	40-140			
Fluorene	3.03	0.10	mg/Kg wet	5.00		60.5	40-140			
Indeno(1,2,3-cd)pyrene	3.96	0.10	mg/Kg wet	5.00		79.2	40-140			
2-Methylnaphthalene	2.86	0.10	mg/Kg wet	5.00		57.1	40-140			
Naphthalene	2.70	0.10	mg/Kg wet	5.00		54.1	40-140			
Phenanthrene	3.44	0.10	mg/Kg wet	5.00		68.7	40-140			
Pyrene	3.78	0.10	mg/Kg wet	5.00		75.6	40-140			
Naphthalene-aliphatic fraction	ND	0.10	mg/Kg wet	5.00			0-5			
2-Methylnaphthalene-aliphatic fraction	ND	0.10	mg/Kg wet	5.00			0-5			
Surrogate: Chlorooctadecane (COD)	*3.18*		mg/Kg wet	5.00		63.7	40-140			

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QUALITY CONTROL

Petroleum Hydrocarbons Analyses - EPH - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B290670 - SW-846 3546										
LCS (B290670-BS1)				Prepared: 09/21/21 Analyzed: 09/23/21						
Surrogate: o-Terphenyl (OTP)	*3.31*		mg/Kg wet	5.00		66.1	40-140			
Surrogate: 2-Bromonaphthalene	*3.51*		mg/Kg wet	5.00		70.2	40-140			
Surrogate: 2-Fluorobiphenyl	*3.47*		mg/Kg wet	5.00		69.4	40-140			
LCS Dup (B290670-BSD1)				Prepared: 09/21/21 Analyzed: 09/23/21						
C9-C18 Aliphatics	22.3	10	mg/Kg wet	30.0		74.3	40-140	3.46	25	
C19-C36 Aliphatics	30.9	10	mg/Kg wet	40.0		77.2	40-140	1.97	25	
Unadjusted C11-C22 Aromatics	70.1	10	mg/Kg wet	85.0		82.5	40-140	5.98	25	
Acenaphthene	3.46	0.10	mg/Kg wet	5.00		69.2	40-140	11.4	25	
Acenaphthylene	3.26	0.10	mg/Kg wet	5.00		65.2	40-140	11.1	25	
Anthracene	3.67	0.10	mg/Kg wet	5.00		73.4	40-140	9.22	25	
Benzo(a)anthracene	4.41	0.10	mg/Kg wet	5.00		88.2	40-140	5.86	25	
Benzo(a)pyrene	4.39	0.10	mg/Kg wet	5.00		87.7	40-140	3.36	25	
Benzo(b)fluoranthene	4.84	0.10	mg/Kg wet	5.00		96.7	40-140	4.16	25	
Benzo(g,h,i)perylene	4.00	0.10	mg/Kg wet	5.00		80.0	40-140	2.00	25	
Benzo(k)fluoranthene	3.65	0.10	mg/Kg wet	5.00		73.0	40-140	3.86	25	
Chrysene	4.28	0.10	mg/Kg wet	5.00		85.6	40-140	4.99	25	
Dibenz(a,h)anthracene	4.28	0.10	mg/Kg wet	5.00		85.6	40-140	2.55	25	
Fluoranthene	3.95	0.10	mg/Kg wet	5.00		79.0	40-140	7.96	25	
Fluorene	3.55	0.10	mg/Kg wet	5.00		71.0	40-140	15.9	25	
Indeno(1,2,3-cd)pyrene	4.05	0.10	mg/Kg wet	5.00		81.1	40-140	2.32	25	
2-Methylnaphthalene	3.22	0.10	mg/Kg wet	5.00		64.3	40-140	11.9	25	
Naphthalene	3.03	0.10	mg/Kg wet	5.00		60.6	40-140	11.3	25	
Phenanthrene	3.79	0.10	mg/Kg wet	5.00		75.8	40-140	9.77	25	
Pyrene	4.07	0.10	mg/Kg wet	5.00		81.5	40-140	7.40	25	
Naphthalene-aliphatic fraction	ND	0.10	mg/Kg wet	5.00			0-5			
2-Methylnaphthalene-aliphatic fraction	ND	0.10	mg/Kg wet	5.00			0-5			
Surrogate: Chlorooctadecane (COD)	*3.24*		mg/Kg wet	5.00		64.7	40-140			
Surrogate: o-Terphenyl (OTP)	*3.68*		mg/Kg wet	5.00		73.6	40-140			
Surrogate: 2-Bromonaphthalene	*3.99*		mg/Kg wet	5.00		79.8	40-140			
Surrogate: 2-Fluorobiphenyl	*3.93*		mg/Kg wet	5.00		78.7	40-140			

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QUALITY CONTROL

Metals Analyses (Total) - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B290882 - SW-846 3050B										
Blank (B290882-BLK1)				Prepared: 09/24/21 Analyzed: 09/26/21						
Arsenic	ND	3.3	mg/Kg wet							
Lead	ND	0.50	mg/Kg wet							
LCS (B290882-BS1)				Prepared: 09/24/21 Analyzed: 09/26/21						
Arsenic	143	9.9	mg/Kg wet	170		84.3	82.9-117.6			
Lead	123	1.5	mg/Kg wet	140		88.1	82.9-117.1			
LCS Dup (B290882-BSD1)				Prepared: 09/24/21 Analyzed: 09/26/21						
Arsenic	144	9.4	mg/Kg wet	170		84.4	82.9-117.6	0.134	30	
Lead	125	1.4	mg/Kg wet	140		89.0	82.9-117.1	0.987	30	
Reference (B290882-SRM1) MRL Check				Prepared: 09/24/21 Analyzed: 09/26/21						
Lead	0.402	0.47	mg/Kg wet	0.474		84.7	80-120			

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IDENTIFICATION SUMMARY FOR SINGLE COMPONENT ANALYTES

SW-846 8082A

1543210917-01

Lab Sample ID: 21I0997-01 Date(s) Analyzed: 09/23/2021 09/23/2021

Instrument ID (1): GCFID4 Instrument ID (2): GCFID4

GC Column (1): ID: (mm) GC Column (2): ID: (mm)

ANALYTE	COL	RT	RT WINDOW		CONCENTRATION	%RPD
			FROM	TO		
Aroclor-1254	1	0.000	0.000	0.000	0.16	
	2	0.000	0.000	0.000	0.20	22.2

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IDENTIFICATION SUMMARY FOR SINGLE COMPONENT ANALYTES

SW-846 8082A

1543210917-03

Lab Sample ID: 21I0997-03 Date(s) Analyzed: 09/23/2021 09/23/2021

Instrument ID (1): GCFID4 Instrument ID (2): GCFID4

GC Column (1): ID: (mm) GC Column (2): ID: (mm)

ANALYTE	COL	RT	RT WINDOW		CONCENTRATION	%RPD
			FROM	TO		
Aroclor-1254	1	0.000	0.000	0.000	0.23	
	2	0.000	0.000	0.000	0.22	4.4

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IDENTIFICATION SUMMARY FOR SINGLE COMPONENT ANALYTES

SW-846 8082A

LCS

Lab Sample ID: B290669-BS1 Date(s) Analyzed: 09/23/2021 09/23/2021

Instrument ID (1): GCFID4 Instrument ID (2): GCFID4

GC Column (1): ID: (mm) GC Column (2): ID: (mm)

ANALYTE	COL	RT	RT WINDOW		CONCENTRATION	%RPD
			FROM	TO		
Aroclor-1016	1	0.000	0.000	0.000	0.17	
	2	0.000	0.000	0.000	0.15	12.5
Aroclor-1260	1	0.000	0.000	0.000	0.18	
	2	0.000	0.000	0.000	0.16	11.8

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IDENTIFICATION SUMMARY FOR SINGLE COMPONENT ANALYTES

SW-846 8082A

LCS Dup

Lab Sample ID: B290669-BSD1 Date(s) Analyzed: 09/23/2021 09/23/2021

Instrument ID (1): GCFID4 Instrument ID (2): GCFID4

GC Column (1): ID: (mm) GC Column (2): ID: (mm)

ANALYTE	COL	RT	RT WINDOW		CONCENTRATION	%RPD
			FROM	TO		
Aroclor-1016	1	0.000	0.000	0.000	0.16	
	2	0.000	0.000	0.000	0.14	13.3
Aroclor-1260	1	0.000	0.000	0.000	0.16	
	2	0.000	0.000	0.000	0.15	6.5

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IDENTIFICATION SUMMARY FOR SINGLE COMPONENT ANALYTES

SW-846 8082A

Matrix Spike

Lab Sample ID: B290669-MS1 Date(s) Analyzed: 09/23/2021 09/23/2021

Instrument ID (1): GCFID4 Instrument ID (2): GCFID4

GC Column (1): ID: (mm) GC Column (2): ID: (mm)

ANALYTE	COL	RT	RT WINDOW		CONCENTRATION	%RPD
			FROM	TO		
Aroclor-1016	1	0.000	0.000	0.000	0.30	
	2	0.000	0.000	0.000	0.25	18.2
Aroclor-1260	1	0.000	0.000	0.000	0.33	
	2	0.000	0.000	0.000	0.28	16.4

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IDENTIFICATION SUMMARY FOR SINGLE COMPONENT ANALYTES

SW-846 8082A

Matrix Spike Dup

Lab Sample ID: B290669-MSD1 Date(s) Analyzed: 09/23/2021 09/23/2021

Instrument ID (1): GCFID4 Instrument ID (2): GCFID4

GC Column (1): ID: (mm) GC Column (2): ID: (mm)

ANALYTE	COL	RT	RT WINDOW		CONCENTRATION	%RPD
			FROM	TO		
Aroclor-1016	1	0.000	0.000	0.000	0.30	
	2	0.000	0.000	0.000	0.26	14.3
Aroclor-1260	1	0.000	0.000	0.000	0.31	
	2	0.000	0.000	0.000	0.27	13.8

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FLAG/QUALIFIER SUMMARY

*	QC result is outside of established limits.
†	Wide recovery limits established for difficult compound.
‡	Wide RPD limits established for difficult compound.
#	Data exceeded client recommended or regulatory level
ND	Not Detected
RL	Reporting Limit is at the level of quantitation (LOQ)
DL	Detection Limit is the lower limit of detection determined by the MDL study
MCL	Maximum Contaminant Level
	Percent recoveries and relative percent differences (RPDs) are determined by the software using values in the calculation which have not been rounded.
	No results have been blank subtracted unless specified in the case narrative section.
O-32	A dilution was performed as part of the standard analytical procedure.

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CERTIFICATIONS

Certified Analyses included in this Report

Analyte	Certifications
MADEP EPH rev 2.1 in Soil	
C9-C18 Aliphatics	CT,NC,ME,NH-P
C19-C36 Aliphatics	CT,NC,ME,NH-P
Unadjusted C11-C22 Aromatics	CT,NC,ME,NH-P
C11-C22 Aromatics	CT,NC,ME,NH-P
Acenaphthene	CT,NC,ME,NH-P
Acenaphthylene	CT,NC,ME,NH-P
Anthracene	CT,NC,ME,NH-P
Benzo(a)anthracene	CT,NC,ME,NH-P
Benzo(a)pyrene	CT,NC,ME,NH-P
Benzo(b)fluoranthene	CT,NC,ME,NH-P
Benzo(g,h,i)perylene	CT,NC,ME,NH-P
Benzo(k)fluoranthene	CT,NC,ME,NH-P
Chrysene	CT,NC,ME,NH-P
Dibenz(a,h)anthracene	CT,NC,ME,NH-P
Fluoranthene	CT,NC,ME,NH-P
Fluorene	CT,NC,ME
Indeno(1,2,3-cd)pyrene	CT,NC,ME,NH-P
2-Methylnaphthalene	CT,NC,ME
Naphthalene	CT,NC,ME,NH-P
Phenanthrene	CT,NC,ME,NH-P
Pyrene	CT,NC,ME,NH-P
SW-846 6010D in Soil	
Arsenic	CT,NH,NY,ME,VA,NC
Lead	CT,NH,NY,AIHA,ME,VA,NC
SW-846 8082A in Soil	
Aroclor-1016	CT,NH,NY,NC,ME,VA,PA
Aroclor-1016 [2C]	CT,NH,NY,NC,ME,VA,PA
Aroclor-1221	CT,NH,NY,NC,ME,VA,PA
Aroclor-1221 [2C]	CT,NH,NY,NC,ME,VA,PA
Aroclor-1232	CT,NH,NY,NC,ME,VA,PA
Aroclor-1232 [2C]	CT,NH,NY,NC,ME,VA,PA
Aroclor-1242	CT,NH,NY,NC,ME,VA,PA
Aroclor-1242 [2C]	CT,NH,NY,NC,ME,VA,PA
Aroclor-1248	CT,NH,NY,NC,ME,VA,PA
Aroclor-1248 [2C]	CT,NH,NY,NC,ME,VA,PA
Aroclor-1254	CT,NH,NY,NC,ME,VA,PA
Aroclor-1254 [2C]	CT,NH,NY,NC,ME,VA,PA
Aroclor-1260	CT,NH,NY,NC,ME,VA,PA
Aroclor-1260 [2C]	CT,NH,NY,NC,ME,VA,PA
Aroclor-1262	NH,NY,NC,ME,VA,PA
Aroclor-1262 [2C]	NH,NY,NC,ME,VA,PA
Aroclor-1268	NH,NY,NC,ME,VA,PA
Aroclor-1268 [2C]	NH,NY,NC,ME,VA,PA
SW-846 8270D-E in Soil	
Acenaphthene	CT,NY,NH,ME,NC,VA
Acenaphthylene	CT,NY,NH,ME,NC,VA

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CERTIFICATIONS

Certified Analyses included in this Report

Analyte	Certifications
SW-846 8270D-E in Soil	
Anthracene	CT,NY,NH,ME,NC,VA
Benzo(a)anthracene	CT,NY,NH,ME,NC,VA
Benzo(a)pyrene	CT,NY,NH,ME,NC,VA
Benzo(b)fluoranthene	CT,NY,NH,ME,NC,VA
Benzo(g,h,i)perylene	CT,NY,NH,ME,NC,VA
Benzo(k)fluoranthene	CT,NY,NH,ME,NC,VA
Chrysene	CT,NY,NH,ME,NC,VA
Dibenz(a,h)anthracene	CT,NY,NH,ME,NC,VA
Fluoranthene	CT,NY,NH,ME,NC,VA
Fluorene	CT,NY,NH,ME,NC,VA
Indeno(1,2,3-cd)pyrene	CT,NY,NH,ME,NC,VA
2-Methylnaphthalene	CT,NY,NH,ME,NC,VA
Naphthalene	CT,NY,NH,ME,NC,VA
Phenanthrene	CT,NY,NH,ME,NC,VA
Pyrene	CT,NY,NH,ME,NC,VA
SW-846 8270D-E in Water	
Acenaphthene	CT,NY,NH,ME,NC,VA
Acenaphthylene	CT,NY,NH,ME,NC,VA
Anthracene	CT,NY,NH,ME,NC,VA
Benzo(a)anthracene	CT,NY,NH,ME,NC,VA
Benzo(a)pyrene	CT,NY,NH,ME,NC,VA
Benzo(b)fluoranthene	CT,NY,NH,ME,NC,VA
Benzo(g,h,i)perylene	CT,NY,NH,ME,NC,VA
Benzo(k)fluoranthene	CT,NY,NH,ME,NC,VA
Chrysene	CT,NY,NH,ME,NC,VA
Dibenz(a,h)anthracene	CT,NY,NH,ME,NC,VA
Fluoranthene	CT,NY,NH,ME,NC,VA
Fluorene	CT,NY,NH,ME,NC,VA
Indeno(1,2,3-cd)pyrene	CT,NY,NH,ME,NC,VA
2-Methylnaphthalene	CT,NY,NH,ME,NC,VA
Naphthalene	CT,NY,NH,ME,NC,VA
Phenanthrene	CT,NY,NH,ME,NC,VA
Pyrene	CT,NY,NH,ME,NC,VA

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Con-Test, a Pace Environmental Laboratory, operates under the following certifications and accreditations:

Code	Description	Number	Expires
AIHA	AIHA-LAP, LLC - ISO17025:2017	100033	03/1/2022
MA	Massachusetts DEP	M-MA100	06/30/2022
CT	Connecticut Department of Publilc Health	PH-0165	12/31/2022
NY	New York State Department of Health	10899 NELAP	04/1/2022
NH-S	New Hampshire Environmental Lab	2516 NELAP	02/5/2022
RI	Rhode Island Department of Health	LAO00112	12/30/2021
NC	North Carolina Div. of Water Quality	652	12/31/2021
NJ	New Jersey DEP	MA007 NELAP	06/30/2022
FL	Florida Department of Health	E871027 NELAP	06/30/2022
VT	Vermont Department of Health Lead Laboratory	LL720741	07/30/2022
ME	State of Maine	MA00100	06/9/2023
VA	Commonwealth of Virginia	460217	12/14/2021
NH-P	New Hampshire Environmental Lab	2557 NELAP	09/6/2022
VT-DW	Vermont Department of Health Drinking Water	VT-255716	06/12/2022
NC-DW	North Carolina Department of Health	25703	07/31/2022
PA	Commonwealth of Pennsylvania DEP	68-05812	06/30/2022
MI	Dept. of Env, Great Lakes, and Energy	9100	09/6/2022

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☒ 108 Myrtle Street, #502, North Quincy, MA 02171
☐ 317 Iron Horse Way, Suite 204, Providence, RI 02908
☐ 80 Washington Street, Suite 301, Poughkeepsie, NY
☐ Other _____

CHAIN-OF-CUSTODY RECORD 41957

Turnaround
☐ 24-Hour* ☐ 72-Hour* ☐ Other _____ (days)
☐ 48-Hour* ☒ Standard (5 days) *Surcharge Applies

PROJECT NAME: MVP GRANT FY22/23
PROJECT LOCATION: HAVERHILL, MA
PROJECT NUMBER: 20170390.U30
LABORATORY: PACE LABS

REPORT TO: Matt Kissane (mkissane@fando.com)
INVOICE TO:
P.O. No.: 1543 20170390.U30
Sampler's Signature: _____ Date: 9/17/21

Source Codes:
MW=Monitoring Well PW=Potable Water T=Treatment Facility S=Soil B=Sediment
SW=Surface Water ST=Stormwater W=Waste A=Air C=Concrete
X=Other _____

Analysis Request

Containers

Item No.	Transfer Check 1	2	3	4	Sample Number	Source Code	Date Sampled	Time Sampled	PCB	Lead	Hexane	EPH Ranges ONLY	VPH 8270	Soil VOA Vial, ☐ methanol	Soil VOA Vial, ☐ water	Glass Soil Container (16) oz	Other:	Other:	Water VOA Vial, ☐ As is ☐ HCl	Glass Amber ( ) ml, ☐ As is ☐ H_2SO_4	Plastic - As is, ☐ 250 ml ☐ 500 ml ☐ 1000 ml	Plastic - H_2SO_4, ☐ 250 ml ☐ 500 ml	Plastic - HNO_3, 250 ml ☐ Filtered ☐ 0.45µ ☐ 10µ	Plastic - NaOH, 250 ml	Comments
1	X	X			1543210917-01	B	9/17/21	0835	X	X	X										1				
2					-02			0855	X	X	X										1				
3					-03			0845	X	X	X										1				
4					-04			0940	X	X	X	X	X								1				
5					-05			0915	X	X	X	X	X								1				
6					-06			0925	X	X	X	X	X								1				
7					-07			0935	X	X	X	X	X								1				
8					-08			1020	X	X	X	X	X								1				
9					-09			1015	X	X	X	X	X								1				
10					-10			1005	X	X	X	X	X								1				

per client they do need the MA MCP form. JLH 9/21/2021

Transfer Number	Relinquished By	Accepted By	Date	Time
1		FedEx	9/17/21	1400
2	Fridge		9/20/21	1145
3			9/20/21	1709
4				

Charge Exceptions: ☐ CT Tax Exempt ☐ QA/QC ☐ Other _____
____ Duplicates ____ Blanks (Item Nos:)
Reporting and Detection Limit Requirements: ☐ RCP Deliverables ☐ MCP CAM Cert.
Additional Comments:

Table of Contents

I Have Not Confirmed Sample Container Numbers With Lab Staff Before Relinquishing Over Samples_____

con-test® ANALYTICAL LABORATORY

Doc# 277 Rev 5 2017

Login Sample Receipt Checklist - (Rejection Criteria Listing - Using Acceptance Policy) Any False Statement will be brought to the attention of the Client - State True or False

Client Fuss & O'Neill

Received By GR Date 9/20/21 Time 1703

How were the samples received? In Cooler T No Cooler _____ On Ice T No Ice _____

Direct from Sampling _____ Ambient _____ Melted Ice _____

Were samples within Temperature? 2-6°C T By Gun # 2 Actual Temp - 5.4

By Blank # _____ Actual Temp - _____

Was Custody Seal Intact? NA Were Samples Tampered with? NA

Was COC Relinquished ? T Does Chain Agree With Samples? T

Are there broken/leaking/loose caps on any samples? F

Is COC in ink/ Legible? T Were samples received within holding time? T

Did COC include all pertinent Information? Client T Analysis T Sampler Name T

Project T ID's T Collection Dates/Times T

Are Sample labels filled out and legible? T

Are there Lab to Filters? F Who was notified? _____

Are there Rushes? F Who was notified? _____

Are there Short Holds? F Who was notified? _____

Is there enough Volume? T

Is there Headspace where applicable? NA MS/MSD? F

Proper Media/Containers Used? T Is splitting samples required? F

Were trip blanks received? F On COC? F

Do all samples have the proper pH? NA Acid _____ Base _____

Vials	#	Containers:	#		#		#
Unp-		1 Liter Amb.		1 Liter Plastic		16 oz Amb.	10
HCL-		500 mL Amb.		500 mL Plastic		8oz Amb/Clear	
Meoh-		250 mL Amb.		250 mL Plastic		4oz Amb/Clear	
Bisulfate-		Flashpoint		Col./Bacteria		2oz Amb/Clear	
DI-		Other Glass		Other Plastic		Encore	
Thiosulfate-		SOC Kit		Plastic Bag		Frozen:	
Sulfuric-		Perchlorate		Ziplock			

Unused Media

Vials	#	Containers:	#		#		#
Unp-		1 Liter Amb.		1 Liter Plastic		16 oz Amb.	
HCL-		500 mL Amb.		500 mL Plastic		8oz Amb/Clear	
Meoh-		250 mL Amb.		250 mL Plastic		4oz Amb/Clear	
Bisulfate-		Col./Bacteria		Flashpoint		2oz Amb/Clear	
DI-		Other Plastic		Other Glass		Encore	
Thiosulfate-		SOC Kit		Plastic Bag		Frozen:	
Sulfuric-		Perchlorate		Ziplock			

Comments:

MADEP MCP Analytical Method Report Certification Form

Laboratory Name: Con-Test, a Pace Analytical Laboratory	Project #: 21I0997
Project Location: Haverhill, MA	RTN:

This Form provides certifications for the following data set: [list Laboratory Sample ID Number(s)]

21I0997-01 thru 21I0997-10

Matrices: Soil

CAM Protocol (check all that below)

8260 VOC CAM II A ( )	7470/7471 Hg CAM IIIB ( )	MassDEP VPH CAM IV A ( )	8082 PCB CAM V A (X)	9014 Total Cyanide/PAC CAM VI A ( )	6860 Perchlorate CAM VIII B ( )
8270 SVOC CAM II B (X)	7010 Metals CAM III C ( )	MassDEP VPH CAM IV C ( )	8081 Pesticides CAM V B ( )	7196 Hex Cr CAM VI B ( )	MassDEP APH CAM IX A ( )
6010 Metals CAM III A (X)	6020 Metals CAM III D ( )	MassDEP EPH CAM IV B (X)	8151 Herbicides CAM V C ( )	8330 Explosives CAM VIII A ( )	TO-15 VOC CAM IX B ( )

Affirmative response to Questions A throughF is required for "Presumptive Certainty" status

A	Were all samples received in a condition consistent with those described on the Chain-of-Custody, properly preserved (including temperature) in the field or laboratory, and prepared/analyzed within method holding times?	☑ Yes	☐ No[1]
B	Were the analytical method(s) and all associated QC requirements specificed in the selected CAM protocol(s) followed?	☑ Yes	☐ No[1]
C	Were all required corrective actions and analytical response actions specified in the selected CAM protocol(s) implemented for all identified performance standard non-conformances?	☑ Yes	☐ No[1]
D	Does the laboratory report comply with all the reporting requirements specified in CAM VII A, Quality Assurance and Quality Control Guidlines for the Acquisition and Reporting of Analytical Data?	☑ Yes	☐ No[1]
E a	VPH, EPH, and APH Methods only: Was each method conducted without significant modification(s)? (Refer to the individual method(s) for a list of significant modifications).	☑ Yes	☐ No[1]
E b	APH and TO-15 Methods only: Was the complete analyte list reported for each method?	☐ Yes	☐ No[1]
F	Were all applicable CAM protocol QC and performance standard non-conformances identified and evaluated in a laboratory narrative (including all No responses to Qestions A through E)?	☑ Yes	☐ No[1]

A response to questions G, H and I below is required for "Presumptive Certainty" status

G	Were the reporting limits at or below all CAM reporting limits specified in the selected CAM protocol(s)?	☑ Yes	☐ No[1]

<u>Data User Note:</u> Data that achieve "Presumptive Certainty" status may not necessarily meet the data usability and representativeness requirements described in 310 CMR 40. 1056 (2)(k) and WSC-07-350.

H	Were all QC perfomance standards specified in the CAM protocol(s) achieved?	☑ Yes	☐ No[1]
I	Were results reported for the complete analyte list specified in the selected CAM protocol(s)?	☐ Yes	☑ No[1]

[1] *All Negative responses must be addressed in an attached Environmental Laboratory case narrative.*

I, the undersigned, attest under the pains and penalties of perjury that, based upon my personal inquiry of those responsible for obtaining the information, the material contained in this analytical report is, to the best of my knowledge and belief, accurate and complete.

Signature: Tod Kopyscinski Position: Laboratory Director

Printed Name: Tod E. Kopyscinski Date: 09/27/21

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October 22, 2021

Matt Kissane
Fuss & O'Neill EnviroScience, LLC - MA
108 Myrtle St,
Quincy, MA 02171

Project Location: Haverhill, MA
Client Job Number:
Project Number: 20170390.U30
Laboratory Work Order Number: 21J0927

Enclosed are results of analyses for samples as received by the laboratory on October 15, 2021. If you have any questions concerning this report, please feel free to contact me.

Sincerely,

Jessica L. Hoffman
Project Manager

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Fuss & O'Neill EnviroScience, LLC - MA
108 Myrtle St,
Quincy, MA 02171
ATTN: Matt Kissane

REPORT DATE: 10/22/2021

PURCHASE ORDER NUMBER:

PROJECT NUMBER: 20170390.U30

ANALYTICAL SUMMARY

WORK ORDER NUMBER: 21J0927

The results of analyses performed on the following samples submitted to CON-TEST, a Pace Analytical Laboratory, are found in this report.

PROJECT LOCATION: Haverhill, MA

FIELD SAMPLE #	LAB ID:	MATRIX	SAMPLE DESCRIPTION	TEST	SUB LAB
1543210907-02	21J0927-01	Soil		SM 2540G SW-846 6010D	

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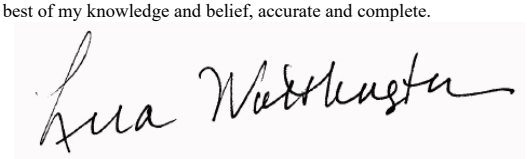
CASE NARRATIVE SUMMARY

All reported results are within defined laboratory quality control objectives unless listed below or otherwise qualified in this report.

The results of analyses reported only relate to samples submitted to Con-Test, a Pace Analytical Laboratory, for testing.
I certify that the analyses listed above, unless specifically listed as subcontracted, if any, were performed under my direction according to the approved methodologies listed in this document, and that based upon my inquiry of those individuals immediately responsible for obtaining the information, the material contained in this report is, to the best of my knowledge and belief, accurate and complete.



Lisa A. Worthington
Technical Representative

39 Spruce Street * East Longmeadow, MA 01028 * FAX 413/525-6405 * TEL. 413/525-2332

Project Location: Haverhill, MA | Sample Description: | Work Order: 21J0927

Date Received: 10/15/2021

Field Sample #: 1543210907-02 | Sampled: 9/7/2021 09:41

Sample ID: 21J0927-01

Sample Matrix: Soil

Conventional Chemistry Parameters by EPA/APHA/SW-846 Methods (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
% Solids	47.4		% Wt	1		SM 2540G	9/10/21	9/13/21 9:51	MJH

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Project Location: Haverhill, MA
Sample Description:
Work Order: 21J0927

Date Received: 10/15/2021

Field Sample #: 1543210907-02
Sampled: 9/7/2021 09:41

Sample ID: 21J0927-01

Sample Matrix: Soil

TCLP - Metals Analyses

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Lead	1.3	0.10	mg/L	1		SW-846 6010D	10/19/21	10/20/21 12:44	QNW

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Sample Extraction Data

Prep Method: % Solids **Analytical Method: SM 2540G**

Lab Number [Field ID]	Batch	Date
21J0927-01 [1543210907-02]	B289999	09/10/21

Prep Method: SW-846 3010A **Analytical Method: SW-846 6010D** **Leachates were extracted on 10/18/2021 per SW-846 1311 in Batch B292664**

Lab Number [Field ID]	Batch	Initial [mL]	Final [mL]	Date
21J0927-01 [1543210907-02]	B292761	50.0	50.0	10/19/21

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QUALITY CONTROL

TCLP - Metals Analyses - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B292761 - SW-846 3010A										
Blank (B292761-BLK1)				Prepared: 10/19/21 Analyzed: 10/20/21						
Lead	ND	0.10	mg/L							
LCS (B292761-BS1)				Prepared: 10/19/21 Analyzed: 10/20/21						
Lead	0.503	0.10	mg/L	0.500		101	80-120			
LCS Dup (B292761-BSD1)				Prepared: 10/19/21 Analyzed: 10/20/21						
Lead	0.498	0.10	mg/L	0.500		99.6	80-120	1.02	20	

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FLAG/QUALIFIER SUMMARY

*	QC result is outside of established limits.
†	Wide recovery limits established for difficult compound.
‡	Wide RPD limits established for difficult compound.
#	Data exceeded client recommended or regulatory level
ND	Not Detected
RL	Reporting Limit is at the level of quantitation (LOQ)
DL	Detection Limit is the lower limit of detection determined by the MDL study
MCL	Maximum Contaminant Level

Percent recoveries and relative percent differences (RPDs) are determined by the software using values in the calculation which have not been rounded.

No results have been blank subtracted unless specified in the case narrative section.

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CERTIFICATIONS

Certified Analyses included in this Report

Analyte	Certifications
SW-846 6010D in Water	
Lead	NY,CT,ME,NC,NH,VA

Con-Test, a Pace Environmental Laboratory, operates under the following certifications and accreditations:

Code	Description	Number	Expires
AIHA	AIHA-LAP, LLC - ISO17025:2017	100033	03/1/2022
MA	Massachusetts DEP	M-MA100	06/30/2022
CT	Connecticut Department of Publilc Health	PH-0165	12/31/2022
NY	New York State Department of Health	10899 NELAP	04/1/2022
NH-S	New Hampshire Environmental Lab	2516 NELAP	02/5/2022
RI	Rhode Island Department of Health	LAO00112	12/30/2021
NC	North Carolina Div. of Water Quality	652	12/31/2021
NJ	New Jersey DEP	MA007 NELAP	06/30/2022
FL	Florida Department of Health	E871027 NELAP	06/30/2022
VT	Vermont Department of Health Lead Laboratory	LL720741	07/30/2022
ME	State of Maine	MA00100	06/9/2023
VA	Commonwealth of Virginia	460217	12/14/2021
NH-P	New Hampshire Environmental Lab	2557 NELAP	09/6/2022
VT-DW	Vermont Department of Health Drinking Water	VT-255716	06/12/2022
NC-DW	North Carolina Department of Health	25703	07/31/2022
PA	Commonwealth of Pennsylvania DEP	68-05812	06/30/2022
MI	Dept. of Env, Great Lakes, and Energy	9100	09/6/2022

21J0927

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☒ 108 Myrtle Street, #502, North Quincy, MA 02171
☐ 317 Iron Horse Way, Suite 204, Providence, RI 02908
☐ 80 Washington Street, Suite 301, Poughkeepsie, NY
☐ Other _____

21J0927

CHAIN-OF-CUSTODY RECORD

41951

Turnaround: Due 9/16/21
☐ 24-Hour* ☐ 72-Hour* ☐ Other _____ (days)
☐ 48-Hour* ☐ Standard (____ days) *Surcharge Applies

PROJECT NAME: MVP Grant FY 22/23
PROJECT LOCATION: Haverhill, MA
PROJECT NUMBER: 20170390.U30
LABORATORY: Pace Labs

REPORT TO: Matt Krissane (MKrissane@fando.com)
INVOICE TO:
P.O. NO.: 1543 20170390.U30
Sampler's Signature: _____ Date: 9/8/21

Source Codes:
MW=Monitoring Well PW=Potable Water T=Treatment Facility S=Soil B=Sediment
SW=Surface Water ST=Stormwater W=Waste A=Air C=Concrete
X=Other TRIP BLANK

Analysis Request / Containers

Item No.	Transfer Check 1 2 3 4	Sample Number	Source Code	Date Sampled	Time Sampled	Total Metals *	PAH's ONLY	PCB's	EPH's	VOC's	Pesticides + Herbicides	TCLP *	Total Organic Carbon	Soil VOA Vial, ★methanol	Soil VOA Vial, ☐ water ★Na(SO)/2	Glass Soil Container (16) oz	Other 6l 8oz	Other 6l 20z	Water VOA Vial, ☐ As is ☐ HCl	Glass Amber (____) ml, ☐ As is ☐ H2SO4	Plastic - As is, ☐ 250 ml ☐ 500 ☐ 1000 ml	Plastic - H2SO4, ☐ 250 ml ☐ 500 ml	Plastic - HNO3, 250 ml ☐ Filtered ☐ 0.45µ ☐ 10µ	Plastic - NaOH, 250 ml	Comments
1	1 X	1543210907-01	X	9/7/21	0842					X						1	2								
2	2 X	01 -02	B	↓	0941	X	X	X	X	X	X	X	X			1	2	1	1	1					
3	3 X	-03	↓		1057	X	X	X	X	X	X	X	X			1	2	1	1	1					
4	4 X	-04			1125	X	X	X	X	X	X	X	X			1	2	1	1	1					
5	5 X	-05			1305	X	X	X	X	X	X	X	X			1	2	1	1	1					
6	6 X	1543210908-06	X	9/8/21	0954					X						1	2								
7	7 X	-07	B		1027	X	X	X	X	X	X	X	X			1	2	1	1	1					
8	8 X	~~08~~	B	↓	1104	X	X	X	X	X	X	X	X												

Client activated sample for TCLP Lead JLH 10/15/2021

Transfer Number	Relinquished By	Accepted By	Date	Time
1		FED Fridge	9/8/21	
2		Paul Ehrling	9-9-21	1135
3	Paul Ehrling		9-9-21	1455
4		17.5 5.2	9/9/21	1902

Charge Exceptions: ☐ CT Tax Exempt ☐ QA/QC ☐ Other _____ ____ Duplicates ☒ Blanks (Item Nos: 1 + 6)
Reporting and Detection Limit Requirements: ☐ RCP Deliverables ☐ MCP CAM Cert.
Additional Comments: * As, Cd, Cr, Cu, Pb, Hg, Ni, Zn
Hold Samples for TCLP

Table of Contents

I Have Not Confirmed Sample Container Numbers With Lab Staff Before Relinquishing Over Samples_____

con-test® ANALYTICAL LABORATORY

Doc# 277 Rev 5 2017

Login Sample Receipt Checklist - (Rejection Criteria Listing - Using Acceptance Policy) Any False Statement will be brought to the attention of the Client - State True or False

Client Fuss O'Neill

Received By [signature] Date 9/4/21 Time 1900

How were the samples received? In Cooler T No Cooler _____ On Ice T No Ice _____ Direct from Sampling _____ Ambient _____ Melted Ice _____

Were samples within Temperature? 2-6°C T By Gun # 3 Actual Temp - 5.2 By Blank # _____ Actual Temp - _____

Was Custody Seal Intact? n/a Were Samples Tampered with? n/a

Was COC Relinquished ? T Does Chain Agree With Samples? T

Are there broken/leaking/loose caps on any samples? F

Is COC in ink/ Legible? T Were samples received within holding time? _____

Did COC include all pertinent Information? Client T Analysis T Sampler Name _____ Project T ID's T Collection Dates/Times _____

Are Sample labels filled out and legible? T

Are there Lab to Filters? F Who was notified? _____

Are there Rushes? F Who was notified? _____

Are there Short Holds? F Who was notified? _____

Is there enough Volume? T

Is there Headspace where applicable? n/a MS/MSD? F

Proper Media/Containers Used? T Is splitting samples required? F

Were trip blanks received? T On COC? T

Do all samples have the proper pH? Acid n/a Base n/a

Vials	#	Containers:	#		#		#
Unp-		1 Liter Amb.		1 Liter Plastic		16 oz Amb.	6
HCL-		500 mL Amb.		500 mL Plastic		8oz Amb/Clear	6
Meoh-	8	250 mL Amb.		250 mL Plastic		4oz Amb/Clear	
Bisulfate-	16	Flashpoint		Col./Bacteria		2oz Amb/Clear	6
DI-		Other Glass		Other Plastic		Encore	
Thiosulfate-		SOC Kit		Plastic Bag		Frozen:	
Sulfuric-		Perchlorate		Ziplock			

Unused Media

Vials	#	Containers:	#		#		#
Unp-		1 Liter Amb.		1 Liter Plastic		16 oz Amb.	
HCL-		500 mL Amb.		500 mL Plastic		8oz Amb/Clear	
Meoh-		250 mL Amb.		250 mL Plastic		4oz Amb/Clear	
Bisulfate-		Col./Bacteria		Flashpoint		2oz Amb/Clear	
DI-		Other Plastic		Other Glass		Encore	
Thiosulfate-		SOC Kit		Plastic Bag		Frozen:	
Sulfuric-		Perchlorate		Ziplock			

Comments:

MADEP MCP Analytical Method Report Certification Form

Laboratory Name: Con-Test, a Pace Analytical Laboratory	Project #: 21J0927
Project Location: Haverhill, MA	RTN:

This Form provides certifications for the following data set: [list Laboratory Sample ID Number(s)]

21J0927-01

Matrices: Soil

CAM Protocol (check all that below)

8260 VOC CAM II A ( )	7470/7471 Hg CAM IIIB ( )	MassDEP VPH CAM IV A ( )	8082 PCB CAM V A ( )	9014 Total Cyanide/PAC CAM VI A ( )	6860 Perchlorate CAM VIII B ( )
8270 SVOC CAM II B ( )	7010 Metals CAM III C ( )	MassDEP VPH CAM IV C ( )	8081 Pesticides CAM V B ( )	7196 Hex Cr CAM VI B ( )	MassDEP APH CAM IX A ( )
6010 Metals CAM III A (X)	6020 Metals CAM III D ( )	MassDEP EPH CAM IV B ( )	8151 Herbicides CAM V C ( )	8330 Explosives CAM VIII A ( )	TO-15 VOC CAM IX B ( )

Affirmative response to Questions A throughF is required for "Presumptive Certainty" status

A	Were all samples received in a condition consistent with those described on the Chain-of-Custody, properly preserved (including temperature) in the field or laboratory, and prepared/analyzed within method holding times?	☑ Yes	☐ No[1]
B	Were the analytical method(s) and all associated QC requirements specificed in the selected CAM protocol(s) followed?	☑ Yes	☐ No[1]
C	Were all required corrective actions and analytical response actions specified in the selected CAM protocol(s) implemented for all identified performance standard non-conformances?	☑ Yes	☐ No[1]
D	Does the laboratory report comply with all the reporting requirements specified in CAM VII A, Quality Assurance and Quality Control Guidlines for the Acquisition and Reporting of Analytical Data?	☑ Yes	☐ No[1]
E a	VPH, EPH, and APH Methods only: Was each method conducted without significant modification(s)? (Refer to the individual method(s) for a list of significant modifications).	☐ Yes	☐ No[1]
E b	APH and TO-15 Methods only: Was the complete analyte list reported for each method?	☐ Yes	☐ No[1]
F	Were all applicable CAM protocol QC and performance standard non-conformances identified and evaluated in a laboratory narrative (including all No responses to Qestions A through E)?	☑ Yes	☐ No[1]

A response to questions G, H and I below is required for "Presumptive Certainty" status

G	Were the reporting limits at or below all CAM reporting limits specified in the selected CAM protocol(s)?	☑ Yes	☐ No[1]

<u>Data User Note:</u> Data that achieve "Presumptive Certainty" status may not necessarily meet the data usability and representativeness requirements described in 310 CMR 40. 1056 (2)(k) and WSC-07-350.

H	Were all QC perfomance standards specified in the CAM protocol(s) achieved?	☑ Yes	☐ No[1]
I	Were results reported for the complete analyte list specified in the selected CAM protocol(s)?	☐ Yes	☑ No[1]

[1] *All Negative responses must be addressed in an attached Environmental Laboratory case narrative.*

I, the undersigned, attest under the pains and penalties of perjury that, based upon my personal inquiry of those responsible for obtaining the information, the material contained in this analytical report is, to the best of my knowledge and belief, accurate and complete.

Signature: Lisa Worthington Position: Technical Representative

Printed Name: Lisa A. Worthington Date: 10/22/21

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October 22, 2021

Matt Kissane
Fuss & O'Neill EnviroScience, LLC - MA
108 Myrtle St,
Quincy, MA 02171

Project Location: Haverhill, MA
Client Job Number:
Project Number: 20170390.U30
Laboratory Work Order Number: 21J0931

Enclosed are results of analyses for samples as received by the laboratory on October 15, 2021. If you have any questions concerning this report, please feel free to contact me.

Sincerely,

Jessica L. Hoffman
Project Manager

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Fuss & O'Neill EnviroScience, LLC - MA
108 Myrtle St,
Quincy, MA 02171
ATTN: Matt Kissane

REPORT DATE: 10/22/2021

PURCHASE ORDER NUMBER:

PROJECT NUMBER: 20170390.U30

ANALYTICAL SUMMARY

WORK ORDER NUMBER: 21J0931

The results of analyses performed on the following samples submitted to CON-TEST, a Pace Analytical Laboratory, are found in this report.

PROJECT LOCATION: Haverhill, MA

FIELD SAMPLE #	LAB ID:	MATRIX	SAMPLE DESCRIPTION	TEST	SUB LAB
1543210917-01	21J0931-01	Soil		SM 2540G	
				SW-846 6010D	
1543210917-02	21J0931-02	Soil		SM 2540G	
				SW-846 6010D	
1543210917-03	21J0931-03	Soil		SM 2540G	
				SW-846 6010D	
1543210917-05	21J0931-04	Soil		SM 2540G	
				SW-846 6010D	
1543210917-07	21J0931-05	Soil		SM 2540G	
				SW-846 6010D	
1543210917-08	21J0931-06	Soil		SM 2540G	
				SW-846 6010D	
1543210917-09	21J0931-07	Soil		SM 2540G	
				SW-846 6010D	
1543210917-10	21J0931-08	Soil		SM 2540G	
				SW-846 6010D	

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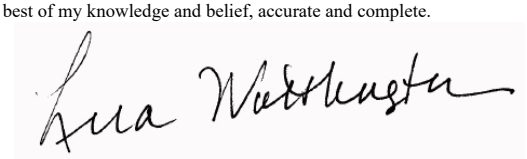
CASE NARRATIVE SUMMARY

All reported results are within defined laboratory quality control objectives unless listed below or otherwise qualified in this report.

The results of analyses reported only relate to samples submitted to Con-Test, a Pace Analytical Laboratory, for testing.
I certify that the analyses listed above, unless specifically listed as subcontracted, if any, were performed under my direction according to the approved methodologies listed in this document, and that based upon my inquiry of those individuals immediately responsible for obtaining the information, the material contained in this report is, to the best of my knowledge and belief, accurate and complete.



Lisa A. Worthington
Technical Representative

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39 Spruce Street * East Longmeadow, MA 01028 * FAX 413/525-6405 * TEL. 413/525-2332

Project Location: Haverhill, MA | Sample Description: | Work Order: 21J0931

Date Received: 10/15/2021

Field Sample #: 1543210917-01 | Sampled: 9/17/2021 08:35

Sample ID: 21J0931-01

Sample Matrix: Soil

Conventional Chemistry Parameters by EPA/APHA/SW-846 Methods (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
% Solids	50.8		% Wt	1		SM 2540G	9/23/21	9/24/21 12:41	MJH

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Project Location: Haverhill, MA
Sample Description:
Work Order: 21J0931

Date Received: 10/15/2021

Field Sample #: 1543210917-01
Sampled: 9/17/2021 08:35

Sample ID: 21J0931-01

Sample Matrix: Soil

TCLP - Metals Analyses

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Lead	0.50	0.10	mg/L	1		SW-846 6010D	10/19/21	10/20/21 12:51	QNW

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21J0931

Date Received: 10/15/2021

Field Sample #: 1543210917-02 | Sampled: 9/17/2021 08:55

Sample ID: 21J0931-02

Sample Matrix: Soil

Conventional Chemistry Parameters by EPA/APHA/SW-846 Methods (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
% Solids	41.2		% Wt	1		SM 2540G	9/23/21	9/24/21 12:41	MJH

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Project Location: Haverhill, MA
Sample Description:
Work Order: 21J0931

Date Received: 10/15/2021

Field Sample #: 1543210917-02
Sampled: 9/17/2021 08:55

Sample ID: 21J0931-02

Sample Matrix: Soil

TCLP - Metals Analyses

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Lead	0.53	0.10	mg/L	1		SW-846 6010D	10/19/21	10/20/21 12:58	QNW

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21J0931

Date Received: 10/15/2021

Field Sample #: 1543210917-03 | Sampled: 9/17/2021 08:45

Sample ID: 21J0931-03

Sample Matrix: Soil

Conventional Chemistry Parameters by EPA/APHA/SW-846 Methods (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
% Solids	52.0		% Wt	1		SM 2540G	9/23/21	9/24/21 12:41	MJH

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Project Location: Haverhill, MA
Sample Description:
Work Order: 21J0931

Date Received: 10/15/2021

Field Sample #: 1543210917-03
Sampled: 9/17/2021 08:45

Sample ID: 21J0931-03

Sample Matrix: Soil

TCLP - Metals Analyses

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Lead	1.4	0.10	mg/L	1		SW-846 6010D	10/19/21	10/20/21 13:05	QNW

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21J0931

Date Received: 10/15/2021

Field Sample #: 1543210917-05 | Sampled: 9/17/2021 09:15

Sample ID: 21J0931-04

Sample Matrix: Soil

Conventional Chemistry Parameters by EPA/APHA/SW-846 Methods (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
% Solids	41.3		% Wt	1		SM 2540G	9/23/21	9/24/21 12:41	MJH

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21J0931

Date Received: 10/15/2021

Field Sample #: 1543210917-05 | Sampled: 9/17/2021 09:15

Sample ID: 21J0931-04

Sample Matrix: Soil

TCLP - Metals Analyses

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Lead	0.59	0.10	mg/L	1		SW-846 6010D	10/19/21	10/20/21 12:18	QNW

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21J0931

Date Received: 10/15/2021

Field Sample #: 1543210917-07 | Sampled: 9/17/2021 09:35

Sample ID: 21J0931-05

Sample Matrix: Soil

Conventional Chemistry Parameters by EPA/APHA/SW-846 Methods (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
% Solids	56.8		% Wt	1		SM 2540G	9/23/21	9/24/21 12:41	MJH

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Project Location: Haverhill, MA
Sample Description:
Work Order: 21J0931

Date Received: 10/15/2021

Field Sample #: 1543210917-07
Sampled: 9/17/2021 09:35

Sample ID: 21J0931-05

Sample Matrix: Soil

TCLP - Metals Analyses

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Lead	0.67	0.10	mg/L	1		SW-846 6010D	10/19/21	10/20/21 13:12	QNW

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21J0931

Date Received: 10/15/2021

Field Sample #: 1543210917-08 | Sampled: 9/17/2021 10:20

Sample ID: 21J0931-06

Sample Matrix: Soil

Conventional Chemistry Parameters by EPA/APHA/SW-846 Methods (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
% Solids	42.9		% Wt	1		SM 2540G	9/23/21	9/24/21 12:41	MJH

39 Spruce Street * East Longmeadow, MA 01028 * FAX 413/525-6405 * TEL. 413/525-2332

Project Location: Haverhill, MA | Sample Description: | Work Order: 21J0931

Date Received: 10/15/2021

Field Sample #: 1543210917-08 | Sampled: 9/17/2021 10:20

Sample ID: 21J0931-06

Sample Matrix: Soil

TCLP - Metals Analyses

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Lead	0.29	0.10	mg/L	1		SW-846 6010D	10/19/21	10/20/21 13:19	QNW

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21J0931

Date Received: 10/15/2021

Field Sample #: 1543210917-09 | Sampled: 9/17/2021 10:15

Sample ID: 21J0931-07

Sample Matrix: Soil

Conventional Chemistry Parameters by EPA/APHA/SW-846 Methods (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
% Solids	57.6		% Wt	1		SM 2540G	9/23/21	9/24/21 12:41	MJH

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Project Location: Haverhill, MA
Sample Description:
Work Order: 21J0931

Date Received: 10/15/2021

Field Sample #: 1543210917-09
Sampled: 9/17/2021 10:15

Sample ID: 21J0931-07

Sample Matrix: Soil

TCLP - Metals Analyses

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Lead	0.94	0.10	mg/L	1		SW-846 6010D	10/19/21	10/20/21 13:26	QNW

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21J0931

Date Received: 10/15/2021

Field Sample #: 1543210917-10 | Sampled: 9/17/2021 10:05

Sample ID: 21J0931-08

Sample Matrix: Soil

Conventional Chemistry Parameters by EPA/APHA/SW-846 Methods (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
% Solids	50.1		% Wt	1		SM 2540G	9/23/21	9/24/21 12:41	MJH

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Project Location: Haverhill, MA | Sample Description: | Work Order: 21J0931

Date Received: 10/15/2021

Field Sample #: 1543210917-10 | Sampled: 9/17/2021 10:05

Sample ID: 21J0931-08

Sample Matrix: Soil

TCLP - Metals Analyses

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Lead	0.58	0.10	mg/L	1		SW-846 6010D	10/19/21	10/20/21 13:33	QNW

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Sample Extraction Data

Prep Method: % Solids **Analytical Method: SM 2540G**

Lab Number [Field ID]	Batch	Date
21J0931-01 [1543210917-01]	B290731	09/23/21
21J0931-02 [1543210917-02]	B290731	09/23/21
21J0931-03 [1543210917-03]	B290731	09/23/21
21J0931-04 [1543210917-05]	B290731	09/23/21
21J0931-05 [1543210917-07]	B290731	09/23/21
21J0931-06 [1543210917-08]	B290731	09/23/21
21J0931-07 [1543210917-09]	B290731	09/23/21
21J0931-08 [1543210917-10]	B290731	09/23/21

Prep Method: SW-846 3010A **Analytical Method: SW-846 6010D** **Leachates were extracted on 10/18/2021 per SW-846 1311 in Batch B292664**

Lab Number [Field ID]	Batch	Initial [mL]	Final [mL]	Date
21J0931-01 [1543210917-01]	B292761	50.0	50.0	10/19/21
21J0931-02 [1543210917-02]	B292761	50.0	50.0	10/19/21
21J0931-03 [1543210917-03]	B292761	50.0	50.0	10/19/21
21J0931-04 [1543210917-05]	B292761	50.0	50.0	10/19/21
21J0931-05 [1543210917-07]	B292761	50.0	50.0	10/19/21
21J0931-06 [1543210917-08]	B292761	50.0	50.0	10/19/21
21J0931-07 [1543210917-09]	B292761	50.0	50.0	10/19/21
21J0931-08 [1543210917-10]	B292761	50.0	50.0	10/19/21

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QUALITY CONTROL

TCLP - Metals Analyses - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B292761 - SW-846 3010A										
Blank (B292761-BLK1)				Prepared: 10/19/21 Analyzed: 10/20/21						
Lead	ND	0.10	mg/L							
LCS (B292761-BS1)				Prepared: 10/19/21 Analyzed: 10/20/21						
Lead	0.503	0.10	mg/L	0.500		101	80-120			
LCS Dup (B292761-BSD1)				Prepared: 10/19/21 Analyzed: 10/20/21						
Lead	0.498	0.10	mg/L	0.500		99.6	80-120	1.02	20	
Matrix Spike (B292761-MS1)	**Source: 21J0931-04**			Prepared: 10/19/21 Analyzed: 10/20/21						
Lead	1.07	0.10	mg/L	0.500	0.587	97.4	75-125			

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FLAG/QUALIFIER SUMMARY

*	QC result is outside of established limits.
†	Wide recovery limits established for difficult compound.
‡	Wide RPD limits established for difficult compound.
#	Data exceeded client recommended or regulatory level
ND	Not Detected
RL	Reporting Limit is at the level of quantitation (LOQ)
DL	Detection Limit is the lower limit of detection determined by the MDL study
MCL	Maximum Contaminant Level

Percent recoveries and relative percent differences (RPDs) are determined by the software using values in the calculation which have not been rounded.

No results have been blank subtracted unless specified in the case narrative section.

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CERTIFICATIONS

Certified Analyses included in this Report

Analyte	Certifications
SW-846 6010D in Water	
Lead	NY,CT,ME,NC,NH,VA

Con-Test, a Pace Environmental Laboratory, operates under the following certifications and accreditations:

Code	Description	Number	Expires
AIHA	AIHA-LAP, LLC - ISO17025:2017	100033	03/1/2022
MA	Massachusetts DEP	M-MA100	06/30/2022
CT	Connecticut Department of Publilc Health	PH-0165	12/31/2022
NY	New York State Department of Health	10899 NELAP	04/1/2022
NH-S	New Hampshire Environmental Lab	2516 NELAP	02/5/2022
RI	Rhode Island Department of Health	LAO00112	12/30/2021
NC	North Carolina Div. of Water Quality	652	12/31/2021
NJ	New Jersey DEP	MA007 NELAP	06/30/2022
FL	Florida Department of Health	E871027 NELAP	06/30/2022
VT	Vermont Department of Health Lead Laboratory	LL720741	07/30/2022
ME	State of Maine	MA00100	06/9/2023
VA	Commonwealth of Virginia	460217	12/14/2021
NH-P	New Hampshire Environmental Lab	2557 NELAP	09/6/2022
VT-DW	Vermont Department of Health Drinking Water	VT-255716	06/12/2022
NC-DW	North Carolina Department of Health	25703	07/31/2022
PA	Commonwealth of Pennsylvania DEP	68-05812	06/30/2022
MI	Dept. of Env, Great Lakes, and Energy	9100	09/6/2022

~~21C0497~~

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☐ 56 Quarry Road, Trumbull, CT 06611
☐ 1419 Richland Street, Columbia, SC 29201
☐ 78 Interstate Drive, West Springfield, MA 01089
☒ 108 Myrtle Street, #502, North Quincy, MA 02171
☐ 317 Iron Horse Way, Suite 204, Providence, RI 02908
☐ 80 Washington Street, Suite 301, Poughkeepsie, NY
☐ Other _____

21J0931

CHAIN-OF-CUSTODY RECORD

41957

Turnaround
☐ 24-Hour* ☐ 72-Hour* ☐ Other _____ (days)
☐ 48-Hour* ☒ Standard (5 days) *Surcharge Applies

PROJECT NAME: MVP GRANT FY 22/23
PROJECT LOCATION: HAVERHILL, MA
PROJECT NUMBER: 2017 0390.U30
LABORATORY: PACE LABS

REPORT TO: Matt Kissane (mkissane@fando.com)
INVOICE TO:
P.O. NO.: 1543 20170390.U30
Sampler's Signature: _____ Date: 9/17/21

Source Codes:
MW=Monitoring Well PW=Potable Water T=Treatment Facility S=Soil B=Sediment
SW=Surface Water ST=Stormwater W=Waste A=Air C=Concrete
X=Other _____

Analysis Request

Containers

Item No.	Transfer Check 1	2	3	4	Sample Number	Source Code	Date Sampled	Time Sampled	PCB	Lead	Hexane	EPH Ranges ONLY	VPH 8270	Soil VOA Vial, ☐ methanol	Soil VOA Vial, ☐ water	Glass Soil Container (16) oz	Other:	Other:	Water VOA Vial, ☐ As is ☐ HCl	Glass Amber ( ) ml, ☐ As is ☐ H_2SO_4	Plastic - As is, ☐ 250 ml ☐ 500 ml ☐ 1000 ml	Plastic - H_2SO_4, ☐ 250 ml ☐ 500 ml	Plastic - HNO_3, 250 ml ☐ Filtered ☐ 0.45µ ☐ 10µ	Plastic - NaOH, 250 ml
1	X	X			01 1543210917-01	B	9/17/21	0835	X	X	X									1				
2					02 -02			0855	X	X	X									1				
3					03 -03			0845	X	X	X									1				
4					-04			0940	X	X	X	X	X							1				
5					04 -05			0915	X	X	X	X	X							1				
6					-06			0925	X	X	X	X	X							1				
7					05 -07			0935	X	X	X	X	X							1				
8					06 -08			1020	X	X	X	X	X							1				
9					07 -09			1015	X	X	X	X	X							1				
10					08 -10			1005	X	X	X	X	X							1				

Client chose to activate TCLP Lead JLH 10/15/2021

per client they do need the MA MCP form. JLH 9/21/2021

Transfer Number	Relinquished By	Accepted By	Date	Time
1		FedEx	9/17/21	1400
2	Fridge		9/20/21	1145
3		5.4	9/20/21	1709
4				

Charge Exceptions: ☐ CT Tax Exempt ☐ QA/QC ☐ Other _____
____ Duplicates ____ Blanks (Item Nos:)
Reporting and Detection Limit Requirements: ☐ RCP Deliverables ☐ MCP CAM Cert.
Additional Comments:

Table of Contents

I Have Not Confirmed Sample Container Numbers With Lab Staff Before Relinquishing Over Samples_____

con-test® ANALYTICAL LABORATORY

Doc# 277 Rev 5 2017

Login Sample Receipt Checklist - (Rejection Criteria Listing - Using Acceptance Policy) Any False Statement will be brought to the attention of the Client - State True or False

Client Fuss & O'Neill

Received By GR Date 9/20/21 Time 1703

How were the samples received? In Cooler T No Cooler _____ On Ice T No Ice _____ Direct from Sampling _____ Ambient _____ Melted Ice _____

Were samples within Temperature? 2-6°C T By Gun # 2 Actual Temp - 5.4 By Blank # _____ Actual Temp - _____

Was Custody Seal Intact? NA Were Samples Tampered with? NA

Was COC Relinquished ? T Does Chain Agree With Samples? T

Are there broken/leaking/loose caps on any samples? F

Is COC in ink/ Legible? T Were samples received within holding time? T

Did COC include all pertinent Information? Client T Project T Analysis T ID's T Sampler Name T Collection Dates/Times T

Are Sample labels filled out and legible? T

Are there Lab to Filters? F Who was notified? _____

Are there Rushes? F Who was notified? _____

Are there Short Holds? F Who was notified? _____

Is there enough Volume? T

Is there Headspace where applicable? NA MS/MSD? F

Proper Media/Containers Used? T Is splitting samples required? F

Were trip blanks received? F On COC? F

Do all samples have the proper pH? NA Acid _____ Base _____

Vials	#	Containers:	#		#		#
Unp-		1 Liter Amb.		1 Liter Plastic		16 oz Amb.	10
HCL-		500 mL Amb.		500 mL Plastic		8oz Amb/Clear	
Meoh-		250 mL Amb.		250 mL Plastic		4oz Amb/Clear	
Bisulfate-		Flashpoint		Col./Bacteria		2oz Amb/Clear	
DI-		Other Glass		Other Plastic		Encore	
Thiosulfate-		SOC Kit		Plastic Bag		Frozen:	
Sulfuric-		Perchlorate		Ziplock			

Unused Media

Vials	#	Containers:	#		#		#
Unp-		1 Liter Amb.		1 Liter Plastic		16 oz Amb.	
HCL-		500 mL Amb.		500 mL Plastic		8oz Amb/Clear	
Meoh-		250 mL Amb.		250 mL Plastic		4oz Amb/Clear	
Bisulfate-		Col./Bacteria		Flashpoint		2oz Amb/Clear	
DI-		Other Plastic		Other Glass		Encore	
Thiosulfate-		SOC Kit		Plastic Bag		Frozen:	
Sulfuric-		Perchlorate		Ziplock			

Comments:

MADEP MCP Analytical Method Report Certification Form

Laboratory Name: Con-Test, a Pace Analytical Laboratory	Project #: 21J0931
Project Location: Haverhill, MA	RTN:

This Form provides certifications for the following data set: [list Laboratory Sample ID Number(s)]

21J0931-01 thru 21J0931-08

Matrices: Soil

CAM Protocol (check all that below)

8260 VOC CAM II A ( )	7470/7471 Hg CAM IIIB ( )	MassDEP VPH CAM IV A ( )	8082 PCB CAM V A ( )	9014 Total Cyanide/PAC CAM VI A ( )	6860 Perchlorate CAM VIII B ( )
8270 SVOC CAM II B ( )	7010 Metals CAM III C ( )	MassDEP VPH CAM IV C ( )	8081 Pesticides CAM V B ( )	7196 Hex Cr CAM VI B ( )	MassDEP APH CAM IX A ( )
6010 Metals CAM III A (X)	6020 Metals CAM III D ( )	MassDEP EPH CAM IV B ( )	8151 Herbicides CAM V C ( )	8330 Explosives CAM VIII A ( )	TO-15 VOC CAM IX B ( )

Affirmative response to Questions A throughF is required for "Presumptive Certainty" status

A	Were all samples received in a condition consistent with those described on the Chain-of-Custody, properly preserved (including temperature) in the field or laboratory, and prepared/analyzed within method holding times?	☑ Yes	☐ No[1]
B	Were the analytical method(s) and all associated QC requirements specificed in the selected CAM protocol(s) followed?	☑ Yes	☐ No[1]
C	Were all required corrective actions and analytical response actions specified in the selected CAM protocol(s) implemented for all identified performance standard non-conformances?	☑ Yes	☐ No[1]
D	Does the laboratory report comply with all the reporting requirements specified in CAM VII A, Quality Assurance and Quality Control Guidlines for the Acquisition and Reporting of Analytical Data?	☑ Yes	☐ No[1]
E a	VPH, EPH, and APH Methods only: Was each method conducted without significant modification(s)? (Refer to the individual method(s) for a list of significant modifications).	☐ Yes	☐ No[1]
E b	APH and TO-15 Methods only: Was the complete analyte list reported for each method?	☐ Yes	☐ No[1]
F	Were all applicable CAM protocol QC and performance standard non-conformances identified and evaluated in a laboratory narrative (including all No responses to Qestions A through E)?	☑ Yes	☐ No[1]

A response to questions G, H and I below is required for "Presumptive Certainty" status

G	Were the reporting limits at or below all CAM reporting limits specified in the selected CAM protocol(s)?	☑ Yes	☐ No[1]

***Data User Note:* Data that achieve "Presumptive Certainty" status may not necessarily meet the data usability and representativeness requirements described in 310 CMR 40. 1056 (2)(k) and WSC-07-350.**

H	Were all QC perfomance standards specified in the CAM protocol(s) achieved?	☑ Yes	☐ No[1]
I	Were results reported for the complete analyte list specified in the selected CAM protocol(s)?	☐ Yes	☑ No[1]

[1] *All Negative responses must be addressed in an attached Environmental Laboratory case narrative.*

I, the undersigned, attest under the pains and penalties of perjury that, based upon my personal inquiry of those responsible for obtaining the information, the material contained in this analytical report is, to the best of my knowledge and belief, accurate and complete.

Signature: Lisa Worthington Position: Technical Representative

Printed Name: Lisa A. Worthington Date: 10/22/21

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39 Spruce Street * East Longmeadow, MA 01028 * FAX 413/525-6405 * TEL. 413/525-2332

June 23, 2022

Matt Kissane
Fuss & O'Neill EnviroScience, LLC - MA
108 Myrtle St,
Quincy, MA 02171

Project Location: Haverhill, MA
Client Job Number:
Project Number: 20170390.U30
Laboratory Work Order Number: 22F0701

Enclosed are results of analyses for samples as received by the laboratory on June 10, 2022. If you have any questions concerning this report, please feel free to contact me.

Sincerely,

Jessica L. Hoffman
Project Manager

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39 Spruce Street * East Longmeadow, MA 01028 * FAX 413/525-6405 * TEL. 413/525-2332

Fuss & O'Neill EnviroScience, LLC - MA
108 Myrtle St,
Quincy, MA 02171
ATTN: Matt Kissane

REPORT DATE: 6/23/2022

PURCHASE ORDER NUMBER: 170820170390.U30

PROJECT NUMBER: 20170390.U30

ANALYTICAL SUMMARY

WORK ORDER NUMBER: 22F0701

The results of analyses performed on the following samples submitted to CON-TEST, a Pace Analytical Laboratory, are found in this report.

PROJECT LOCATION: Haverhill, MA

FIELD SAMPLE #	LAB ID:	MATRIX	SAMPLE DESCRIPTION	TEST	SUB LAB
1708220608-01	22F0701-01	Sediment	SED-18	SM 2540G	
				SW-846 6010D	
				SW-846 7471B	
				SW-846 8270E	
1708220608-02	22F0701-02	Sediment	SED-19	SM 2540G	
				SW-846 6010D	
				SW-846 7471B	
				SW-846 8270E	
1708220608-03	22F0701-03	Sediment	SED-20	SM 2540G	
				SW-846 6010D	
				SW-846 7471B	
				SW-846 8270E	
1708220608-04	22F0701-04	Sediment	SED-21	SM 2540G	
				SW-846 6010D	
				SW-846 7471B	
				SW-846 8270E	
1708220608-05	22F0701-05	Sediment	SED-22	SM 2540G	
				SW-846 6010D	
				SW-846 7471B	
				SW-846 8270E	
1708220608-06	22F0701-06	Sediment	SED-17	SM 2540G	
				SW-846 6010D	
				SW-846 7471B	
				SW-846 8270E	
1708220608-07	22F0701-07	Sediment	SED-16	SM 2540G	
				SW-846 6010D	
				SW-846 7471B	
				SW-846 8270E	
1708220608-08	22F0701-08	Sediment	SED-15	SM 2540G	
				SW-846 6010D	
				SW-846 7471B	
				SW-846 8270E	
1708220608-09	22F0701-09	Sediment	SED-14	SM 2540G	
				SW-846 6010D	
				SW-846 7471B	
				SW-846 8270E	
1708220608-10	22F0701-10	Sediment	SED-13	SM 2540G	
				SW-846 6010D	
				SW-846 7471B	
				SW-846 8270E	

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Fuss & O'Neill EnviroScience, LLC - MA
108 Myrtle St,
Quincy, MA 02171
ATTN: Matt Kissane

REPORT DATE: 6/23/2022

PURCHASE ORDER NUMBER: 170820170390.U30

PROJECT NUMBER: 20170390.U30

ANALYTICAL SUMMARY

WORK ORDER NUMBER: 22F0701

The results of analyses performed on the following samples submitted to CON-TEST, a Pace Analytical Laboratory, are found in this report.

PROJECT LOCATION: Haverhill, MA

FIELD SAMPLE #	LAB ID:	MATRIX	SAMPLE DESCRIPTION	TEST	SUB LAB
1708220608-11	22F0701-11	Sediment	BELOW		MA M-MA071/CT PH-0520
				ASTM D3173	MA M-MA071/CT PH-0520
				MADEP EPH rev 2.1	
				SM 2540G	
				SW 846 9060A	
				SW-846 6010D	
				SW-846 7470A	
				SW-846 7471B	
				SW-846 8082A	
				SW-846 8260D	
				SW-846 8270E	
1708220608-12	22F0701-12	Sediment	ABOVE		MA M-MA071/CT PH-0520
				ASTM D3173	MA M-MA071/CT PH-0520
				MADEP EPH rev 2.1	
				SM 2540G	
				SW 846 9060A	
				SW-846 6010D	
				SW-846 7470A	
				SW-846 7471B	
				SW-846 8082A	
				SW-846 8260D	
				SW-846 8270E	
1708220608-13	22F0701-13	Sediment	TRIP	SW-846 8260D	

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CASE NARRATIVE SUMMARY

All reported results are within defined laboratory quality control objectives unless listed below or otherwise qualified in this report.

For method MA EPH, only hydrocarbon ranges were requested and reported.
For method 8270E, only PAHs were requested and reported.

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SW-846 6010D

Qualifications:

M-10

The reporting limit verification for the AIHA lead program is outside of control limits for this element. Any reported result at or near the detection limit may be biased on the high side.

Analyte & Samples(s) Qualified:

Lead

22F0701-01[1708220608-01], 22F0701-02[1708220608-02], 22F0701-03[1708220608-03], 22F0701-04[1708220608-04], 22F0701-05[1708220608-05], 22F0701-06[1708220608-06], 22F0701-07[1708220608-07], 22F0701-08[1708220608-08], 22F0701-09[1708220608-09], 22F0701-10[1708220608-10], 22F0701-11[1708220608-11], 22F0701-12[1708220608-12], B310537-SRM1

SW-846 7470A

Qualifications:

B

Analyte is found in the associated laboratory blank as well as in the sample.

Analyte & Samples(s) Qualified:

Mercury

B310749-BS1, B310749-BSD1

B-05

Data is not affected by elevated level in laboratory blank since sample(s) result is "Not Detected".

Analyte & Samples(s) Qualified:

Mercury

22F0701-11[1708220608-11], 22F0701-12[1708220608-12], B310749-BLK1

SW-846 8082A

Qualifications:

O-32

A dilution was performed as part of the standard analytical procedure.

Analyte & Samples(s) Qualified:

22F0701-11[1708220608-11], 22F0701-12[1708220608-12]

SW-846 8260D

Qualifications:

L-04

Laboratory fortified blank/laboratory control sample recovery and duplicate recovery are outside of control limits. Reported value for this compound is likely to be biased on the low side.

Analyte & Samples(s) Qualified:

1,2,3-Trichlorobenzene

22F0701-11[1708220608-11], B310614-BLK1, B310614-BS1, B310614-BSD1

Naphthalene

22F0701-11[1708220608-11], B310614-BLK1, B310614-BS1, B310614-BSD1

L-07

Either laboratory fortified blank/laboratory control sample or duplicate recovery is outside of control limits, but the other is within limits. RPD between the two LFB/LCS results is within method specified criteria.

Analyte & Samples(s) Qualified:

Bromomethane

B310614-BSD1

RL-05

Elevated reporting limit due to high concentration of target compounds. MA CAM reporting limit not met.

Analyte & Samples(s) Qualified:

22F0701-11[1708220608-11]

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V-05

Continuing calibration verification (CCV) did not meet method specifications and was biased on the low side for this compound.

Analyte & Samples(s) Qualified:

1,2,3-Trichlorobenzene
22F0701-11[1708220608-11], B310614-BLK1, B310614-BS1, B310614-BSD1, S072752-CCV1

1,2,4-Trichlorobenzene
22F0701-11[1708220608-11], B310614-BLK1, B310614-BS1, B310614-BSD1, S072752-CCV1

1,2-Dibromo-3-chloropropane (DB
22F0701-11[1708220608-11], B310614-BLK1, B310614-BS1, B310614-BSD1, S072752-CCV1

Chloromethane
22F0701-11[1708220608-11], B310614-BLK1, B310614-BS1, B310614-BSD1, S072752-CCV1

Hexachlorobutadiene
22F0701-11[1708220608-11], B310614-BLK1, B310614-BS1, B310614-BSD1, S072752-CCV1

Naphthalene
22F0701-11[1708220608-11], B310614-BLK1, B310614-BS1, B310614-BSD1, S072752-CCV1

V-16

Response factor is less than method specified minimum acceptable value. Reduced precision and accuracy may be associated with reported result.

Analyte & Samples(s) Qualified:

1,4-Dioxane
S072665-CCV1, S072752-CCV1

V-20

Continuing calibration verification (CCV) did not meet method specifications and was biased on the high side. Data validation is not affected since sample result was "not detected" for this compound.

Analyte & Samples(s) Qualified:

Bromomethane
B310614-BS1, B310614-BSD1, S072752-CCV1

V-34

Initial calibration verification (ICV) did not meet method specifications and was biased on the low side for this compound. Reported result is estimated.

Analyte & Samples(s) Qualified:

Bromomethane
22F0701-11[1708220608-11], 22F0701-12[1708220608-12], 22F0701-13[1708220608-13], B310578-BLK1, B310578-BS1, B310578-BSD1, B310614-BLK1, B310614-BS1, B310614-BSD1, S072665-CCV1, S072752-CCV1

Chloromethane
22F0701-11[1708220608-11], B310614-BLK1, B310614-BS1, B310614-BSD1, S072752-CCV1

V-36

Initial calibration verification (ICV) did not meet method specifications and was biased on the high side. Data validation is not affected since sample result was "not detected" for this compound.

Analyte & Samples(s) Qualified:

2-Butanone (MEK)
B310578-BS1, B310578-BSD1, S072665-CCV1

2-Hexanone (MBK)
B310578-BS1, B310578-BSD1, S072665-CCV1

Acetone
B310578-BS1, B310578-BSD1, S072665-CCV1

SW-846 8270E

Qualifications:

RL-12

Elevated reporting limit due to matrix interference.

Analyte & Samples(s) Qualified:

22F0701-11[1708220608-11]

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S-01

The surrogate recovery for this sample is not available due to sample dilution below the surrogate reporting limit required from high analyte concentration and/or matrix interferences.

Analyte & Samples(s) Qualified:

2-Fluorobiphenyl

22F0701-11RE1[1708220608-11], 22F0701-11RE2[1708220608-11]

Nitrobenzene-d5

22F0701-11RE1[1708220608-11], 22F0701-11RE2[1708220608-11]

p-Terphenyl-d14

22F0701-11RE1[1708220608-11], 22F0701-11RE2[1708220608-11]

The results of analyses reported only relate to samples submitted to Con-Test, a Pace Analytical Laboratory, for testing.
I certify that the analyses listed above, unless specifically listed as subcontracted, if any, were performed under my direction according to the approved methodologies listed in this document, and that based upon my inquiry of those individuals immediately responsible for obtaining the information, the material contained in this report is, to the best of my knowledge and belief, accurate and complete.

Lisa A. Worthington
Technical Representative

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39 Spruce Street * East Longmeadow, MA 01028 * FAX 413/525-6405 * TEL. 413/525-2332

Project Location: Haverhill, MA | Sample Description: SED-18 | Work Order: 22F0701

Date Received: 6/10/2022

Field Sample #: 1708220608-01 | Sampled: 6/8/2022 09:45

Sample ID: 22F0701-01

Sample Matrix: Sediment

Semivolatile Organic Compounds by GC/MS

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Acenaphthene	ND	0.45	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 18:24	IMR
Acenaphthylene	0.58	0.45	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 18:24	IMR
Anthracene	0.75	0.45	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 18:24	IMR
Benzo(a)anthracene	3.2	0.45	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 18:24	IMR
Benzo(a)pyrene	3.3	0.45	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 18:24	IMR
Benzo(b)fluoranthene	4.4	0.45	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 18:24	IMR
Benzo(g,h,i)perylene	1.6	0.45	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 18:24	IMR
Benzo(k)fluoranthene	1.7	0.45	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 18:24	IMR
Chrysene	3.3	0.45	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 18:24	IMR
Dibenz(a,h)anthracene	0.47	0.45	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 18:24	IMR
Fluoranthene	7.4	0.45	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 18:24	IMR
Fluorene	ND	0.45	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 18:24	IMR
Indeno(1,2,3-cd)pyrene	1.8	0.45	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 18:24	IMR
2-Methylnaphthalene	ND	0.45	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 18:24	IMR
Naphthalene	ND	0.45	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 18:24	IMR
Phenanthrene	3.3	0.45	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 18:24	IMR
Pyrene	7.0	0.45	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 18:24	IMR

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Nitrobenzene-d5	79.4	30-130		6/17/22 18:24
2-Fluorobiphenyl	64.4	30-130		6/17/22 18:24
p-Terphenyl-d14	69.8	30-130		6/17/22 18:24

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Project Location: Haverhill, MA | Sample Description: SED-18 | Work Order: 22F0701

Date Received: 6/10/2022

Field Sample #: 1708220608-01 | Sampled: 6/8/2022 09:45

Sample ID: 22F0701-01

Sample Matrix: Sediment

Metals Analyses (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Antimony	ND	4.3	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 17:33	ATP
Arsenic	15	8.5	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 17:33	ATP
Barium	73	4.3	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 17:33	ATP
Beryllium	0.69	0.43	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 17:33	ATP
Cadmium	0.91	0.85	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 17:33	ATP
Chromium	31	1.7	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 17:33	ATP
Copper	35	1.7	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 17:33	ATP
Lead	220	1.3	mg/Kg dry	1	M-10	SW-846 6010D	6/13/22	6/15/22 17:33	ATP
Mercury	0.21	0.065	mg/Kg dry	1		SW-846 7471B	6/15/22	6/16/22 13:32	TDK
Nickel	19	1.7	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 17:33	ATP
Selenium	ND	8.5	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 17:33	ATP
Silver	ND	0.85	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 17:33	ATP
Thallium	ND	4.3	mg/Kg dry	1		SW-846 6010D	6/13/22	6/21/22 19:02	MJH
Vanadium	28	1.7	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 17:33	ATP
Zinc	220	1.7	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 17:33	ATP

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Project Location: Haverhill, MA | Sample Description: SED-18 | Work Order: 22F0701

Date Received: 6/10/2022

Field Sample #: 1708220608-01 | Sampled: 6/8/2022 09:45

Sample ID: 22F0701-01

Sample Matrix: Sediment

Conventional Chemistry Parameters by EPA/APHA/SW-846 Methods (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
% Solids	37.6		% Wt	1		SM 2540G	6/13/22	6/13/22 15:23	BMV

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Project Location: Haverhill, MA | Sample Description: SED-19 | Work Order: 22F0701

Date Received: 6/10/2022

Field Sample #: 1708220608-02 | Sampled: 6/8/2022 10:50

Sample ID: 22F0701-02

Sample Matrix: Sediment

Semivolatile Organic Compounds by GC/MS

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Acenaphthene	0.94	0.24	mg/Kg dry	1		SW-846 8270E	6/17/22	6/20/22 16:09	BGL
Acenaphthylene	0.84	0.24	mg/Kg dry	1		SW-846 8270E	6/17/22	6/20/22 16:09	BGL
Anthracene	2.8	0.24	mg/Kg dry	1		SW-846 8270E	6/17/22	6/20/22 16:09	BGL
Benzo(a)anthracene	5.1	0.24	mg/Kg dry	1		SW-846 8270E	6/17/22	6/20/22 16:09	BGL
Benzo(a)pyrene	4.4	0.24	mg/Kg dry	1		SW-846 8270E	6/17/22	6/20/22 16:09	BGL
Benzo(b)fluoranthene	5.5	0.24	mg/Kg dry	1		SW-846 8270E	6/17/22	6/20/22 16:09	BGL
Benzo(g,h,i)perylene	2.4	0.24	mg/Kg dry	1		SW-846 8270E	6/17/22	6/20/22 16:09	BGL
Benzo(k)fluoranthene	1.9	0.24	mg/Kg dry	1		SW-846 8270E	6/17/22	6/20/22 16:09	BGL
Chrysene	5.1	0.24	mg/Kg dry	1		SW-846 8270E	6/17/22	6/20/22 16:09	BGL
Dibenz(a,h)anthracene	0.65	0.24	mg/Kg dry	1		SW-846 8270E	6/17/22	6/20/22 16:09	BGL
Fluoranthene	13	1.2	mg/Kg dry	5		SW-846 8270E	6/17/22	6/21/22 13:04	BGL
Fluorene	1.5	0.24	mg/Kg dry	1		SW-846 8270E	6/17/22	6/20/22 16:09	BGL
Indeno(1,2,3-cd)pyrene	2.5	0.24	mg/Kg dry	1		SW-846 8270E	6/17/22	6/20/22 16:09	BGL
2-Methylnaphthalene	0.63	0.24	mg/Kg dry	1		SW-846 8270E	6/17/22	6/20/22 16:09	BGL
Naphthalene	1.4	0.24	mg/Kg dry	1		SW-846 8270E	6/17/22	6/20/22 16:09	BGL
Phenanthrene	13	1.2	mg/Kg dry	5		SW-846 8270E	6/17/22	6/21/22 13:04	BGL
Pyrene	13	1.2	mg/Kg dry	5		SW-846 8270E	6/17/22	6/21/22 13:04	BGL

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Nitrobenzene-d5	103	30-130		6/20/22 16:09
Nitrobenzene-d5	114	30-130		6/21/22 13:04
2-Fluorobiphenyl	79.9	30-130		6/20/22 16:09
2-Fluorobiphenyl	89.7	30-130		6/21/22 13:04
p-Terphenyl-d14	90.4	30-130		6/20/22 16:09
p-Terphenyl-d14	96.0	30-130		6/21/22 13:04

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Project Location: Haverhill, MA | Sample Description: SED-19 | Work Order: 22F0701

Date Received: 6/10/2022

Field Sample #: 1708220608-02 | Sampled: 6/8/2022 10:50

Sample ID: 22F0701-02

Sample Matrix: Sediment

Metals Analyses (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Antimony	25	2.2	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 17:40	ATP
Arsenic	7.5	4.5	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 17:40	ATP
Barium	40	2.2	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 17:40	ATP
Beryllium	ND	0.22	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 17:40	ATP
Cadmium	ND	0.45	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 17:40	ATP
Chromium	9.3	0.90	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 17:40	ATP
Copper	11	0.90	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 17:40	ATP
Lead	660	0.67	mg/Kg dry	1	M-10	SW-846 6010D	6/13/22	6/15/22 17:40	ATP
Mercury	ND	0.035	mg/Kg dry	1		SW-846 7471B	6/15/22	6/16/22 13:34	TDK
Nickel	6.5	0.90	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 17:40	ATP
Selenium	ND	4.5	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 17:40	ATP
Silver	ND	0.45	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 17:40	ATP
Thallium	ND	2.2	mg/Kg dry	1		SW-846 6010D	6/13/22	6/21/22 19:21	MJH
Vanadium	7.3	0.90	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 17:40	ATP
Zinc	130	0.90	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 17:40	ATP

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Project Location: Haverhill, MA | Sample Description: SED-19 | Work Order: 22F0701

Date Received: 6/10/2022

Field Sample #: 1708220608-02 | Sampled: 6/8/2022 10:50

Sample ID: 22F0701-02

Sample Matrix: Sediment

Conventional Chemistry Parameters by EPA/APHA/SW-846 Methods (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
% Solids	69.6		% Wt	1		SM 2540G	6/13/22	6/13/22 15:23	BMV

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Project Location: Haverhill, MA | Sample Description: SED-20 | Work Order: 22F0701

Date Received: 6/10/2022

Field Sample #: 1708220608-03 | Sampled: 6/8/2022 11:10

Sample ID: 22F0701-03

Sample Matrix: Sediment

Semivolatile Organic Compounds by GC/MS

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Acenaphthene	0.42	0.27	mg/Kg dry	1		SW-846 8270E	6/17/22	6/20/22 16:36	BGL
Acenaphthylene	0.81	0.27	mg/Kg dry	1		SW-846 8270E	6/17/22	6/20/22 16:36	BGL
Anthracene	1.0	0.27	mg/Kg dry	1		SW-846 8270E	6/17/22	6/20/22 16:36	BGL
Benzo(a)anthracene	3.5	0.27	mg/Kg dry	1		SW-846 8270E	6/17/22	6/20/22 16:36	BGL
Benzo(a)pyrene	3.7	0.27	mg/Kg dry	1		SW-846 8270E	6/17/22	6/20/22 16:36	BGL
Benzo(b)fluoranthene	5.2	0.27	mg/Kg dry	1		SW-846 8270E	6/17/22	6/20/22 16:36	BGL
Benzo(g,h,i)perylene	2.2	0.27	mg/Kg dry	1		SW-846 8270E	6/17/22	6/20/22 16:36	BGL
Benzo(k)fluoranthene	1.9	0.27	mg/Kg dry	1		SW-846 8270E	6/17/22	6/20/22 16:36	BGL
Chrysene	4.5	0.27	mg/Kg dry	1		SW-846 8270E	6/17/22	6/20/22 16:36	BGL
Dibenz(a,h)anthracene	0.62	0.27	mg/Kg dry	1		SW-846 8270E	6/17/22	6/20/22 16:36	BGL
Fluoranthene	8.5	1.3	mg/Kg dry	5		SW-846 8270E	6/17/22	6/21/22 13:30	BGL
Fluorene	0.83	0.27	mg/Kg dry	1		SW-846 8270E	6/17/22	6/20/22 16:36	BGL
Indeno(1,2,3-cd)pyrene	2.4	0.27	mg/Kg dry	1		SW-846 8270E	6/17/22	6/20/22 16:36	BGL
2-Methylnaphthalene	0.42	0.27	mg/Kg dry	1		SW-846 8270E	6/17/22	6/20/22 16:36	BGL
Naphthalene	0.73	0.27	mg/Kg dry	1		SW-846 8270E	6/17/22	6/20/22 16:36	BGL
Phenanthrene	5.9	0.27	mg/Kg dry	1		SW-846 8270E	6/17/22	6/20/22 16:36	BGL
Pyrene	7.8	1.3	mg/Kg dry	5		SW-846 8270E	6/17/22	6/21/22 13:30	BGL

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Nitrobenzene-d5	97.2	30-130		6/20/22 16:36
Nitrobenzene-d5	93.0	30-130		6/21/22 13:30
2-Fluorobiphenyl	77.7	30-130		6/20/22 16:36
2-Fluorobiphenyl	78.5	30-130		6/21/22 13:30
p-Terphenyl-d14	89.6	30-130		6/20/22 16:36
p-Terphenyl-d14	79.4	30-130		6/21/22 13:30

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Project Location: Haverhill, MA | Sample Description: SED-20 | Work Order: 22F0701

Date Received: 6/10/2022

Field Sample #: 1708220608-03 | Sampled: 6/8/2022 11:10

Sample ID: 22F0701-03

Sample Matrix: Sediment

Metals Analyses (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Antimony	ND	2.5	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 18:56	ATP
Arsenic	12	5.0	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 18:56	ATP
Barium	77	2.5	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 18:56	ATP
Beryllium	0.66	0.25	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 18:56	ATP
Cadmium	ND	0.50	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 18:56	ATP
Chromium	25	1.0	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 18:56	ATP
Copper	23	1.0	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 18:56	ATP
Lead	130	0.76	mg/Kg dry	1	M-10	SW-846 6010D	6/13/22	6/15/22 18:56	ATP
Mercury	0.060	0.041	mg/Kg dry	1		SW-846 7471B	6/15/22	6/16/22 13:36	TDK
Nickel	15	1.0	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 18:56	ATP
Selenium	ND	5.0	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 18:56	ATP
Silver	ND	0.50	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 18:56	ATP
Thallium	ND	2.5	mg/Kg dry	1		SW-846 6010D	6/13/22	6/21/22 19:28	MJH
Vanadium	23	1.0	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 18:56	ATP
Zinc	130	1.0	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 18:56	ATP

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Project Location: Haverhill, MA | Sample Description: SED-20 | Work Order: 22F0701

Date Received: 6/10/2022

Field Sample #: 1708220608-03 | Sampled: 6/8/2022 11:10

Sample ID: 22F0701-03

Sample Matrix: Sediment

Conventional Chemistry Parameters by EPA/APHA/SW-846 Methods (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
% Solids	63.6		% Wt	1		SM 2540G	6/13/22	6/13/22 15:23	BMV

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Project Location: Haverhill, MA | Sample Description: SED-21 | Work Order: 22F0701

Date Received: 6/10/2022

Field Sample #: 1708220608-04 | Sampled: 6/8/2022 11:25

Sample ID: 22F0701-04

Sample Matrix: Sediment

Semivolatile Organic Compounds by GC/MS

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Acenaphthene	ND	0.29	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 18:50	IMR
Acenaphthylene	ND	0.29	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 18:50	IMR
Anthracene	ND	0.29	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 18:50	IMR
Benzo(a)anthracene	ND	0.29	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 18:50	IMR
Benzo(a)pyrene	ND	0.29	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 18:50	IMR
Benzo(b)fluoranthene	ND	0.29	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 18:50	IMR
Benzo(g,h,i)perylene	ND	0.29	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 18:50	IMR
Benzo(k)fluoranthene	ND	0.29	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 18:50	IMR
Chrysene	ND	0.29	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 18:50	IMR
Dibenz(a,h)anthracene	ND	0.29	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 18:50	IMR
Fluoranthene	ND	0.29	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 18:50	IMR
Fluorene	ND	0.29	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 18:50	IMR
Indeno(1,2,3-cd)pyrene	ND	0.29	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 18:50	IMR
2-Methylnaphthalene	ND	0.29	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 18:50	IMR
Naphthalene	ND	0.29	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 18:50	IMR
Phenanthrene	ND	0.29	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 18:50	IMR
Pyrene	ND	0.29	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 18:50	IMR

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Nitrobenzene-d5	79.8	30-130		6/17/22 18:50
2-Fluorobiphenyl	63.9	30-130		6/17/22 18:50
p-Terphenyl-d14	59.0	30-130		6/17/22 18:50

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Project Location: Haverhill, MA | Sample Description: SED-21 | Work Order: 22F0701

Date Received: 6/10/2022

Field Sample #: 1708220608-04 | Sampled: 6/8/2022 11:25

Sample ID: 22F0701-04

Sample Matrix: Sediment

Metals Analyses (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Antimony	ND	2.7	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 19:03	ATP
Arsenic	ND	5.4	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 19:03	ATP
Barium	33	2.7	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 19:03	ATP
Beryllium	0.34	0.27	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 19:03	ATP
Cadmium	ND	0.54	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 19:03	ATP
Chromium	16	1.1	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 19:03	ATP
Copper	4.2	1.1	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 19:03	ATP
Lead	4.1	0.81	mg/Kg dry	1	M-10	SW-846 6010D	6/13/22	6/15/22 19:03	ATP
Mercury	ND	0.043	mg/Kg dry	1		SW-846 7471B	6/15/22	6/16/22 13:38	TDK
Nickel	9.8	1.1	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 19:03	ATP
Selenium	ND	5.4	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 19:03	ATP
Silver	ND	0.54	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 19:03	ATP
Thallium	ND	2.7	mg/Kg dry	1		SW-846 6010D	6/13/22	6/21/22 19:35	MJH
Vanadium	14	1.1	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 19:03	ATP
Zinc	23	1.1	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 19:03	ATP

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Project Location: Haverhill, MA | Sample Description: SED-21 | Work Order: 22F0701

Date Received: 6/10/2022

Field Sample #: 1708220608-04 | Sampled: 6/8/2022 11:25

Sample ID: 22F0701-04

Sample Matrix: Sediment

Conventional Chemistry Parameters by EPA/APHA/SW-846 Methods (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
% Solids	59.1		% Wt	1		SM 2540G	6/13/22	6/13/22 15:24	BMV

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Project Location: Haverhill, MA | Sample Description: SED-22 | Work Order: 22F0701

Date Received: 6/10/2022

Field Sample #: 1708220608-05 | Sampled: 6/8/2022 11:35

Sample ID: 22F0701-05

Sample Matrix: Sediment

Semivolatile Organic Compounds by GC/MS

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Acenaphthene	ND	0.28	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 19:16	IMR
Acenaphthylene	ND	0.28	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 19:16	IMR
Anthracene	ND	0.28	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 19:16	IMR
Benzo(a)anthracene	ND	0.28	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 19:16	IMR
Benzo(a)pyrene	ND	0.28	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 19:16	IMR
Benzo(b)fluoranthene	ND	0.28	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 19:16	IMR
Benzo(g,h,i)perylene	ND	0.28	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 19:16	IMR
Benzo(k)fluoranthene	ND	0.28	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 19:16	IMR
Chrysene	ND	0.28	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 19:16	IMR
Dibenz(a,h)anthracene	ND	0.28	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 19:16	IMR
Fluoranthene	ND	0.28	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 19:16	IMR
Fluorene	ND	0.28	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 19:16	IMR
Indeno(1,2,3-cd)pyrene	ND	0.28	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 19:16	IMR
2-Methylnaphthalene	ND	0.28	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 19:16	IMR
Naphthalene	ND	0.28	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 19:16	IMR
Phenanthrene	ND	0.28	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 19:16	IMR
Pyrene	ND	0.28	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 19:16	IMR

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Nitrobenzene-d5	75.8	30-130		6/17/22 19:16
2-Fluorobiphenyl	62.6	30-130		6/17/22 19:16
p-Terphenyl-d14	64.7	30-130		6/17/22 19:16

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Project Location: Haverhill, MA | Sample Description: SED-22 | Work Order: 22F0701

Date Received: 6/10/2022

Field Sample #: 1708220608-05 | Sampled: 6/8/2022 11:35

Sample ID: 22F0701-05

Sample Matrix: Sediment

Metals Analyses (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Antimony	ND	2.7	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 19:34	ATP
Arsenic	10	5.5	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 19:34	ATP
Barium	48	2.7	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 19:34	ATP
Beryllium	0.45	0.27	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 19:34	ATP
Cadmium	ND	0.55	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 19:34	ATP
Chromium	20	1.1	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 19:34	ATP
Copper	5.6	1.1	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 19:34	ATP
Lead	6.7	0.82	mg/Kg dry	1	M-10	SW-846 6010D	6/13/22	6/15/22 19:34	ATP
Mercury	ND	0.040	mg/Kg dry	1		SW-846 7471B	6/15/22	6/16/22 13:39	TDK
Nickel	12	1.1	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 19:34	ATP
Selenium	ND	5.5	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 19:34	ATP
Silver	ND	0.55	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 19:34	ATP
Thallium	ND	2.7	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 19:34	ATP
Vanadium	17	1.1	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 19:34	ATP
Zinc	31	1.1	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 19:34	ATP

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Project Location: Haverhill, MA | Sample Description: SED-22 | Work Order: 22F0701

Date Received: 6/10/2022

Field Sample #: 1708220608-05 | Sampled: 6/8/2022 11:35

Sample ID: 22F0701-05

Sample Matrix: Sediment

Conventional Chemistry Parameters by EPA/APHA/SW-846 Methods (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
% Solids	60.3		% Wt	1		SM 2540G	6/13/22	6/13/22 15:24	BMV

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Project Location: Haverhill, MA | Sample Description: SED-17 | Work Order: 22F0701

Date Received: 6/10/2022

Field Sample #: 1708220608-06 | Sampled: 6/8/2022 12:25

Sample ID: 22F0701-06

Sample Matrix: Sediment

Semivolatile Organic Compounds by GC/MS

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Acenaphthene	ND	0.23	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 19:42	IMR
Acenaphthylene	ND	0.23	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 19:42	IMR
Anthracene	ND	0.23	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 19:42	IMR
Benzo(a)anthracene	ND	0.23	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 19:42	IMR
Benzo(a)pyrene	ND	0.23	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 19:42	IMR
Benzo(b)fluoranthene	ND	0.23	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 19:42	IMR
Benzo(g,h,i)perylene	ND	0.23	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 19:42	IMR
Benzo(k)fluoranthene	ND	0.23	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 19:42	IMR
Chrysene	ND	0.23	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 19:42	IMR
Dibenz(a,h)anthracene	ND	0.23	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 19:42	IMR
Fluoranthene	ND	0.23	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 19:42	IMR
Fluorene	ND	0.23	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 19:42	IMR
Indeno(1,2,3-cd)pyrene	ND	0.23	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 19:42	IMR
2-Methylnaphthalene	ND	0.23	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 19:42	IMR
Naphthalene	ND	0.23	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 19:42	IMR
Phenanthrene	ND	0.23	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 19:42	IMR
Pyrene	ND	0.23	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 19:42	IMR

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Nitrobenzene-d5	76.5	30-130		6/17/22 19:42
2-Fluorobiphenyl	63.3	30-130		6/17/22 19:42
p-Terphenyl-d14	63.6	30-130		6/17/22 19:42

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Project Location: Haverhill, MA | Sample Description: SED-17 | Work Order: 22F0701

Date Received: 6/10/2022

Field Sample #: 1708220608-06 | Sampled: 6/8/2022 12:25

Sample ID: 22F0701-06

Sample Matrix: Sediment

Metals Analyses (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Antimony	ND	2.2	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 19:41	ATP
Arsenic	ND	4.3	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 19:41	ATP
Barium	8.8	2.2	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 19:41	ATP
Beryllium	ND	0.22	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 19:41	ATP
Cadmium	ND	0.43	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 19:41	ATP
Chromium	6.8	0.86	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 19:41	ATP
Copper	ND	0.86	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 19:41	ATP
Lead	1.5	0.65	mg/Kg dry	1	M-10	SW-846 6010D	6/13/22	6/15/22 19:41	ATP
Mercury	ND	0.035	mg/Kg dry	1		SW-846 7471B	6/15/22	6/16/22 13:46	TDK
Nickel	3.3	0.86	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 19:41	ATP
Selenium	ND	4.3	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 19:41	ATP
Silver	ND	0.43	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 19:41	ATP
Thallium	ND	2.2	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 19:41	ATP
Vanadium	5.3	0.86	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 19:41	ATP
Zinc	7.7	0.86	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 19:41	ATP

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Project Location: Haverhill, MA | Sample Description: SED-17 | Work Order: 22F0701

Date Received: 6/10/2022

Field Sample #: 1708220608-06 | Sampled: 6/8/2022 12:25

Sample ID: 22F0701-06

Sample Matrix: Sediment

Conventional Chemistry Parameters by EPA/APHA/SW-846 Methods (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
% Solids	72.9		% Wt	1		SM 2540G	6/13/22	6/13/22 15:24	BMV

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Project Location: Haverhill, MA | Sample Description: SED-16 | Work Order: 22F0701

Date Received: 6/10/2022

Field Sample #: 1708220608-07 | Sampled: 6/8/2022 12:35

Sample ID: 22F0701-07

Sample Matrix: Sediment

Semivolatile Organic Compounds by GC/MS

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Acenaphthene	ND	0.31	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 20:09	IMR
Acenaphthylene	ND	0.31	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 20:09	IMR
Anthracene	ND	0.31	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 20:09	IMR
Benzo(a)anthracene	ND	0.31	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 20:09	IMR
Benzo(a)pyrene	ND	0.31	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 20:09	IMR
Benzo(b)fluoranthene	ND	0.31	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 20:09	IMR
Benzo(g,h,i)perylene	ND	0.31	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 20:09	IMR
Benzo(k)fluoranthene	ND	0.31	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 20:09	IMR
Chrysene	ND	0.31	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 20:09	IMR
Dibenz(a,h)anthracene	ND	0.31	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 20:09	IMR
Fluoranthene	ND	0.31	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 20:09	IMR
Fluorene	ND	0.31	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 20:09	IMR
Indeno(1,2,3-cd)pyrene	ND	0.31	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 20:09	IMR
2-Methylnaphthalene	ND	0.31	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 20:09	IMR
Naphthalene	ND	0.31	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 20:09	IMR
Phenanthrene	ND	0.31	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 20:09	IMR
Pyrene	ND	0.31	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 20:09	IMR

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Nitrobenzene-d5	78.8	30-130		6/17/22 20:09
2-Fluorobiphenyl	62.7	30-130		6/17/22 20:09
p-Terphenyl-d14	61.5	30-130		6/17/22 20:09

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Project Location: Haverhill, MA | Sample Description: SED-16 | Work Order: 22F0701

Date Received: 6/10/2022

Field Sample #: 1708220608-07 | Sampled: 6/8/2022 12:35

Sample ID: 22F0701-07

Sample Matrix: Sediment

Metals Analyses (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Antimony	ND	3.0	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 19:48	ATP
Arsenic	ND	6.0	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 19:48	ATP
Barium	20	3.0	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 19:48	ATP
Beryllium	ND	0.30	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 19:48	ATP
Cadmium	ND	0.60	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 19:48	ATP
Chromium	9.8	1.2	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 19:48	ATP
Copper	2.6	1.2	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 19:48	ATP
Lead	2.4	0.89	mg/Kg dry	1	M-10	SW-846 6010D	6/13/22	6/15/22 19:48	ATP
Mercury	ND	0.047	mg/Kg dry	1		SW-846 7471B	6/15/22	6/16/22 13:47	TDK
Nickel	6.0	1.2	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 19:48	ATP
Selenium	ND	6.0	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 19:48	ATP
Silver	ND	0.60	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 19:48	ATP
Thallium	ND	3.0	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 19:48	ATP
Vanadium	7.8	1.2	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 19:48	ATP
Zinc	14	1.2	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 19:48	ATP

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Project Location: Haverhill, MA | Sample Description: SED-16 | Work Order: 22F0701

Date Received: 6/10/2022

Field Sample #: 1708220608-07 | Sampled: 6/8/2022 12:35

Sample ID: 22F0701-07

Sample Matrix: Sediment

Conventional Chemistry Parameters by EPA/APHA/SW-846 Methods (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
% Solids	54.5		% Wt	1		SM 2540G	6/13/22	6/13/22 15:24	BMV

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Project Location: Haverhill, MA | Sample Description: SED-15 | Work Order: 22F0701

Date Received: 6/10/2022

Field Sample #: 1708220608-08 | Sampled: 6/8/2022 12:45

Sample ID: 22F0701-08

Sample Matrix: Sediment

Semivolatile Organic Compounds by GC/MS

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Acenaphthene	ND	0.27	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 20:35	IMR
Acenaphthylene	ND	0.27	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 20:35	IMR
Anthracene	ND	0.27	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 20:35	IMR
Benzo(a)anthracene	ND	0.27	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 20:35	IMR
Benzo(a)pyrene	ND	0.27	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 20:35	IMR
Benzo(b)fluoranthene	ND	0.27	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 20:35	IMR
Benzo(g,h,i)perylene	ND	0.27	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 20:35	IMR
Benzo(k)fluoranthene	ND	0.27	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 20:35	IMR
Chrysene	ND	0.27	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 20:35	IMR
Dibenz(a,h)anthracene	ND	0.27	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 20:35	IMR
Fluoranthene	ND	0.27	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 20:35	IMR
Fluorene	ND	0.27	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 20:35	IMR
Indeno(1,2,3-cd)pyrene	ND	0.27	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 20:35	IMR
2-Methylnaphthalene	ND	0.27	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 20:35	IMR
Naphthalene	ND	0.27	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 20:35	IMR
Phenanthrene	ND	0.27	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 20:35	IMR
Pyrene	ND	0.27	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 20:35	IMR

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Nitrobenzene-d5	81.5	30-130		6/17/22 20:35
2-Fluorobiphenyl	68.2	30-130		6/17/22 20:35
p-Terphenyl-d14	70.2	30-130		6/17/22 20:35

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Project Location: Haverhill, MA | Sample Description: SED-15 | Work Order: 22F0701

Date Received: 6/10/2022

Field Sample #: 1708220608-08 | Sampled: 6/8/2022 12:45

Sample ID: 22F0701-08

Sample Matrix: Sediment

Metals Analyses (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Antimony	ND	2.7	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 19:55	ATP
Arsenic	5.5	5.3	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 19:55	ATP
Barium	40	2.7	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 19:55	ATP
Beryllium	0.38	0.27	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 19:55	ATP
Cadmium	ND	0.53	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 19:55	ATP
Chromium	17	1.1	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 19:55	ATP
Copper	7.0	1.1	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 19:55	ATP
Lead	11	0.80	mg/Kg dry	1	M-10	SW-846 6010D	6/13/22	6/15/22 19:55	ATP
Mercury	0.047	0.039	mg/Kg dry	1		SW-846 7471B	6/15/22	6/16/22 13:49	TDK
Nickel	11	1.1	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 19:55	ATP
Selenium	ND	5.3	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 19:55	ATP
Silver	3.1	0.53	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 19:55	ATP
Thallium	ND	2.7	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 19:55	ATP
Vanadium	16	1.1	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 19:55	ATP
Zinc	37	1.1	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 19:55	ATP

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Project Location: Haverhill, MA | Sample Description: SED-15 | Work Order: 22F0701

Date Received: 6/10/2022

Field Sample #: 1708220608-08 | Sampled: 6/8/2022 12:45

Sample ID: 22F0701-08

Sample Matrix: Sediment

Conventional Chemistry Parameters by EPA/APHA/SW-846 Methods (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
% Solids	62.2		% Wt	1		SM 2540G	6/13/22	6/13/22 15:24	BMV

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Project Location: Haverhill, MA | Sample Description: SED-14 | Work Order: 22F0701

Date Received: 6/10/2022

Field Sample #: 1708220608-09 | Sampled: 6/8/2022 13:15

Sample ID: 22F0701-09

Sample Matrix: Sediment

Semivolatile Organic Compounds by GC/MS

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Acenaphthene	ND	0.25	mg/Kg dry	1		SW-846 8270E	6/17/22	6/20/22 17:02	BGL
Acenaphthylene	ND	0.25	mg/Kg dry	1		SW-846 8270E	6/17/22	6/20/22 17:02	BGL
Anthracene	ND	0.25	mg/Kg dry	1		SW-846 8270E	6/17/22	6/20/22 17:02	BGL
Benzo(a)anthracene	ND	0.25	mg/Kg dry	1		SW-846 8270E	6/17/22	6/20/22 17:02	BGL
Benzo(a)pyrene	ND	0.25	mg/Kg dry	1		SW-846 8270E	6/17/22	6/20/22 17:02	BGL
Benzo(b)fluoranthene	ND	0.25	mg/Kg dry	1		SW-846 8270E	6/17/22	6/20/22 17:02	BGL
Benzo(g,h,i)perylene	ND	0.25	mg/Kg dry	1		SW-846 8270E	6/17/22	6/20/22 17:02	BGL
Benzo(k)fluoranthene	ND	0.25	mg/Kg dry	1		SW-846 8270E	6/17/22	6/20/22 17:02	BGL
Chrysene	ND	0.25	mg/Kg dry	1		SW-846 8270E	6/17/22	6/20/22 17:02	BGL
Dibenz(a,h)anthracene	ND	0.25	mg/Kg dry	1		SW-846 8270E	6/17/22	6/20/22 17:02	BGL
Fluoranthene	ND	0.25	mg/Kg dry	1		SW-846 8270E	6/17/22	6/20/22 17:02	BGL
Fluorene	ND	0.25	mg/Kg dry	1		SW-846 8270E	6/17/22	6/20/22 17:02	BGL
Indeno(1,2,3-cd)pyrene	ND	0.25	mg/Kg dry	1		SW-846 8270E	6/17/22	6/20/22 17:02	BGL
2-Methylnaphthalene	ND	0.25	mg/Kg dry	1		SW-846 8270E	6/17/22	6/20/22 17:02	BGL
Naphthalene	ND	0.25	mg/Kg dry	1		SW-846 8270E	6/17/22	6/20/22 17:02	BGL
Phenanthrene	ND	0.25	mg/Kg dry	1		SW-846 8270E	6/17/22	6/20/22 17:02	BGL
Pyrene	ND	0.25	mg/Kg dry	1		SW-846 8270E	6/17/22	6/20/22 17:02	BGL

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Nitrobenzene-d5	82.0	30-130		6/20/22 17:02
2-Fluorobiphenyl	68.0	30-130		6/20/22 17:02
p-Terphenyl-d14	74.6	30-130		6/20/22 17:02

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Project Location: Haverhill, MA | Sample Description: SED-14 | Work Order: 22F0701

Date Received: 6/10/2022

Field Sample #: 1708220608-09 | Sampled: 6/8/2022 13:15

Sample ID: 22F0701-09

Sample Matrix: Sediment

Metals Analyses (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Antimony	ND	2.3	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 20:02	ATP
Arsenic	8.4	4.7	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 20:02	ATP
Barium	54	2.3	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 20:02	ATP
Beryllium	0.54	0.23	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 20:02	ATP
Cadmium	ND	0.47	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 20:02	ATP
Chromium	23	0.94	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 20:02	ATP
Copper	8.2	0.94	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 20:02	ATP
Lead	12	0.70	mg/Kg dry	1	M-10	SW-846 6010D	6/13/22	6/15/22 20:02	ATP
Mercury	ND	0.037	mg/Kg dry	1		SW-846 7471B	6/15/22	6/16/22 13:51	TDK
Nickel	14	0.94	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 20:02	ATP
Selenium	ND	4.7	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 20:02	ATP
Silver	ND	0.47	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 20:02	ATP
Thallium	ND	2.3	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 20:02	ATP
Vanadium	21	0.94	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 20:02	ATP
Zinc	42	0.94	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 20:02	ATP

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Project Location: Haverhill, MA | Sample Description: SED-14 | Work Order: 22F0701

Date Received: 6/10/2022

Field Sample #: 1708220608-09 | Sampled: 6/8/2022 13:15

Sample ID: 22F0701-09

Sample Matrix: Sediment

Conventional Chemistry Parameters by EPA/APHA/SW-846 Methods (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
% Solids	67.3		% Wt	1		SM 2540G	6/13/22	6/14/22 13:57	BMV

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Project Location: Haverhill, MA | Sample Description: SED-13 | Work Order: 22F0701

Date Received: 6/10/2022

Field Sample #: 1708220608-10 | Sampled: 6/8/2022 13:50

Sample ID: 22F0701-10

Sample Matrix: Sediment

Semivolatile Organic Compounds by GC/MS

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Acenaphthene	ND	0.38	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 21:01	IMR
Acenaphthylene	ND	0.38	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 21:01	IMR
Anthracene	ND	0.38	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 21:01	IMR
Benzo(a)anthracene	0.49	0.38	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 21:01	IMR
Benzo(a)pyrene	0.45	0.38	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 21:01	IMR
Benzo(b)fluoranthene	0.66	0.38	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 21:01	IMR
Benzo(g,h,i)perylene	ND	0.38	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 21:01	IMR
Benzo(k)fluoranthene	ND	0.38	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 21:01	IMR
Chrysene	0.59	0.38	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 21:01	IMR
Dibenz(a,h)anthracene	ND	0.38	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 21:01	IMR
Fluoranthene	1.2	0.38	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 21:01	IMR
Fluorene	ND	0.38	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 21:01	IMR
Indeno(1,2,3-cd)pyrene	ND	0.38	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 21:01	IMR
2-Methylnaphthalene	ND	0.38	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 21:01	IMR
Naphthalene	ND	0.38	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 21:01	IMR
Phenanthrene	0.53	0.38	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 21:01	IMR
Pyrene	1.0	0.38	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 21:01	IMR

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Nitrobenzene-d5	85.6	30-130		6/17/22 21:01
2-Fluorobiphenyl	72.9	30-130		6/17/22 21:01
p-Terphenyl-d14	72.7	30-130		6/17/22 21:01

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Project Location: Haverhill, MA | Sample Description: SED-13 | Work Order: 22F0701

Date Received: 6/10/2022

Field Sample #: 1708220608-10 | Sampled: 6/8/2022 13:50

Sample ID: 22F0701-10

Sample Matrix: Sediment

Metals Analyses (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Antimony	ND	3.5	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 20:09	ATP
Arsenic	11	7.0	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 20:09	ATP
Barium	77	3.5	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 20:09	ATP
Beryllium	0.79	0.35	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 20:09	ATP
Cadmium	ND	0.70	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 20:09	ATP
Chromium	29	1.4	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 20:09	ATP
Copper	16	1.4	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 20:09	ATP
Lead	68	1.1	mg/Kg dry	1	M-10	SW-846 6010D	6/13/22	6/15/22 20:09	ATP
Mercury	0.12	0.057	mg/Kg dry	1		SW-846 7471B	6/15/22	6/16/22 13:53	TDK
Nickel	19	1.4	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 20:09	ATP
Selenium	ND	7.0	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 20:09	ATP
Silver	ND	0.70	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 20:09	ATP
Thallium	ND	3.5	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 20:09	ATP
Vanadium	28	1.4	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 20:09	ATP
Zinc	110	1.4	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 20:09	ATP

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Project Location: Haverhill, MA | Sample Description: SED-13 | Work Order: 22F0701

Date Received: 6/10/2022

Field Sample #: 1708220608-10 | Sampled: 6/8/2022 13:50

Sample ID: 22F0701-10

Sample Matrix: Sediment

Conventional Chemistry Parameters by EPA/APHA/SW-846 Methods (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
% Solids	45.1		% Wt	1		SM 2540G	6/13/22	6/13/22 15:24	BMV

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Project Location: Haverhill, MA | Sample Description: BELOW | Work Order: 22F0701

Date Received: 6/10/2022

Field Sample #: 1708220608-11 | Sampled: 6/8/2022 14:00

Sample ID: 22F0701-11

Sample Matrix: Sediment

Sample Flags: RL-05

Volatile Organic Compounds by GC/MS

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Acetone	ND	58	mg/Kg dry	20		SW-846 8260D	6/14/22	6/14/22 18:14	MFF
tert-Amyl Methyl Ether (TAME)	ND	0.58	mg/Kg dry	20		SW-846 8260D	6/14/22	6/14/22 18:14	MFF
Benzene	ND	1.2	mg/Kg dry	20		SW-846 8260D	6/14/22	6/14/22 18:14	MFF
Bromobenzene	ND	1.2	mg/Kg dry	20		SW-846 8260D	6/14/22	6/14/22 18:14	MFF
Bromochloromethane	ND	1.2	mg/Kg dry	20		SW-846 8260D	6/14/22	6/14/22 18:14	MFF
Bromodichloromethane	ND	1.2	mg/Kg dry	20		SW-846 8260D	6/14/22	6/14/22 18:14	MFF
Bromoform	ND	1.2	mg/Kg dry	20		SW-846 8260D	6/14/22	6/14/22 18:14	MFF
Bromomethane	ND	5.8	mg/Kg dry	20	V-34	SW-846 8260D	6/14/22	6/14/22 18:14	MFF
2-Butanone (MEK)	ND	23	mg/Kg dry	20		SW-846 8260D	6/14/22	6/14/22 18:14	MFF
n-Butylbenzene	1.9	1.2	mg/Kg dry	20		SW-846 8260D	6/14/22	6/14/22 18:14	MFF
sec-Butylbenzene	ND	1.2	mg/Kg dry	20		SW-846 8260D	6/14/22	6/14/22 18:14	MFF
tert-Butylbenzene	ND	1.2	mg/Kg dry	20		SW-846 8260D	6/14/22	6/14/22 18:14	MFF
tert-Butyl Ethyl Ether (TBEE)	ND	0.58	mg/Kg dry	20		SW-846 8260D	6/14/22	6/14/22 18:14	MFF
Carbon Disulfide	ND	12	mg/Kg dry	20		SW-846 8260D	6/14/22	6/14/22 18:14	MFF
Carbon Tetrachloride	ND	1.2	mg/Kg dry	20		SW-846 8260D	6/14/22	6/14/22 18:14	MFF
Chlorobenzene	ND	1.2	mg/Kg dry	20		SW-846 8260D	6/14/22	6/14/22 18:14	MFF
Chlorodibromomethane	ND	0.58	mg/Kg dry	20		SW-846 8260D	6/14/22	6/14/22 18:14	MFF
Chloroethane	ND	2.3	mg/Kg dry	20		SW-846 8260D	6/14/22	6/14/22 18:14	MFF
Chloroform	ND	2.3	mg/Kg dry	20		SW-846 8260D	6/14/22	6/14/22 18:14	MFF
Chloromethane	ND	2.3	mg/Kg dry	20	V-05, V-34	SW-846 8260D	6/14/22	6/14/22 18:14	MFF
2-Chlorotoluene	ND	1.2	mg/Kg dry	20		SW-846 8260D	6/14/22	6/14/22 18:14	MFF
4-Chlorotoluene	ND	1.2	mg/Kg dry	20		SW-846 8260D	6/14/22	6/14/22 18:14	MFF
1,2-Dibromo-3-chloropropane (DBCP)	ND	4.7	mg/Kg dry	20	V-05	SW-846 8260D	6/14/22	6/14/22 18:14	MFF
1,2-Dibromoethane (EDB)	ND	0.58	mg/Kg dry	20		SW-846 8260D	6/14/22	6/14/22 18:14	MFF
Dibromomethane	ND	1.2	mg/Kg dry	20		SW-846 8260D	6/14/22	6/14/22 18:14	MFF
1,2-Dichlorobenzene	ND	1.2	mg/Kg dry	20		SW-846 8260D	6/14/22	6/14/22 18:14	MFF
1,3-Dichlorobenzene	ND	1.2	mg/Kg dry	20		SW-846 8260D	6/14/22	6/14/22 18:14	MFF
1,4-Dichlorobenzene	ND	1.2	mg/Kg dry	20		SW-846 8260D	6/14/22	6/14/22 18:14	MFF
Dichlorodifluoromethane (Freon 12)	ND	2.3	mg/Kg dry	20		SW-846 8260D	6/14/22	6/14/22 18:14	MFF
1,1-Dichloroethane	ND	1.2	mg/Kg dry	20		SW-846 8260D	6/14/22	6/14/22 18:14	MFF
1,2-Dichloroethane	ND	1.2	mg/Kg dry	20		SW-846 8260D	6/14/22	6/14/22 18:14	MFF
1,1-Dichloroethylene	ND	1.2	mg/Kg dry	20		SW-846 8260D	6/14/22	6/14/22 18:14	MFF
cis-1,2-Dichloroethylene	ND	1.2	mg/Kg dry	20		SW-846 8260D	6/14/22	6/14/22 18:14	MFF
trans-1,2-Dichloroethylene	ND	1.2	mg/Kg dry	20		SW-846 8260D	6/14/22	6/14/22 18:14	MFF
1,2-Dichloropropane	ND	1.2	mg/Kg dry	20		SW-846 8260D	6/14/22	6/14/22 18:14	MFF
1,3-Dichloropropane	ND	0.58	mg/Kg dry	20		SW-846 8260D	6/14/22	6/14/22 18:14	MFF
2,2-Dichloropropane	ND	1.2	mg/Kg dry	20		SW-846 8260D	6/14/22	6/14/22 18:14	MFF
1,1-Dichloropropene	ND	2.3	mg/Kg dry	20		SW-846 8260D	6/14/22	6/14/22 18:14	MFF
cis-1,3-Dichloropropene	ND	0.58	mg/Kg dry	20		SW-846 8260D	6/14/22	6/14/22 18:14	MFF
trans-1,3-Dichloropropene	ND	0.58	mg/Kg dry	20		SW-846 8260D	6/14/22	6/14/22 18:14	MFF
Diethyl Ether	ND	2.3	mg/Kg dry	20		SW-846 8260D	6/14/22	6/14/22 18:14	MFF
Diisopropyl Ether (DIPE)	ND	0.58	mg/Kg dry	20		SW-846 8260D	6/14/22	6/14/22 18:14	MFF
1,4-Dioxane	ND	58	mg/Kg dry	20		SW-846 8260D	6/14/22	6/14/22 18:14	MFF
Ethylbenzene	ND	1.2	mg/Kg dry	20		SW-846 8260D	6/14/22	6/14/22 18:14	MFF

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Project Location: Haverhill, MA | Sample Description: BELOW | Work Order: 22F0701

Date Received: 6/10/2022

Field Sample #: 1708220608-11 | Sampled: 6/8/2022 14:00

Sample ID: 22F0701-11

Sample Matrix: Sediment

Sample Flags: RL-05

Volatile Organic Compounds by GC/MS

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Hexachlorobutadiene	ND	1.2	mg/Kg dry	20	V-05	SW-846 8260D	6/14/22	6/14/22 18:14	MFF
2-Hexanone (MBK)	ND	12	mg/Kg dry	20		SW-846 8260D	6/14/22	6/14/22 18:14	MFF
Isopropylbenzene (Cumene)	ND	1.2	mg/Kg dry	20		SW-846 8260D	6/14/22	6/14/22 18:14	MFF
p-Isopropyltoluene (p-Cymene)	1.4	1.2	mg/Kg dry	20		SW-846 8260D	6/14/22	6/14/22 18:14	MFF
Methyl tert-Butyl Ether (MTBE)	ND	1.2	mg/Kg dry	20		SW-846 8260D	6/14/22	6/14/22 18:14	MFF
Methylene Chloride	ND	5.8	mg/Kg dry	20		SW-846 8260D	6/14/22	6/14/22 18:14	MFF
4-Methyl-2-pentanone (MIBK)	ND	12	mg/Kg dry	20		SW-846 8260D	6/14/22	6/14/22 18:14	MFF
Naphthalene	77	2.3	mg/Kg dry	20	V-05, L-04	SW-846 8260D	6/14/22	6/14/22 18:14	MFF
n-Propylbenzene	ND	1.2	mg/Kg dry	20		SW-846 8260D	6/14/22	6/14/22 18:14	MFF
Styrene	ND	1.2	mg/Kg dry	20		SW-846 8260D	6/14/22	6/14/22 18:14	MFF
1,1,1,2-Tetrachloroethane	ND	1.2	mg/Kg dry	20		SW-846 8260D	6/14/22	6/14/22 18:14	MFF
1,1,2,2-Tetrachloroethane	ND	0.58	mg/Kg dry	20		SW-846 8260D	6/14/22	6/14/22 18:14	MFF
Tetrachloroethylene	ND	1.2	mg/Kg dry	20		SW-846 8260D	6/14/22	6/14/22 18:14	MFF
Tetrahydrofuran	ND	4.7	mg/Kg dry	20		SW-846 8260D	6/14/22	6/14/22 18:14	MFF
Toluene	ND	1.2	mg/Kg dry	20		SW-846 8260D	6/14/22	6/14/22 18:14	MFF
1,2,3-Trichlorobenzene	ND	4.7	mg/Kg dry	20	V-05, L-04	SW-846 8260D	6/14/22	6/14/22 18:14	MFF
1,2,4-Trichlorobenzene	ND	1.2	mg/Kg dry	20	V-05	SW-846 8260D	6/14/22	6/14/22 18:14	MFF
1,1,1-Trichloroethane	ND	1.2	mg/Kg dry	20		SW-846 8260D	6/14/22	6/14/22 18:14	MFF
1,1,2-Trichloroethane	ND	1.2	mg/Kg dry	20		SW-846 8260D	6/14/22	6/14/22 18:14	MFF
Trichloroethylene	ND	1.2	mg/Kg dry	20		SW-846 8260D	6/14/22	6/14/22 18:14	MFF
Trichlorofluoromethane (Freon 11)	ND	2.3	mg/Kg dry	20		SW-846 8260D	6/14/22	6/14/22 18:14	MFF
1,2,3-Trichloropropane	ND	2.3	mg/Kg dry	20		SW-846 8260D	6/14/22	6/14/22 18:14	MFF
1,2,4-Trimethylbenzene	4.3	1.2	mg/Kg dry	20		SW-846 8260D	6/14/22	6/14/22 18:14	MFF
1,3,5-Trimethylbenzene	1.4	1.2	mg/Kg dry	20		SW-846 8260D	6/14/22	6/14/22 18:14	MFF
Vinyl Chloride	ND	2.3	mg/Kg dry	20		SW-846 8260D	6/14/22	6/14/22 18:14	MFF
m+p Xylene	ND	2.3	mg/Kg dry	20		SW-846 8260D	6/14/22	6/14/22 18:14	MFF
o-Xylene	ND	1.2	mg/Kg dry	20		SW-846 8260D	6/14/22	6/14/22 18:14	MFF

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
1,2-Dichloroethane-d4	91.6	70-130		6/14/22 18:14
Toluene-d8	98.2	70-130		6/14/22 18:14
4-Bromofluorobenzene	99.2	70-130		6/14/22 18:14

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Project Location: Haverhill, MA | Sample Description: BELOW | Work Order: 22F0701

Date Received: 6/10/2022

Field Sample #: 1708220608-11 | Sampled: 6/8/2022 14:00

Sample ID: 22F0701-11

Sample Matrix: Sediment

Semivolatile Organic Compounds by GC/MS

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Acenaphthene	120	11	mg/Kg dry	50		SW-846 8270E	6/15/22	6/20/22 17:28	BGL
Acenaphthylene	21	1.1	mg/Kg dry	5		SW-846 8270E	6/15/22	6/17/22 21:27	IMR
Anthracene	78	11	mg/Kg dry	50		SW-846 8270E	6/15/22	6/20/22 17:28	BGL
Benzo(a)anthracene	85	11	mg/Kg dry	50		SW-846 8270E	6/15/22	6/20/22 17:28	BGL
Benzo(a)pyrene	65	11	mg/Kg dry	50		SW-846 8270E	6/15/22	6/20/22 17:28	BGL
Benzo(b)fluoranthene	59	11	mg/Kg dry	50		SW-846 8270E	6/15/22	6/20/22 17:28	BGL
Benzo(g,h,i)perylene	29	11	mg/Kg dry	50		SW-846 8270E	6/15/22	6/20/22 17:28	BGL
Benzo(k)fluoranthene	17	1.1	mg/Kg dry	5		SW-846 8270E	6/15/22	6/17/22 21:27	IMR
Chrysene	100	11	mg/Kg dry	50		SW-846 8270E	6/15/22	6/20/22 17:28	BGL
Dibenz(a,h)anthracene	7.9	1.1	mg/Kg dry	5		SW-846 8270E	6/15/22	6/17/22 21:27	IMR
Fluoranthene	150	11	mg/Kg dry	50		SW-846 8270E	6/15/22	6/20/22 17:28	BGL
Fluorene	82	11	mg/Kg dry	50		SW-846 8270E	6/15/22	6/20/22 17:28	BGL
Indeno(1,2,3-cd)pyrene	25	1.1	mg/Kg dry	5		SW-846 8270E	6/15/22	6/17/22 21:27	IMR
2-Methylnaphthalene	240	11	mg/Kg dry	50		SW-846 8270E	6/15/22	6/20/22 17:28	BGL
Naphthalene	140	11	mg/Kg dry	50		SW-846 8270E	6/15/22	6/20/22 17:28	BGL
Phenanthrene	330	56	mg/Kg dry	250		SW-846 8270E	6/15/22	6/20/22 17:55	BGL
Pyrene	220	11	mg/Kg dry	50		SW-846 8270E	6/15/22	6/20/22 17:28	BGL

Surrogates	% Recovery		Recovery Limits	Flag/Qual	
Nitrobenzene-d5		*	30-130	S-01	6/20/22 17:55
Nitrobenzene-d5	82.7		30-130		6/17/22 21:27
Nitrobenzene-d5		*	30-130	S-01	6/20/22 17:28
2-Fluorobiphenyl		*	30-130	S-01	6/20/22 17:55
2-Fluorobiphenyl	54.8		30-130		6/17/22 21:27
2-Fluorobiphenyl		*	30-130	S-01	6/20/22 17:28
p-Terphenyl-d14		*	30-130	S-01	6/20/22 17:55
p-Terphenyl-d14	62.2		30-130		6/17/22 21:27
p-Terphenyl-d14		*	30-130	S-01	6/20/22 17:28

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Project Location: Haverhill, MA | Sample Description: BELOW | Work Order: 22F0701

Date Received: 6/10/2022

Field Sample #: 1708220608-11 | Sampled: 6/8/2022 14:00

Sample ID: 22F0701-11

Sample Matrix: Sediment

Sample Flags: O-32

Polychlorinated Biphenyls By GC/ECD

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Aroclor-1016 [1]	ND	0.11	mg/Kg dry	4		SW-846 8082A	6/15/22	6/16/22 17:01	TG
Aroclor-1221 [1]	ND	0.11	mg/Kg dry	4		SW-846 8082A	6/15/22	6/16/22 17:01	TG
Aroclor-1232 [1]	ND	0.11	mg/Kg dry	4		SW-846 8082A	6/15/22	6/16/22 17:01	TG
Aroclor-1242 [1]	ND	0.11	mg/Kg dry	4		SW-846 8082A	6/15/22	6/16/22 17:01	TG
Aroclor-1248 [1]	ND	0.11	mg/Kg dry	4		SW-846 8082A	6/15/22	6/16/22 17:01	TG
Aroclor-1254 [2]	ND	0.11	mg/Kg dry	4		SW-846 8082A	6/15/22	6/16/22 17:01	TG
Aroclor-1260 [1]	ND	0.11	mg/Kg dry	4		SW-846 8082A	6/15/22	6/16/22 17:01	TG
Aroclor-1262 [1]	ND	0.11	mg/Kg dry	4		SW-846 8082A	6/15/22	6/16/22 17:01	TG
Aroclor-1268 [1]	ND	0.11	mg/Kg dry	4		SW-846 8082A	6/15/22	6/16/22 17:01	TG

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Decachlorobiphenyl [1]	70.1	30-150		6/16/22 17:01
Decachlorobiphenyl [2]	84.8	30-150		6/16/22 17:01
Tetrachloro-m-xylene [1]	68.8	30-150		6/16/22 17:01
Tetrachloro-m-xylene [2]	68.0	30-150		6/16/22 17:01

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Project Location: Haverhill, MA | Sample Description: BELOW | Work Order: 22F0701

Date Received: 6/10/2022

Field Sample #: 1708220608-11 | Sampled: 6/8/2022 14:00

Sample ID: 22F0701-11

Sample Matrix: Sediment

Petroleum Hydrocarbons Analyses - EPH

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
C9-C18 Aliphatics	210	26	mg/Kg dry	2		MADEP EPH rev 2.1	6/15/22	6/22/22 10:16	TYH
C19-C36 Aliphatics	170	13	mg/Kg dry	1		MADEP EPH rev 2.1	6/15/22	6/21/22 16:16	TYH
Unadjusted C11-C22 Aromatics	3600	130	mg/Kg dry	10		MADEP EPH rev 2.1	6/15/22	6/22/22 10:16	TYH
C11-C22 Aromatics	3000	130	mg/Kg dry	10		MADEP EPH rev 2.1	6/15/22	6/22/22 10:16	TYH

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Chlorooctadecane (COD)	72.2	40-140		6/21/22 16:16
Chlorooctadecane (COD)	76.2	40-140		6/22/22 10:16
o-Terphenyl (OTP)	58.1	40-140		6/21/22 16:16
o-Terphenyl (OTP)	130	40-140		6/22/22 10:16
2-Bromonaphthalene	105	40-140		6/21/22 16:16
2-Fluorobiphenyl	121	40-140		6/21/22 16:16

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Project Location: Haverhill, MA | Sample Description: BELOW | Work Order: 22F0701

Date Received: 6/10/2022

Field Sample #: 1708220608-11 | Sampled: 6/8/2022 14:00

Sample ID: 22F0701-11

Sample Matrix: Sediment

Metals Analyses (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Arsenic	8.9	4.3	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 20:15	ATP
Cadmium	0.98	0.43	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 20:15	ATP
Chromium	44	0.87	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 20:15	ATP
Copper	53	0.87	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 20:15	ATP
Lead	130	0.65	mg/Kg dry	1	M-10	SW-846 6010D	6/13/22	6/15/22 20:15	ATP
Mercury	0.26	0.032	mg/Kg dry	1		SW-846 7471B	6/15/22	6/16/22 13:55	TDK
Nickel	21	0.87	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 20:15	ATP
Zinc	100	0.87	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 20:15	ATP

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Project Location: Haverhill, MA | Sample Description: BELOW | Work Order: 22F0701

Date Received: 6/10/2022

Field Sample #: 1708220608-11 | Sampled: 6/8/2022 14:00

Sample ID: 22F0701-11

Sample Matrix: Sediment

Conventional Chemistry Parameters by EPA/APHA/SW-846 Methods (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
% Solids	75.5		% Wt	1		SM 2540G	6/13/22	6/13/22 15:25	BMV
Total Organic Carbon	60000	130	mg/Kg dry	1		SW 846 9060A	6/13/22	6/13/22 12:44	IS

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Project Location: Haverhill, MA | Sample Description: BELOW | Work Order: 22F0701

Date Received: 6/10/2022

Field Sample #: 1708220608-11 | Sampled: 6/8/2022 14:00

Sample ID: 22F0701-11

Sample Matrix: Sediment

TCLP - Metals Analyses

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Antimony	ND	0.050	mg/L	1		SW-846 6010D	6/14/22	6/17/22 11:48	MJH
Arsenic	ND	0.050	mg/L	1		SW-846 6010D	6/14/22	6/17/22 11:48	MJH
Beryllium	ND	0.0040	mg/L	1		SW-846 6010D	6/14/22	6/17/22 11:48	MJH
Mercury	ND	0.00010	mg/L	1	B-05	SW-846 7470A	6/15/22	6/15/22 15:14	TDK
Nickel	0.064	0.010	mg/L	1		SW-846 6010D	6/14/22	6/17/22 11:48	MJH
Thallium	ND	0.050	mg/L	1		SW-846 6010D	6/14/22	6/17/22 11:48	MJH
Vanadium	ND	0.010	mg/L	1		SW-846 6010D	6/14/22	6/17/22 11:48	MJH
Zinc	0.91	0.50	mg/L	1		SW-846 6010D	6/14/22	6/17/22 11:48	MJH
Barium	ND	0.50	mg/L	1		SW-846 6010D	6/14/22	6/17/22 11:48	MJH
Cadmium	ND	0.010	mg/L	1		SW-846 6010D	6/14/22	6/17/22 11:48	MJH
Chromium	ND	0.050	mg/L	1		SW-846 6010D	6/14/22	6/17/22 11:48	MJH
Lead	2.3	0.10	mg/L	1		SW-846 6010D	6/14/22	6/17/22 11:48	MJH
Selenium	ND	0.050	mg/L	1		SW-846 6010D	6/14/22	6/17/22 11:48	MJH
Silver	ND	0.050	mg/L	1		SW-846 6010D	6/14/22	6/17/22 11:48	MJH

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Project Location: Haverhill, MA | Sample Description: BELOW | Work Order: 22F0701

Date Received: 6/10/2022

Field Sample #: 1708220608-11 | Sampled: 6/8/2022 14:00

Sample ID: 22F0701-11

Sample Matrix: Sediment

Conventional Chemistry Parameters by ASTM D3173

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Percent water	25.95	0.1	% Wt	1		ASTM D3173		6/15/22 0:00	SAI

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Project Location: Haverhill, MA | Sample Description: ABOVE | Work Order: 22F0701

Date Received: 6/10/2022

Field Sample #: 1708220608-12 | Sampled: 6/8/2022 14:30

Sample ID: 22F0701-12

Sample Matrix: Sediment

Volatile Organic Compounds by GC/MS

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Acetone	ND	0.073	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
tert-Amyl Methyl Ether (TAME)	ND	0.00073	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
Benzene	ND	0.0015	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
Bromobenzene	ND	0.0015	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
Bromochloromethane	ND	0.0015	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
Bromodichloromethane	ND	0.0015	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
Bromoform	ND	0.0015	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
Bromomethane	ND	0.0073	mg/Kg dry	1	V-34	SW-846 8260D	6/13/22	6/13/22 6:35	MFF
2-Butanone (MEK)	ND	0.029	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
n-Butylbenzene	ND	0.0015	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
sec-Butylbenzene	ND	0.0015	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
tert-Butylbenzene	ND	0.0015	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
tert-Butyl Ethyl Ether (TBEE)	ND	0.00073	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
Carbon Disulfide	ND	0.0073	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
Carbon Tetrachloride	ND	0.0015	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
Chlorobenzene	ND	0.0015	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
Chlorodibromomethane	ND	0.00073	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
Chloroethane	ND	0.015	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
Chloroform	ND	0.0029	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
Chloromethane	ND	0.0073	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
2-Chlorotoluene	ND	0.0015	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
4-Chlorotoluene	ND	0.0015	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
1,2-Dibromo-3-chloropropane (DBCP)	ND	0.0015	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
1,2-Dibromoethane (EDB)	ND	0.00073	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
Dibromomethane	ND	0.0015	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
1,2-Dichlorobenzene	ND	0.0015	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
1,3-Dichlorobenzene	ND	0.0015	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
1,4-Dichlorobenzene	ND	0.0015	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
Dichlorodifluoromethane (Freon 12)	ND	0.015	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
1,1-Dichloroethane	ND	0.0015	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
1,2-Dichloroethane	ND	0.0015	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
1,1-Dichloroethylene	ND	0.0029	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
cis-1,2-Dichloroethylene	ND	0.0015	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
trans-1,2-Dichloroethylene	ND	0.0015	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
1,2-Dichloropropane	ND	0.0015	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
1,3-Dichloropropane	ND	0.00073	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
2,2-Dichloropropane	ND	0.0015	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
1,1-Dichloropropene	ND	0.0015	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
cis-1,3-Dichloropropene	ND	0.00073	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
trans-1,3-Dichloropropene	ND	0.0029	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
Diethyl Ether	ND	0.015	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
Diisopropyl Ether (DIPE)	ND	0.00073	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
1,4-Dioxane	ND	0.073	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
Ethylbenzene	ND	0.0015	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF

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Project Location: Haverhill, MA | Sample Description: ABOVE | Work Order: 22F0701

Date Received: 6/10/2022

Field Sample #: 1708220608-12 | Sampled: 6/8/2022 14:30

Sample ID: 22F0701-12

Sample Matrix: Sediment

Volatile Organic Compounds by GC/MS

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Hexachlorobutadiene	ND	0.0015	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
2-Hexanone (MBK)	ND	0.015	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
Isopropylbenzene (Cumene)	ND	0.0015	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
p-Isopropyltoluene (p-Cymene)	ND	0.0015	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
Methyl tert-Butyl Ether (MTBE)	ND	0.0029	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
Methylene Chloride	ND	0.015	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
4-Methyl-2-pentanone (MIBK)	ND	0.015	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
Naphthalene	ND	0.0029	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
n-Propylbenzene	ND	0.0015	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
Styrene	ND	0.0015	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
1,1,1,2-Tetrachloroethane	ND	0.0015	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
1,1,2,2-Tetrachloroethane	ND	0.00073	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
Tetrachloroethylene	ND	0.0015	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
Tetrahydrofuran	ND	0.0073	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
Toluene	ND	0.0015	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
1,2,3-Trichlorobenzene	ND	0.0015	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
1,2,4-Trichlorobenzene	ND	0.0015	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
1,1,1-Trichloroethane	ND	0.0015	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
1,1,2-Trichloroethane	ND	0.0015	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
Trichloroethylene	ND	0.0015	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
Trichlorofluoromethane (Freon 11)	ND	0.0073	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
1,2,3-Trichloropropane	ND	0.0015	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
1,2,4-Trimethylbenzene	ND	0.0015	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
1,3,5-Trimethylbenzene	ND	0.0015	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
Vinyl Chloride	ND	0.0073	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
m+p Xylene	ND	0.0029	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF
o-Xylene	ND	0.0015	mg/Kg dry	1		SW-846 8260D	6/13/22	6/13/22 6:35	MFF

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
1,2-Dichloroethane-d4	103	70-130		6/13/22 6:35
Toluene-d8	95.2	70-130		6/13/22 6:35
4-Bromofluorobenzene	96.2	70-130		6/13/22 6:35

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Project Location: Haverhill, MA | Sample Description: ABOVE | Work Order: 22F0701

Date Received: 6/10/2022

Field Sample #: 1708220608-12 | Sampled: 6/8/2022 14:30

Sample ID: 22F0701-12

Sample Matrix: Sediment

Semivolatile Organic Compounds by GC/MS

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Acenaphthene	ND	0.20	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 21:54	IMR
Acenaphthylene	ND	0.20	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 21:54	IMR
Anthracene	ND	0.20	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 21:54	IMR
Benzo(a)anthracene	ND	0.20	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 21:54	IMR
Benzo(a)pyrene	ND	0.20	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 21:54	IMR
Benzo(b)fluoranthene	0.21	0.20	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 21:54	IMR
Benzo(g,h,i)perylene	ND	0.20	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 21:54	IMR
Benzo(k)fluoranthene	ND	0.20	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 21:54	IMR
Chrysene	ND	0.20	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 21:54	IMR
Dibenz(a,h)anthracene	ND	0.20	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 21:54	IMR
Fluoranthene	0.46	0.20	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 21:54	IMR
Fluorene	ND	0.20	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 21:54	IMR
Indeno(1,2,3-cd)pyrene	ND	0.20	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 21:54	IMR
2-Methylnaphthalene	ND	0.20	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 21:54	IMR
Naphthalene	ND	0.20	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 21:54	IMR
Phenanthrene	0.37	0.20	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 21:54	IMR
Pyrene	0.36	0.20	mg/Kg dry	1		SW-846 8270E	6/15/22	6/17/22 21:54	IMR

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Nitrobenzene-d5	87.2	30-130		6/17/22 21:54
2-Fluorobiphenyl	73.9	30-130		6/17/22 21:54
p-Terphenyl-d14	81.3	30-130		6/17/22 21:54

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Project Location: Haverhill, MA | Sample Description: ABOVE | Work Order: 22F0701

Date Received: 6/10/2022

Field Sample #: 1708220608-12 | Sampled: 6/8/2022 14:30

Sample ID: 22F0701-12

Sample Matrix: Sediment

Sample Flags: O-32

Polychlorinated Biphenyls By GC/ECD

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Aroclor-1016 [1]	ND	0.096	mg/Kg dry	4		SW-846 8082A	6/15/22	6/16/22 17:19	TG
Aroclor-1221 [1]	ND	0.096	mg/Kg dry	4		SW-846 8082A	6/15/22	6/16/22 17:19	TG
Aroclor-1232 [1]	ND	0.096	mg/Kg dry	4		SW-846 8082A	6/15/22	6/16/22 17:19	TG
Aroclor-1242 [1]	ND	0.096	mg/Kg dry	4		SW-846 8082A	6/15/22	6/16/22 17:19	TG
Aroclor-1248 [1]	ND	0.096	mg/Kg dry	4		SW-846 8082A	6/15/22	6/16/22 17:19	TG
Aroclor-1254 [1]	ND	0.096	mg/Kg dry	4		SW-846 8082A	6/15/22	6/16/22 17:19	TG
Aroclor-1260 [1]	ND	0.096	mg/Kg dry	4		SW-846 8082A	6/15/22	6/16/22 17:19	TG
Aroclor-1262 [1]	ND	0.096	mg/Kg dry	4		SW-846 8082A	6/15/22	6/16/22 17:19	TG
Aroclor-1268 [1]	ND	0.096	mg/Kg dry	4		SW-846 8082A	6/15/22	6/16/22 17:19	TG

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Decachlorobiphenyl [1]	87.2	30-150		6/16/22 17:19
Decachlorobiphenyl [2]	93.0	30-150		6/16/22 17:19
Tetrachloro-m-xylene [1]	87.2	30-150		6/16/22 17:19
Tetrachloro-m-xylene [2]	87.4	30-150		6/16/22 17:19

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Project Location: Haverhill, MA | Sample Description: ABOVE | Work Order: 22F0701

Date Received: 6/10/2022

Field Sample #: 1708220608-12 | Sampled: 6/8/2022 14:30

Sample ID: 22F0701-12

Sample Matrix: Sediment

Petroleum Hydrocarbons Analyses - EPH

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
C9-C18 Aliphatics	ND	12	mg/Kg dry	1		MADEP EPH rev 2.1	6/15/22	6/21/22 15:56	TYH
C19-C36 Aliphatics	ND	12	mg/Kg dry	1		MADEP EPH rev 2.1	6/15/22	6/21/22 15:56	TYH
Unadjusted C11-C22 Aromatics	ND	12	mg/Kg dry	1		MADEP EPH rev 2.1	6/15/22	6/21/22 15:56	TYH
C11-C22 Aromatics	ND	12	mg/Kg dry	1		MADEP EPH rev 2.1	6/15/22	6/21/22 15:56	TYH

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
Chlorooctadecane (COD)	94.3	40-140		6/21/22 15:56
o-Terphenyl (OTP)	86.6	40-140		6/21/22 15:56
2-Bromonaphthalene	102	40-140		6/21/22 15:56
2-Fluorobiphenyl	98.1	40-140		6/21/22 15:56

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Project Location: Haverhill, MA | Sample Description: ABOVE | Work Order: 22F0701

Date Received: 6/10/2022

Field Sample #: 1708220608-12 | Sampled: 6/8/2022 14:30

Sample ID: 22F0701-12

Sample Matrix: Sediment

Metals Analyses (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Arsenic	6.6	4.0	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 20:22	ATP
Cadmium	ND	0.40	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 20:22	ATP
Chromium	17	0.80	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 20:22	ATP
Copper	6.1	0.80	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 20:22	ATP
Lead	12	0.60	mg/Kg dry	1	M-10	SW-846 6010D	6/13/22	6/15/22 20:22	ATP
Mercury	ND	0.031	mg/Kg dry	1		SW-846 7471B	6/14/22	6/15/22 16:20	TDK
Nickel	7.1	0.80	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 20:22	ATP
Zinc	35	0.80	mg/Kg dry	1		SW-846 6010D	6/13/22	6/15/22 20:22	ATP

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Project Location: Haverhill, MA | Sample Description: ABOVE | Work Order: 22F0701

Date Received: 6/10/2022

Field Sample #: 1708220608-12 | Sampled: 6/8/2022 14:30

Sample ID: 22F0701-12

Sample Matrix: Sediment

Conventional Chemistry Parameters by EPA/APHA/SW-846 Methods (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
% Solids	83.0		% Wt	1		SM 2540G	6/13/22	6/13/22 15:25	BMV
Total Organic Carbon	690	120	mg/Kg dry	1		SW 846 9060A	6/13/22	6/13/22 13:13	IS

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Project Location: Haverhill, MA | Sample Description: ABOVE | Work Order: 22F0701

Date Received: 6/10/2022

Field Sample #: 1708220608-12 | Sampled: 6/8/2022 14:30

Sample ID: 22F0701-12

Sample Matrix: Sediment

TCLP - Metals Analyses

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Antimony	ND	0.050	mg/L	1		SW-846 6010D	6/14/22	6/17/22 11:55	MJH
Arsenic	ND	0.050	mg/L	1		SW-846 6010D	6/14/22	6/17/22 11:55	MJH
Beryllium	ND	0.0040	mg/L	1		SW-846 6010D	6/14/22	6/17/22 11:55	MJH
Mercury	ND	0.00010	mg/L	1	B-05	SW-846 7470A	6/15/22	6/15/22 15:16	ICP
Nickel	ND	0.010	mg/L	1		SW-846 6010D	6/14/22	6/17/22 11:55	MJH
Thallium	ND	0.050	mg/L	1		SW-846 6010D	6/14/22	6/17/22 11:55	MJH
Vanadium	ND	0.010	mg/L	1		SW-846 6010D	6/14/22	6/17/22 11:55	MJH
Zinc	ND	0.50	mg/L	1		SW-846 6010D	6/14/22	6/17/22 11:55	MJH
Barium	ND	0.50	mg/L	1		SW-846 6010D	6/14/22	6/17/22 11:55	MJH
Cadmium	ND	0.010	mg/L	1		SW-846 6010D	6/14/22	6/17/22 11:55	MJH
Chromium	ND	0.050	mg/L	1		SW-846 6010D	6/14/22	6/17/22 11:55	MJH
Lead	ND	0.10	mg/L	1		SW-846 6010D	6/14/22	6/17/22 11:55	MJH
Selenium	ND	0.050	mg/L	1		SW-846 6010D	6/14/22	6/17/22 11:55	MJH
Silver	ND	0.050	mg/L	1		SW-846 6010D	6/14/22	6/17/22 11:55	MJH

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Project Location: Haverhill, MA | Sample Description: ABOVE | Work Order: 22F0701

Date Received: 6/10/2022

Field Sample #: 1708220608-12 | Sampled: 6/8/2022 14:30

Sample ID: 22F0701-12

Sample Matrix: Sediment

Conventional Chemistry Parameters by ASTM D3173

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Percent Water	15.42	0.1	% Wt	1		ASTM D3173		6/15/22 0:00	SAI

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Project Location: Haverhill, MA | Sample Description: TRIP | Work Order: 22F0701

Date Received: 6/10/2022

Field Sample #: 1708220608-13 | Sampled: 6/8/2022 00:00

Sample ID: 22F0701-13

Sample Matrix: Sediment

Volatile Organic Compounds by GC/MS

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Acetone	ND	0.10	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
tert-Amyl Methyl Ether (TAME)	ND	0.0010	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
Benzene	ND	0.0020	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
Bromobenzene	ND	0.0020	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
Bromochloromethane	ND	0.0020	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
Bromodichloromethane	ND	0.0020	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
Bromoform	ND	0.0020	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
Bromomethane	ND	0.010	mg/Kg wet	1	V-34	SW-846 8260D	6/13/22	6/13/22 6:09	MFF
2-Butanone (MEK)	ND	0.040	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
n-Butylbenzene	ND	0.0020	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
sec-Butylbenzene	ND	0.0020	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
tert-Butylbenzene	ND	0.0020	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
tert-Butyl Ethyl Ether (TBEE)	ND	0.0010	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
Carbon Disulfide	ND	0.010	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
Carbon Tetrachloride	ND	0.0020	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
Chlorobenzene	ND	0.0020	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
Chlorodibromomethane	ND	0.0010	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
Chloroethane	ND	0.020	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
Chloroform	ND	0.0040	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
Chloromethane	ND	0.010	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
2-Chlorotoluene	ND	0.0020	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
4-Chlorotoluene	ND	0.0020	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
1,2-Dibromo-3-chloropropane (DBCP)	ND	0.0020	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
1,2-Dibromoethane (EDB)	ND	0.0010	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
Dibromomethane	ND	0.0020	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
1,2-Dichlorobenzene	ND	0.0020	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
1,3-Dichlorobenzene	ND	0.0020	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
1,4-Dichlorobenzene	ND	0.0020	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
Dichlorodifluoromethane (Freon 12)	ND	0.020	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
1,1-Dichloroethane	ND	0.0020	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
1,2-Dichloroethane	ND	0.0020	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
1,1-Dichloroethylene	ND	0.0040	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
cis-1,2-Dichloroethylene	ND	0.0020	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
trans-1,2-Dichloroethylene	ND	0.0020	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
1,2-Dichloropropane	ND	0.0020	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
1,3-Dichloropropane	ND	0.0010	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
2,2-Dichloropropane	ND	0.0020	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
1,1-Dichloropropene	ND	0.0020	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
cis-1,3-Dichloropropene	ND	0.0010	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
trans-1,3-Dichloropropene	ND	0.0040	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
Diethyl Ether	ND	0.020	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
Diisopropyl Ether (DIPE)	ND	0.0010	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
1,4-Dioxane	ND	0.10	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
Ethylbenzene	ND	0.0020	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF

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Project Location: Haverhill, MA | Sample Description: TRIP | Work Order: 22F0701

Date Received: 6/10/2022

Field Sample #: 1708220608-13 | Sampled: 6/8/2022 00:00

Sample ID: 22F0701-13

Sample Matrix: Sediment

Volatile Organic Compounds by GC/MS

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Hexachlorobutadiene	ND	0.0020	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
2-Hexanone (MBK)	ND	0.020	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
Isopropylbenzene (Cumene)	ND	0.0020	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
p-Isopropyltoluene (p-Cymene)	ND	0.0020	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
Methyl tert-Butyl Ether (MTBE)	ND	0.0040	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
Methylene Chloride	ND	0.020	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
4-Methyl-2-pentanone (MIBK)	ND	0.020	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
Naphthalene	ND	0.0040	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
n-Propylbenzene	ND	0.0020	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
Styrene	ND	0.0020	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
1,1,1,2-Tetrachloroethane	ND	0.0020	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
1,1,2,2-Tetrachloroethane	ND	0.0010	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
Tetrachloroethylene	ND	0.0020	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
Tetrahydrofuran	ND	0.010	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
Toluene	ND	0.0020	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
1,2,3-Trichlorobenzene	ND	0.0020	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
1,2,4-Trichlorobenzene	ND	0.0020	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
1,1,1-Trichloroethane	ND	0.0020	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
1,1,2-Trichloroethane	ND	0.0020	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
Trichloroethylene	ND	0.0020	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
Trichlorofluoromethane (Freon 11)	ND	0.010	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
1,2,3-Trichloropropane	ND	0.0020	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
1,2,4-Trimethylbenzene	ND	0.0020	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
1,3,5-Trimethylbenzene	ND	0.0020	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
Vinyl Chloride	ND	0.010	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
m+p Xylene	ND	0.0040	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF
o-Xylene	ND	0.0020	mg/Kg wet	1		SW-846 8260D	6/13/22	6/13/22 6:09	MFF

Surrogates	% Recovery	Recovery Limits	Flag/Qual	
1,2-Dichloroethane-d4	101	70-130		6/13/22 6:09
Toluene-d8	96.3	70-130		6/13/22 6:09
4-Bromofluorobenzene	96.3	70-130		6/13/22 6:09

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Sample Extraction Data

Prep Method: SW-846 3546 **Analytical Method: MADEP EPH rev 2.1**

Lab Number [Field ID]	Batch	Initial [g]	Final [mL]	Date
22F0701-11 [1708220608-11]	B310786	20.0	2.00	06/15/22
22F0701-11RE1 [1708220608-11]	B310786	20.0	2.00	06/15/22
22F0701-12 [1708220608-12]	B310786	20.0	2.00	06/15/22

Prep Method: % Solids **Analytical Method: SM 2540G**

Lab Number [Field ID]	Batch	Date
22F0701-01 [1708220608-01]	B310544	06/13/22
22F0701-02 [1708220608-02]	B310544	06/13/22
22F0701-03 [1708220608-03]	B310544	06/13/22
22F0701-04 [1708220608-04]	B310544	06/13/22
22F0701-05 [1708220608-05]	B310544	06/13/22
22F0701-06 [1708220608-06]	B310544	06/13/22
22F0701-07 [1708220608-07]	B310544	06/13/22
22F0701-08 [1708220608-08]	B310544	06/13/22
22F0701-09 [1708220608-09]	B310544	06/13/22
22F0701-10 [1708220608-10]	B310544	06/13/22
22F0701-11 [1708220608-11]	B310544	06/13/22
22F0701-12 [1708220608-12]	B310544	06/13/22

SW 846 9060A

Lab Number [Field ID]	Batch	Initial [g]	Final [mL]	Date
22F0701-11 [1708220608-11]	B310495	1.00	1.00	06/13/22
22F0701-12 [1708220608-12]	B310495	1.00	1.00	06/13/22

Prep Method: SW-846 3050B **Analytical Method: SW-846 6010D**

Lab Number [Field ID]	Batch	Initial [g]	Final [mL]	Date
22F0701-01 [1708220608-01]	B310537	1.56	50.0	06/13/22
22F0701-02 [1708220608-02]	B310537	1.60	50.0	06/13/22
22F0701-03 [1708220608-03]	B310537	1.56	50.0	06/13/22
22F0701-04 [1708220608-04]	B310537	1.57	50.0	06/13/22
22F0701-05 [1708220608-05]	B310537	1.52	50.0	06/13/22
22F0701-06 [1708220608-06]	B310537	1.59	50.0	06/13/22
22F0701-07 [1708220608-07]	B310537	1.54	50.0	06/13/22
22F0701-08 [1708220608-08]	B310537	1.52	50.0	06/13/22
22F0701-09 [1708220608-09]	B310537	1.58	50.0	06/13/22
22F0701-10 [1708220608-10]	B310537	1.58	50.0	06/13/22
22F0701-11 [1708220608-11]	B310537	1.52	50.0	06/13/22
22F0701-12 [1708220608-12]	B310537	1.50	50.0	06/13/22

Prep Method: SW-846 3010A **Analytical Method: SW-846 6010D** **Leachates were extracted on 6/13/2022 per SW-846 1311 in Batch B310554**

Lab Number [Field ID]	Batch	Initial [mL]	Final [mL]	Date
22F0701-11 [1708220608-11]	B310708	50.0	50.0	06/14/22
22F0701-12 [1708220608-12]	B310708	50.0	50.0	06/14/22

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Sample Extraction Data

Prep Method: SW-846 7470A Prep **Analytical Method: SW-846 7470A** **Aliquots were extracted on 6/13/2022 per SW-846 1311 in Batch B310554**

Lab Number [Field ID]	Batch	Initial [mL]	Final [mL]	Date
22F0701-11 [1708220608-11]	B310749	10.0	10.0	06/15/22
22F0701-12 [1708220608-12]	B310749	10.0	10.0	06/15/22

Prep Method: SW-846 7471 **Analytical Method: SW-846 7471B**

Lab Number [Field ID]	Batch	Initial [g]	Final [mL]	Date
22F0701-12 [1708220608-12]	B310691	0.592	50.0	06/14/22

Prep Method: SW-846 7471 **Analytical Method: SW-846 7471B**

Lab Number [Field ID]	Batch	Initial [g]	Final [mL]	Date
22F0701-01 [1708220608-01]	B310773	0.617	50.0	06/15/22
22F0701-02 [1708220608-02]	B310773	0.616	50.0	06/15/22
22F0701-03 [1708220608-03]	B310773	0.582	50.0	06/15/22
22F0701-04 [1708220608-04]	B310773	0.586	50.0	06/15/22
22F0701-05 [1708220608-05]	B310773	0.620	50.0	06/15/22
22F0701-06 [1708220608-06]	B310773	0.585	50.0	06/15/22
22F0701-07 [1708220608-07]	B310773	0.588	50.0	06/15/22
22F0701-08 [1708220608-08]	B310773	0.617	50.0	06/15/22
22F0701-09 [1708220608-09]	B310773	0.595	50.0	06/15/22
22F0701-10 [1708220608-10]	B310773	0.589	50.0	06/15/22
22F0701-11 [1708220608-11]	B310773	0.615	50.0	06/15/22

Prep Method: SW-846 3546 **Analytical Method: SW-846 8082A**

Lab Number [Field ID]	Batch	Initial [g]	Final [mL]	Date
22F0701-11 [1708220608-11]	B310797	10.0	10.0	06/15/22
22F0701-12 [1708220608-12]	B310797	10.0	10.0	06/15/22

Prep Method: SW-846 5035 **Analytical Method: SW-846 8260D**

Lab Number [Field ID]	Batch	Initial [g]	Final [mL]	Date
22F0701-12 [1708220608-12]	B310578	8.31	10.0	06/13/22
22F0701-13 [1708220608-13]	B310578	5.00	10.0	06/13/22

Prep Method: SW-846 5035 **Analytical Method: SW-846 8260D**

Lab Number [Field ID]	Batch	Sample Amount(g)	Methanol Volume(mL)	Methanol Aliquot(mL)	Final Volume(mL)	Date
22F0701-11 [1708220608-11]	B310614	7.85	6.92	0.05	50	06/14/22

Prep Method: SW-846 3546 **Analytical Method: SW-846 8270E**

Lab Number [Field ID]	Batch	Initial [g]	Final [mL]	Date
22F0701-01 [1708220608-01]	B310808	30.0	1.00	06/15/22
22F0701-04 [1708220608-04]	B310808	30.0	1.00	06/15/22
22F0701-05 [1708220608-05]	B310808	30.0	1.00	06/15/22
22F0701-06 [1708220608-06]	B310808	30.0	1.00	06/15/22
22F0701-07 [1708220608-07]	B310808	30.0	1.00	06/15/22

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Sample Extraction Data

Prep Method: SW-846 3546 **Analytical Method: SW-846 8270E**

Lab Number [Field ID]	Batch	Initial [g]	Final [mL]	Date
22F0701-08 [1708220608-08]	B310808	30.0	1.00	06/15/22
22F0701-10 [1708220608-10]	B310808	30.0	1.00	06/15/22
22F0701-11 [1708220608-11]	B310808	30.0	1.00	06/15/22
22F0701-11RE1 [1708220608-11]	B310808	30.0	1.00	06/15/22
22F0701-11RE2 [1708220608-11]	B310808	30.0	1.00	06/15/22
22F0701-12 [1708220608-12]	B310808	30.0	1.00	06/15/22

Prep Method: SW-846 3546 **Analytical Method: SW-846 8270E**

Lab Number [Field ID]	Batch	Initial [g]	Final [mL]	Date
22F0701-02RE1 [1708220608-02]	B311045	30.0	1.00	06/17/22
22F0701-02RE2 [1708220608-02]	B311045	30.0	1.00	06/17/22
22F0701-03RE1 [1708220608-03]	B311045	30.0	1.00	06/17/22
22F0701-03RE2 [1708220608-03]	B311045	30.0	1.00	06/17/22
22F0701-09RE1 [1708220608-09]	B311045	30.0	1.00	06/17/22

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QUALITY CONTROL

Volatile Organic Compounds by GC/MS - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B310578 - SW-846 5035										
Blank (B310578-BLK1)				Prepared & Analyzed: 06/13/22						
Acetone	ND	0.10	mg/Kg wet							
tert-Amyl Methyl Ether (TAME)	ND	0.0010	mg/Kg wet							
Benzene	ND	0.0020	mg/Kg wet							
Bromobenzene	ND	0.0020	mg/Kg wet							
Bromochloromethane	ND	0.0020	mg/Kg wet							
Bromodichloromethane	ND	0.0020	mg/Kg wet							
Bromoform	ND	0.0020	mg/Kg wet							
Bromomethane	ND	0.010	mg/Kg wet							V-34
2-Butanone (MEK)	ND	0.040	mg/Kg wet							
n-Butylbenzene	ND	0.0020	mg/Kg wet							
sec-Butylbenzene	ND	0.0020	mg/Kg wet							
tert-Butylbenzene	ND	0.0020	mg/Kg wet							
tert-Butyl Ethyl Ether (TBEE)	ND	0.0010	mg/Kg wet							
Carbon Disulfide	ND	0.010	mg/Kg wet							
Carbon Tetrachloride	ND	0.0020	mg/Kg wet							
Chlorobenzene	ND	0.0020	mg/Kg wet							
Chlorodibromomethane	ND	0.0010	mg/Kg wet							
Chloroethane	ND	0.020	mg/Kg wet							
Chloroform	ND	0.0040	mg/Kg wet							
Chloromethane	ND	0.010	mg/Kg wet							
2-Chlorotoluene	ND	0.0020	mg/Kg wet							
4-Chlorotoluene	ND	0.0020	mg/Kg wet							
1,2-Dibromo-3-chloropropane (DBCP)	ND	0.0020	mg/Kg wet							
1,2-Dibromoethane (EDB)	ND	0.0010	mg/Kg wet							
Dibromomethane	ND	0.0020	mg/Kg wet							
1,2-Dichlorobenzene	ND	0.0020	mg/Kg wet							
1,3-Dichlorobenzene	ND	0.0020	mg/Kg wet							
1,4-Dichlorobenzene	ND	0.0020	mg/Kg wet							
Dichlorodifluoromethane (Freon 12)	ND	0.020	mg/Kg wet							
1,1-Dichloroethane	ND	0.0020	mg/Kg wet							
1,2-Dichloroethane	ND	0.0020	mg/Kg wet							
1,1-Dichloroethylene	ND	0.0040	mg/Kg wet							
cis-1,2-Dichloroethylene	ND	0.0020	mg/Kg wet							
trans-1,2-Dichloroethylene	ND	0.0020	mg/Kg wet							
1,2-Dichloropropane	ND	0.0020	mg/Kg wet							
1,3-Dichloropropane	ND	0.0010	mg/Kg wet							
2,2-Dichloropropane	ND	0.0020	mg/Kg wet							
1,1-Dichloropropene	ND	0.0020	mg/Kg wet							
cis-1,3-Dichloropropene	ND	0.0010	mg/Kg wet							
trans-1,3-Dichloropropene	ND	0.0010	mg/Kg wet							
Diethyl Ether	ND	0.020	mg/Kg wet							
Diisopropyl Ether (DIPE)	ND	0.0010	mg/Kg wet							
1,4-Dioxane	ND	0.10	mg/Kg wet							
Ethylbenzene	ND	0.0020	mg/Kg wet							
Hexachlorobutadiene	ND	0.0020	mg/Kg wet							
2-Hexanone (MBK)	ND	0.020	mg/Kg wet							
Isopropylbenzene (Cumene)	ND	0.0020	mg/Kg wet							
p-Isopropyltoluene (p-Cymene)	ND	0.0020	mg/Kg wet							
Methyl tert-Butyl Ether (MTBE)	ND	0.0040	mg/Kg wet							
Methylene Chloride	ND	0.020	mg/Kg wet							
4-Methyl-2-pentanone (MIBK)	ND	0.020	mg/Kg wet							
Naphthalene	ND	0.0040	mg/Kg wet							

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QUALITY CONTROL

Volatile Organic Compounds by GC/MS - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes	
Batch B310578 - SW-846 5035											
Blank (B310578-BLK1)				Prepared & Analyzed: 06/13/22							
n-Propylbenzene	ND	0.0020	mg/Kg wet								
Styrene	ND	0.0020	mg/Kg wet								
1,1,1,2-Tetrachloroethane	ND	0.0020	mg/Kg wet								
1,1,2,2-Tetrachloroethane	ND	0.0010	mg/Kg wet								
Tetrachloroethylene	ND	0.0020	mg/Kg wet								
Tetrahydrofuran	ND	0.010	mg/Kg wet								
Toluene	ND	0.0020	mg/Kg wet								
1,2,3-Trichlorobenzene	ND	0.0020	mg/Kg wet								
1,2,4-Trichlorobenzene	ND	0.0020	mg/Kg wet								
1,1,1-Trichloroethane	ND	0.0020	mg/Kg wet								
1,1,2-Trichloroethane	ND	0.0020	mg/Kg wet								
Trichloroethylene	ND	0.0020	mg/Kg wet								
Trichlorofluoromethane (Freon 11)	ND	0.010	mg/Kg wet								
1,2,3-Trichloropropane	ND	0.0020	mg/Kg wet								
1,2,4-Trimethylbenzene	ND	0.0020	mg/Kg wet								
1,3,5-Trimethylbenzene	ND	0.0020	mg/Kg wet								
Vinyl Chloride	ND	0.010	mg/Kg wet								
m+p Xylene	ND	0.0040	mg/Kg wet								
o-Xylene	ND	0.0020	mg/Kg wet								
Surrogate: 1,2-Dichloroethane-d4	*0.0489*		mg/Kg wet	0.0500		97.8	70-130				
Surrogate: Toluene-d8	*0.0481*		mg/Kg wet	0.0500		96.2	70-130				
Surrogate: 4-Bromofluorobenzene	*0.0481*		mg/Kg wet	0.0500		96.1	70-130				
LCS (B310578-BS1)				Prepared & Analyzed: 06/13/22							
Acetone	0.219	0.10	mg/Kg wet	0.200		110	40-160			V-36	†
tert-Amyl Methyl Ether (TAME)	0.0228	0.0010	mg/Kg wet	0.0200		114	70-130				
Benzene	0.0206	0.0020	mg/Kg wet	0.0200		103	70-130				
Bromobenzene	0.0205	0.0020	mg/Kg wet	0.0200		103	70-130				
Bromochloromethane	0.0218	0.0020	mg/Kg wet	0.0200		109	70-130				
Bromodichloromethane	0.0202	0.0020	mg/Kg wet	0.0200		101	70-130				
Bromoform	0.0215	0.0020	mg/Kg wet	0.0200		107	70-130				
Bromomethane	0.0237	0.010	mg/Kg wet	0.0200		119	40-160			V-34	†
2-Butanone (MEK)	0.238	0.040	mg/Kg wet	0.200		119	40-160			V-36	†
n-Butylbenzene	0.0209	0.0020	mg/Kg wet	0.0200		105	70-130				
sec-Butylbenzene	0.0209	0.0020	mg/Kg wet	0.0200		105	70-130				
tert-Butylbenzene	0.0211	0.0020	mg/Kg wet	0.0200		105	70-130				
tert-Butyl Ethyl Ether (TBEE)	0.0191	0.0010	mg/Kg wet	0.0200		95.7	70-130				
Carbon Disulfide	0.234	0.010	mg/Kg wet	0.200		117	70-130				
Carbon Tetrachloride	0.0211	0.0020	mg/Kg wet	0.0200		106	70-130				
Chlorobenzene	0.0200	0.0020	mg/Kg wet	0.0200		100	70-130				
Chlorodibromomethane	0.0205	0.0010	mg/Kg wet	0.0200		102	70-130				
Chloroethane	0.0209	0.020	mg/Kg wet	0.0200		104	70-130				
Chloroform	0.0206	0.0040	mg/Kg wet	0.0200		103	70-130				
Chloromethane	0.0209	0.010	mg/Kg wet	0.0200		104	40-160				†
2-Chlorotoluene	0.0213	0.0020	mg/Kg wet	0.0200		106	70-130				
4-Chlorotoluene	0.0211	0.0020	mg/Kg wet	0.0200		106	70-130				
1,2-Dibromo-3-chloropropane (DBCP)	0.0199	0.0020	mg/Kg wet	0.0200		99.4	70-130				
1,2-Dibromoethane (EDB)	0.0203	0.0010	mg/Kg wet	0.0200		101	70-130				
Dibromomethane	0.0205	0.0020	mg/Kg wet	0.0200		102	70-130				
1,2-Dichlorobenzene	0.0197	0.0020	mg/Kg wet	0.0200		98.4	70-130				
1,3-Dichlorobenzene	0.0200	0.0020	mg/Kg wet	0.0200		100	70-130				
1,4-Dichlorobenzene	0.0192	0.0020	mg/Kg wet	0.0200		96.1	70-130				

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QUALITY CONTROL

Volatile Organic Compounds by GC/MS - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes	
Batch B310578 - SW-846 5035											
LCS (B310578-BS1)				Prepared & Analyzed: 06/13/22							
Dichlorodifluoromethane (Freon 12)	0.0200	0.020	mg/Kg wet	0.0200		100	40-160				†
1,1-Dichloroethane	0.0214	0.0020	mg/Kg wet	0.0200		107	70-130				
1,2-Dichloroethane	0.0186	0.0020	mg/Kg wet	0.0200		92.9	70-130				
1,1-Dichloroethylene	0.0206	0.0040	mg/Kg wet	0.0200		103	70-130				
cis-1,2-Dichloroethylene	0.0203	0.0020	mg/Kg wet	0.0200		102	70-130				
trans-1,2-Dichloroethylene	0.0212	0.0020	mg/Kg wet	0.0200		106	70-130				
1,2-Dichloropropane	0.0219	0.0020	mg/Kg wet	0.0200		110	70-130				
1,3-Dichloropropane	0.0208	0.0010	mg/Kg wet	0.0200		104	70-130				
2,2-Dichloropropane	0.0213	0.0020	mg/Kg wet	0.0200		106	70-130				
1,1-Dichloropropene	0.0211	0.0020	mg/Kg wet	0.0200		105	70-130				
cis-1,3-Dichloropropene	0.0215	0.0010	mg/Kg wet	0.0200		108	70-130				
trans-1,3-Dichloropropene	0.0187	0.0010	mg/Kg wet	0.0200		93.4	70-130				
Diethyl Ether	0.0203	0.020	mg/Kg wet	0.0200		101	70-130				
Diisopropyl Ether (DIPE)	0.0207	0.0010	mg/Kg wet	0.0200		103	70-130				
1,4-Dioxane	0.216	0.10	mg/Kg wet	0.200		108	40-160				†
Ethylbenzene	0.0208	0.0020	mg/Kg wet	0.0200		104	70-130				
Hexachlorobutadiene	0.0211	0.0020	mg/Kg wet	0.0200		106	70-130				
2-Hexanone (MBK)	0.215	0.020	mg/Kg wet	0.200		107	40-160			V-36	†
Isopropylbenzene (Cumene)	0.0210	0.0020	mg/Kg wet	0.0200		105	70-130				
p-Isopropyltoluene (p-Cymene)	0.0204	0.0020	mg/Kg wet	0.0200		102	70-130				
Methyl tert-Butyl Ether (MTBE)	0.0199	0.0040	mg/Kg wet	0.0200		99.5	70-130				
Methylene Chloride	0.0199	0.020	mg/Kg wet	0.0200		99.4	70-130				
4-Methyl-2-pentanone (MIBK)	0.211	0.020	mg/Kg wet	0.200		105	40-160				†
Naphthalene	0.0193	0.0040	mg/Kg wet	0.0200		96.7	70-130				
n-Propylbenzene	0.0216	0.0020	mg/Kg wet	0.0200		108	70-130				
Styrene	0.0212	0.0020	mg/Kg wet	0.0200		106	70-130				
1,1,1,2-Tetrachloroethane	0.0215	0.0020	mg/Kg wet	0.0200		108	70-130				
1,1,2,2-Tetrachloroethane	0.0207	0.0010	mg/Kg wet	0.0200		103	70-130				
Tetrachloroethylene	0.0207	0.0020	mg/Kg wet	0.0200		103	70-130				
Tetrahydrofuran	0.0185	0.010	mg/Kg wet	0.0200		92.7	70-130				
Toluene	0.0201	0.0020	mg/Kg wet	0.0200		101	70-130				
1,2,3-Trichlorobenzene	0.0189	0.0020	mg/Kg wet	0.0200		94.3	70-130				
1,2,4-Trichlorobenzene	0.0185	0.0020	mg/Kg wet	0.0200		92.4	70-130				
1,1,1-Trichloroethane	0.0217	0.0020	mg/Kg wet	0.0200		108	70-130				
1,1,2-Trichloroethane	0.0206	0.0020	mg/Kg wet	0.0200		103	70-130				
Trichloroethylene	0.0205	0.0020	mg/Kg wet	0.0200		103	70-130				
Trichlorofluoromethane (Freon 11)	0.0200	0.010	mg/Kg wet	0.0200		100	70-130				
1,2,3-Trichloropropane	0.0212	0.0020	mg/Kg wet	0.0200		106	70-130				
1,2,4-Trimethylbenzene	0.0203	0.0020	mg/Kg wet	0.0200		102	70-130				
1,3,5-Trimethylbenzene	0.0210	0.0020	mg/Kg wet	0.0200		105	70-130				
Vinyl Chloride	0.0204	0.010	mg/Kg wet	0.0200		102	70-130				
m+p Xylene	0.0430	0.0040	mg/Kg wet	0.0400		108	70-130				
o-Xylene	0.0209	0.0020	mg/Kg wet	0.0200		105	70-130				
Surrogate: 1,2-Dichloroethane-d4	*0.0452*		mg/Kg wet	0.0500		90.4	70-130				
Surrogate: Toluene-d8	*0.0484*		mg/Kg wet	0.0500		96.9	70-130				
Surrogate: 4-Bromofluorobenzene	*0.0496*		mg/Kg wet	0.0500		99.3	70-130				

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QUALITY CONTROL

Volatile Organic Compounds by GC/MS - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes	
Batch B310578 - SW-846 5035											
LCS Dup (B310578-BSD1)				Prepared & Analyzed: 06/13/22							
Acetone	0.223	0.10	mg/Kg wet	0.200		111	40-160	1.72	20	V-36	†
tert-Amyl Methyl Ether (TAME)	0.0236	0.0010	mg/Kg wet	0.0200		118	70-130	3.10	20		
Benzene	0.0211	0.0020	mg/Kg wet	0.0200		105	70-130	2.11	20		
Bromobenzene	0.0206	0.0020	mg/Kg wet	0.0200		103	70-130	0.389	20		
Bromochloromethane	0.0219	0.0020	mg/Kg wet	0.0200		109	70-130	0.275	20		
Bromodichloromethane	0.0202	0.0020	mg/Kg wet	0.0200		101	70-130	0.0992	20		
Bromoform	0.0216	0.0020	mg/Kg wet	0.0200		108	70-130	0.465	20		
Bromomethane	0.0250	0.010	mg/Kg wet	0.0200		125	40-160	5.41	20	V-34	†
2-Butanone (MEK)	0.253	0.040	mg/Kg wet	0.200		127	40-160	6.13	20	V-36	†
n-Butylbenzene	0.0208	0.0020	mg/Kg wet	0.0200		104	70-130	0.479	20		
sec-Butylbenzene	0.0209	0.0020	mg/Kg wet	0.0200		105	70-130	0.00	20		
tert-Butylbenzene	0.0209	0.0020	mg/Kg wet	0.0200		104	70-130	1.05	20		
tert-Butyl Ethyl Ether (TBEE)	0.0194	0.0010	mg/Kg wet	0.0200		97.1	70-130	1.45	20		
Carbon Disulfide	0.238	0.010	mg/Kg wet	0.200		119	70-130	2.04	20		
Carbon Tetrachloride	0.0215	0.0020	mg/Kg wet	0.0200		107	70-130	1.50	20		
Chlorobenzene	0.0202	0.0020	mg/Kg wet	0.0200		101	70-130	0.994	20		
Chlorodibromomethane	0.0204	0.0010	mg/Kg wet	0.0200		102	70-130	0.196	20		
Chloroethane	0.0217	0.020	mg/Kg wet	0.0200		109	70-130	4.04	20		
Chloroform	0.0210	0.0040	mg/Kg wet	0.0200		105	70-130	1.92	20		
Chloromethane	0.0210	0.010	mg/Kg wet	0.0200		105	40-160	0.668	20		†
2-Chlorotoluene	0.0214	0.0020	mg/Kg wet	0.0200		107	70-130	0.750	20		
4-Chlorotoluene	0.0210	0.0020	mg/Kg wet	0.0200		105	70-130	0.285	20		
1,2-Dibromo-3-chloropropane (DBCP)	0.0207	0.0020	mg/Kg wet	0.0200		104	70-130	4.14	20		
1,2-Dibromoethane (EDB)	0.0204	0.0010	mg/Kg wet	0.0200		102	70-130	0.689	20		
Dibromomethane	0.0204	0.0020	mg/Kg wet	0.0200		102	70-130	0.196	20		
1,2-Dichlorobenzene	0.0197	0.0020	mg/Kg wet	0.0200		98.4	70-130	0.00	20		
1,3-Dichlorobenzene	0.0199	0.0020	mg/Kg wet	0.0200		99.6	70-130	0.401	20		
1,4-Dichlorobenzene	0.0193	0.0020	mg/Kg wet	0.0200		96.4	70-130	0.312	20		
Dichlorodifluoromethane (Freon 12)	0.0204	0.020	mg/Kg wet	0.0200		102	40-160	2.08	20		†
1,1-Dichloroethane	0.0220	0.0020	mg/Kg wet	0.0200		110	70-130	3.04	20		
1,2-Dichloroethane	0.0188	0.0020	mg/Kg wet	0.0200		93.8	70-130	0.964	20		
1,1-Dichloroethylene	0.0210	0.0040	mg/Kg wet	0.0200		105	70-130	1.92	20		
cis-1,2-Dichloroethylene	0.0204	0.0020	mg/Kg wet	0.0200		102	70-130	0.491	20		
trans-1,2-Dichloroethylene	0.0217	0.0020	mg/Kg wet	0.0200		108	70-130	2.14	20		
1,2-Dichloropropane	0.0224	0.0020	mg/Kg wet	0.0200		112	70-130	2.26	20		
1,3-Dichloropropane	0.0209	0.0010	mg/Kg wet	0.0200		105	70-130	0.767	20		
2,2-Dichloropropane	0.0214	0.0020	mg/Kg wet	0.0200		107	70-130	0.281	20		
1,1-Dichloropropene	0.0216	0.0020	mg/Kg wet	0.0200		108	70-130	2.34	20		
cis-1,3-Dichloropropene	0.0216	0.0010	mg/Kg wet	0.0200		108	70-130	0.649	20		
trans-1,3-Dichloropropene	0.0186	0.0010	mg/Kg wet	0.0200		92.9	70-130	0.537	20		
Diethyl Ether	0.0210	0.020	mg/Kg wet	0.0200		105	70-130	3.49	20		
Diisopropyl Ether (DIPE)	0.0210	0.0010	mg/Kg wet	0.0200		105	70-130	1.34	20		
1,4-Dioxane	0.224	0.10	mg/Kg wet	0.200		112	40-160	3.92	20		†
Ethylbenzene	0.0208	0.0020	mg/Kg wet	0.0200		104	70-130	0.0961	20		
Hexachlorobutadiene	0.0213	0.0020	mg/Kg wet	0.0200		106	70-130	0.566	20		
2-Hexanone (MBK)	0.224	0.020	mg/Kg wet	0.200		112	40-160	4.15	20	V-36	†
Isopropylbenzene (Cumene)	0.0210	0.0020	mg/Kg wet	0.0200		105	70-130	0.00	20		
p-Isopropyltoluene (p-Cymene)	0.0203	0.0020	mg/Kg wet	0.0200		102	70-130	0.295	20		
Methyl tert-Butyl Ether (MTBE)	0.0202	0.0040	mg/Kg wet	0.0200		101	70-130	1.40	20		
Methylene Chloride	0.0204	0.020	mg/Kg wet	0.0200		102	70-130	2.58	20		
4-Methyl-2-pentanone (MIBK)	0.218	0.020	mg/Kg wet	0.200		109	40-160	3.47	20		†
Naphthalene	0.0196	0.0040	mg/Kg wet	0.0200		98.2	70-130	1.54	20		

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QUALITY CONTROL

Volatile Organic Compounds by GC/MS - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B310578 - SW-846 5035										
LCS Dup (B310578-BSD1)				Prepared & Analyzed: 06/13/22						
n-Propylbenzene	0.0216	0.0020	mg/Kg wet	0.0200		108	70-130	0.278	20	
Styrene	0.0213	0.0020	mg/Kg wet	0.0200		106	70-130	0.282	20	
1,1,1,2-Tetrachloroethane	0.0213	0.0020	mg/Kg wet	0.0200		106	70-130	1.22	20	
1,1,2,2-Tetrachloroethane	0.0208	0.0010	mg/Kg wet	0.0200		104	70-130	0.386	20	
Tetrachloroethylene	0.0205	0.0020	mg/Kg wet	0.0200		103	70-130	0.583	20	
Tetrahydrofuran	0.0196	0.010	mg/Kg wet	0.0200		98.2	70-130	5.76	20	
Toluene	0.0196	0.0020	mg/Kg wet	0.0200		98.0	70-130	2.62	20	
1,2,3-Trichlorobenzene	0.0186	0.0020	mg/Kg wet	0.0200		93.0	70-130	1.39	20	
1,2,4-Trichlorobenzene	0.0182	0.0020	mg/Kg wet	0.0200		91.0	70-130	1.53	20	
1,1,1-Trichloroethane	0.0221	0.0020	mg/Kg wet	0.0200		111	70-130	2.01	20	
1,1,2-Trichloroethane	0.0205	0.0020	mg/Kg wet	0.0200		102	70-130	0.584	20	
Trichloroethylene	0.0208	0.0020	mg/Kg wet	0.0200		104	70-130	1.26	20	
Trichlorofluoromethane (Freon 11)	0.0205	0.010	mg/Kg wet	0.0200		103	70-130	2.57	20	
1,2,3-Trichloropropane	0.0213	0.0020	mg/Kg wet	0.0200		106	70-130	0.471	20	
1,2,4-Trimethylbenzene	0.0201	0.0020	mg/Kg wet	0.0200		100	70-130	1.19	20	
1,3,5-Trimethylbenzene	0.0209	0.0020	mg/Kg wet	0.0200		104	70-130	0.573	20	
Vinyl Chloride	0.0206	0.010	mg/Kg wet	0.0200		103	70-130	0.974	20	
m+p Xylene	0.0430	0.0040	mg/Kg wet	0.0400		108	70-130	0.0930	20	
o-Xylene	0.0209	0.0020	mg/Kg wet	0.0200		104	70-130	0.287	20	
Surrogate: 1,2-Dichloroethane-d4	*0.0461*		mg/Kg wet	0.0500		92.2	70-130			
Surrogate: Toluene-d8	*0.0486*		mg/Kg wet	0.0500		97.2	70-130			
Surrogate: 4-Bromofluorobenzene	*0.0495*		mg/Kg wet	0.0500		99.1	70-130			
Batch B310614 - SW-846 5035										
Blank (B310614-BLK1)				Prepared & Analyzed: 06/14/22						
Acetone	ND	2.5	mg/Kg wet							
tert-Amyl Methyl Ether (TAME)	ND	0.025	mg/Kg wet							
Benzene	ND	0.050	mg/Kg wet							
Bromobenzene	ND	0.050	mg/Kg wet							
Bromochloromethane	ND	0.050	mg/Kg wet							
Bromodichloromethane	ND	0.050	mg/Kg wet							
Bromoform	ND	0.050	mg/Kg wet							
Bromomethane	ND	0.10	mg/Kg wet							V-34
2-Butanone (MEK)	ND	1.0	mg/Kg wet							
n-Butylbenzene	ND	0.050	mg/Kg wet							
sec-Butylbenzene	ND	0.050	mg/Kg wet							
tert-Butylbenzene	ND	0.050	mg/Kg wet							
tert-Butyl Ethyl Ether (TBEE)	ND	0.025	mg/Kg wet							
Carbon Disulfide	ND	0.50	mg/Kg wet							
Carbon Tetrachloride	ND	0.050	mg/Kg wet							
Chlorobenzene	ND	0.050	mg/Kg wet							
Chlorodibromomethane	ND	0.025	mg/Kg wet							
Chloroethane	ND	0.10	mg/Kg wet							
Chloroform	ND	0.10	mg/Kg wet							
Chloromethane	ND	0.10	mg/Kg wet							V-05, V-34
2-Chlorotoluene	ND	0.050	mg/Kg wet							
4-Chlorotoluene	ND	0.050	mg/Kg wet							
1,2-Dibromo-3-chloropropane (DBCP)	ND	0.20	mg/Kg wet							V-05
1,2-Dibromoethane (EDB)	ND	0.025	mg/Kg wet							
Dibromomethane	ND	0.050	mg/Kg wet							
1,2-Dichlorobenzene	ND	0.050	mg/Kg wet							
1,3-Dichlorobenzene	ND	0.050	mg/Kg wet							

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QUALITY CONTROL

Volatile Organic Compounds by GC/MS - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B310614 - SW-846 5035										
Blank (B310614-BLK1)				Prepared & Analyzed: 06/14/22						
1,4-Dichlorobenzene	ND	0.050	mg/Kg wet							
Dichlorodifluoromethane (Freon 12)	ND	0.10	mg/Kg wet							
1,1-Dichloroethane	ND	0.050	mg/Kg wet							
1,2-Dichloroethane	ND	0.050	mg/Kg wet							
1,1-Dichloroethylene	ND	0.050	mg/Kg wet							
cis-1,2-Dichloroethylene	ND	0.050	mg/Kg wet							
trans-1,2-Dichloroethylene	ND	0.050	mg/Kg wet							
1,2-Dichloropropane	ND	0.050	mg/Kg wet							
1,3-Dichloropropane	ND	0.025	mg/Kg wet							
2,2-Dichloropropane	ND	0.050	mg/Kg wet							
1,1-Dichloropropene	ND	0.10	mg/Kg wet							
cis-1,3-Dichloropropene	ND	0.025	mg/Kg wet							
trans-1,3-Dichloropropene	ND	0.025	mg/Kg wet							
Diethyl Ether	ND	0.10	mg/Kg wet							
Diisopropyl Ether (DIPE)	ND	0.025	mg/Kg wet							
1,4-Dioxane	ND	2.5	mg/Kg wet							
Ethylbenzene	ND	0.050	mg/Kg wet							
Hexachlorobutadiene	ND	0.050	mg/Kg wet							V-05
2-Hexanone (MBK)	ND	0.50	mg/Kg wet							
Isopropylbenzene (Cumene)	ND	0.050	mg/Kg wet							
p-Isopropyltoluene (p-Cymene)	ND	0.050	mg/Kg wet							
Methyl tert-Butyl Ether (MTBE)	ND	0.050	mg/Kg wet							
Methylene Chloride	ND	0.25	mg/Kg wet							
4-Methyl-2-pentanone (MIBK)	ND	0.50	mg/Kg wet							
Naphthalene	ND	0.10	mg/Kg wet							L-04, V-05
n-Propylbenzene	ND	0.050	mg/Kg wet							
Styrene	ND	0.050	mg/Kg wet							
1,1,1,2-Tetrachloroethane	ND	0.050	mg/Kg wet							
1,1,2,2-Tetrachloroethane	ND	0.025	mg/Kg wet							
Tetrachloroethylene	ND	0.050	mg/Kg wet							
Tetrahydrofuran	ND	0.20	mg/Kg wet							
Toluene	ND	0.050	mg/Kg wet							
1,2,3-Trichlorobenzene	ND	0.20	mg/Kg wet							L-04, V-05
1,2,4-Trichlorobenzene	ND	0.050	mg/Kg wet							V-05
1,1,1-Trichloroethane	ND	0.050	mg/Kg wet							
1,1,2-Trichloroethane	ND	0.050	mg/Kg wet							
Trichloroethylene	ND	0.050	mg/Kg wet							
Trichlorofluoromethane (Freon 11)	ND	0.10	mg/Kg wet							
1,2,3-Trichloropropane	ND	0.10	mg/Kg wet							
1,2,4-Trimethylbenzene	ND	0.050	mg/Kg wet							
1,3,5-Trimethylbenzene	ND	0.050	mg/Kg wet							
Vinyl Chloride	ND	0.10	mg/Kg wet							
m+p Xylene	ND	0.10	mg/Kg wet							
o-Xylene	ND	0.050	mg/Kg wet							
Surrogate: 1,2-Dichloroethane-d4	*0.0239*		mg/Kg wet	0.0250		95.4	70-130			
Surrogate: Toluene-d8	*0.0250*		mg/Kg wet	0.0250		99.8	70-130			
Surrogate: 4-Bromofluorobenzene	*0.0251*		mg/Kg wet	0.0250		100	70-130			

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QUALITY CONTROL

Volatile Organic Compounds by GC/MS - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC		%REC Limits	RPD	RPD Limit	Notes	
Batch B310614 - SW-846 5035												
LCS (B310614-BS1)				Prepared & Analyzed: 06/14/22								
Acetone	0.0977	0.057	mg/Kg wet	0.113		86.2		40-160				†
tert-Amyl Methyl Ether (TAME)	0.0121	0.00057	mg/Kg wet	0.0113		107		70-130				
Benzene	0.0112	0.0011	mg/Kg wet	0.0113		98.7		70-130				
Bromobenzene	0.0119	0.0011	mg/Kg wet	0.0113		105		70-130				
Bromochloromethane	0.0130	0.0011	mg/Kg wet	0.0113		115		70-130				
Bromodichloromethane	0.0121	0.0011	mg/Kg wet	0.0113		106		70-130				
Bromoform	0.0108	0.0011	mg/Kg wet	0.0113		95.5		70-130				
Bromomethane	0.0171	0.0023	mg/Kg wet	0.0113		151		40-160			L-14, V-20, V-34	†
2-Butanone (MEK)	0.0979	0.023	mg/Kg wet	0.113		86.4		40-160				†
n-Butylbenzene	0.0107	0.0011	mg/Kg wet	0.0113		94.3		70-130				
sec-Butylbenzene	0.0111	0.0011	mg/Kg wet	0.0113		97.7		70-130				
tert-Butylbenzene	0.0121	0.0011	mg/Kg wet	0.0113		107		70-130				
tert-Butyl Ethyl Ether (TBEE)	0.0117	0.00057	mg/Kg wet	0.0113		103		70-130				
Carbon Disulfide	0.119	0.011	mg/Kg wet	0.113		105		70-130				
Carbon Tetrachloride	0.0117	0.0011	mg/Kg wet	0.0113		104		70-130				
Chlorobenzene	0.0116	0.0011	mg/Kg wet	0.0113		103		70-130				
Chlorodibromomethane	0.0115	0.00057	mg/Kg wet	0.0113		101		70-130				
Chloroethane	0.0116	0.0023	mg/Kg wet	0.0113		102		70-130				
Chloroform	0.0121	0.0023	mg/Kg wet	0.0113		107		70-130				
Chloromethane	0.00471	0.0023	mg/Kg wet	0.0113		41.6		40-160			L-14, V-05, V-34	†
2-Chlorotoluene	0.0115	0.0011	mg/Kg wet	0.0113		102		70-130				
4-Chlorotoluene	0.0115	0.0011	mg/Kg wet	0.0113		102		70-130				
1,2-Dibromo-3-chloropropane (DBCP)	0.00918	0.0045	mg/Kg wet	0.0113		81.0		70-130			V-05	
1,2-Dibromoethane (EDB)	0.0124	0.00057	mg/Kg wet	0.0113		110		70-130				
Dibromomethane	0.0121	0.0011	mg/Kg wet	0.0113		107		70-130				
1,2-Dichlorobenzene	0.0108	0.0011	mg/Kg wet	0.0113		95.5		70-130				
1,3-Dichlorobenzene	0.0111	0.0011	mg/Kg wet	0.0113		97.8		70-130				
1,4-Dichlorobenzene	0.0113	0.0011	mg/Kg wet	0.0113		99.6		70-130				
Dichlorodifluoromethane (Freon 12)	0.0116	0.0023	mg/Kg wet	0.0113		103		40-160				†
1,1-Dichloroethane	0.0120	0.0011	mg/Kg wet	0.0113		106		70-130				
1,2-Dichloroethane	0.0124	0.0011	mg/Kg wet	0.0113		110		70-130				
1,1-Dichloroethylene	0.0120	0.0011	mg/Kg wet	0.0113		106		70-130				
cis-1,2-Dichloroethylene	0.0120	0.0011	mg/Kg wet	0.0113		106		70-130				
trans-1,2-Dichloroethylene	0.0124	0.0011	mg/Kg wet	0.0113		110		70-130				
1,2-Dichloropropane	0.0119	0.0011	mg/Kg wet	0.0113		105		70-130				
1,3-Dichloropropane	0.0120	0.00057	mg/Kg wet	0.0113		106		70-130				
2,2-Dichloropropane	0.0113	0.0011	mg/Kg wet	0.0113		99.4		70-130				
1,1-Dichloropropene	0.0120	0.0023	mg/Kg wet	0.0113		106		70-130				
cis-1,3-Dichloropropene	0.0111	0.00057	mg/Kg wet	0.0113		97.6		70-130				
trans-1,3-Dichloropropene	0.0109	0.00057	mg/Kg wet	0.0113		96.2		70-130				
Diethyl Ether	0.0108	0.0023	mg/Kg wet	0.0113		94.9		70-130				
Diisopropyl Ether (DIPE)	0.0114	0.00057	mg/Kg wet	0.0113		100		70-130				
1,4-Dioxane	0.0869	0.057	mg/Kg wet	0.113		76.7		40-160				†
Ethylbenzene	0.0114	0.0011	mg/Kg wet	0.0113		101		70-130				
Hexachlorobutadiene	0.00899	0.0011	mg/Kg wet	0.0113		79.3		70-130			V-05	
2-Hexanone (MBK)	0.107	0.011	mg/Kg wet	0.113		94.1		40-160				†
Isopropylbenzene (Cumene)	0.0114	0.0011	mg/Kg wet	0.0113		101		70-130				
p-Isopropyltoluene (p-Cymene)	0.0121	0.0011	mg/Kg wet	0.0113		107		70-130				
Methyl tert-Butyl Ether (MTBE)	0.0119	0.0011	mg/Kg wet	0.0113		105		70-130				
Methylene Chloride	0.0118	0.0057	mg/Kg wet	0.0113		104		70-130				
4-Methyl-2-pentanone (MIBK)	0.110	0.011	mg/Kg wet	0.113		96.7		40-160				†
Naphthalene	0.00765	0.0023	mg/Kg wet	0.0113		**67.5**	*	70-130			L-04, V-05	

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QUALITY CONTROL

Volatile Organic Compounds by GC/MS - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC		%REC Limits	RPD	RPD Limit	Notes	
Batch B310614 - SW-846 5035												
LCS (B310614-BS1)				Prepared & Analyzed: 06/14/22								
n-Propylbenzene	0.0115	0.0011	mg/Kg wet	0.0113		101		70-130				
Styrene	0.0115	0.0011	mg/Kg wet	0.0113		102		70-130				
1,1,1,2-Tetrachloroethane	0.0124	0.0011	mg/Kg wet	0.0113		109		70-130				
1,1,2,2-Tetrachloroethane	0.0121	0.00057	mg/Kg wet	0.0113		106		70-130				
Tetrachloroethylene	0.0114	0.0011	mg/Kg wet	0.0113		101		70-130				
Tetrahydrofuran	0.0111	0.0045	mg/Kg wet	0.0113		98.2		70-130				
Toluene	0.0111	0.0011	mg/Kg wet	0.0113		98.3		70-130				
1,2,3-Trichlorobenzene	0.00766	0.0045	mg/Kg wet	0.0113		**67.6**	*	70-130			L-04, V-05	
1,2,4-Trichlorobenzene	0.00900	0.0011	mg/Kg wet	0.0113		79.4		70-130			V-05	
1,1,1-Trichloroethane	0.0121	0.0011	mg/Kg wet	0.0113		107		70-130				
1,1,2-Trichloroethane	0.0125	0.0011	mg/Kg wet	0.0113		111		70-130				
Trichloroethylene	0.0127	0.0011	mg/Kg wet	0.0113		112		70-130				
Trichlorofluoromethane (Freon 11)	0.0105	0.0023	mg/Kg wet	0.0113		92.3		70-130				
1,2,3-Trichloropropane	0.0123	0.0023	mg/Kg wet	0.0113		108		70-130				
1,2,4-Trimethylbenzene	0.0112	0.0011	mg/Kg wet	0.0113		98.8		70-130				
1,3,5-Trimethylbenzene	0.0114	0.0011	mg/Kg wet	0.0113		100		70-130				
Vinyl Chloride	0.0114	0.0023	mg/Kg wet	0.0113		100		70-130				
m+p Xylene	0.0234	0.0023	mg/Kg wet	0.0227		103		70-130				
o-Xylene	0.0116	0.0011	mg/Kg wet	0.0113		103		70-130				
Surrogate: 1,2-Dichloroethane-d4	*0.0260*		mg/Kg wet	0.0283		91.9		70-130				
Surrogate: Toluene-d8	*0.0277*		mg/Kg wet	0.0283		97.8		70-130				
Surrogate: 4-Bromofluorobenzene	*0.0278*		mg/Kg wet	0.0283		98.1		70-130				
LCS Dup (B310614-BSD1)				Prepared & Analyzed: 06/14/22								
Acetone	0.0958	0.057	mg/Kg wet	0.113		84.6		40-160	1.96	20		†
tert-Amyl Methyl Ether (TAME)	0.0112	0.00057	mg/Kg wet	0.0113		98.6		70-130	7.89	20		
Benzene	0.0113	0.0011	mg/Kg wet	0.0113		99.5		70-130	0.807	20		
Bromobenzene	0.0120	0.0011	mg/Kg wet	0.0113		106		70-130	1.33	20		
Bromochloromethane	0.0128	0.0011	mg/Kg wet	0.0113		113		70-130	1.49	20		
Bromodichloromethane	0.0122	0.0011	mg/Kg wet	0.0113		108		70-130	1.49	20		
Bromoform	0.0112	0.0011	mg/Kg wet	0.0113		99.1		70-130	3.70	20		
Bromomethane	0.0186	0.0023	mg/Kg wet	0.0113		**164**	*	40-160	8.70	20	L-07, V-20, V-34	†
2-Butanone (MEK)	0.0957	0.023	mg/Kg wet	0.113		84.5		40-160	2.27	20		†
n-Butylbenzene	0.0107	0.0011	mg/Kg wet	0.0113		94.2		70-130	0.106	20		
sec-Butylbenzene	0.0112	0.0011	mg/Kg wet	0.0113		99.2		70-130	1.52	20		
tert-Butylbenzene	0.0122	0.0011	mg/Kg wet	0.0113		108		70-130	0.465	20		
tert-Butyl Ethyl Ether (TBEE)	0.0113	0.00057	mg/Kg wet	0.0113		100		70-130	2.96	20		
Carbon Disulfide	0.120	0.011	mg/Kg wet	0.113		106		70-130	0.788	20		
Carbon Tetrachloride	0.0117	0.0011	mg/Kg wet	0.0113		103		70-130	0.484	20		
Chlorobenzene	0.0120	0.0011	mg/Kg wet	0.0113		106		70-130	3.17	20		
Chlorodibromomethane	0.0115	0.00057	mg/Kg wet	0.0113		102		70-130	0.492	20		
Chloroethane	0.0118	0.0023	mg/Kg wet	0.0113		104		70-130	1.36	20		
Chloroform	0.0119	0.0023	mg/Kg wet	0.0113		105		70-130	1.51	20		
Chloromethane	0.00464	0.0023	mg/Kg wet	0.0113		40.9		40-160	1.70	20	L-14, V-05, V-34	†
2-Chlorotoluene	0.0114	0.0011	mg/Kg wet	0.0113		101		70-130	0.987	20		
4-Chlorotoluene	0.0116	0.0011	mg/Kg wet	0.0113		103		70-130	0.881	20		
1,2-Dibromo-3-chloropropane (DBCP)	0.00947	0.0045	mg/Kg wet	0.0113		83.6		70-130	3.16	20	V-05	
1,2-Dibromoethane (EDB)	0.0124	0.00057	mg/Kg wet	0.0113		109		70-130	0.457	20		
Dibromomethane	0.0118	0.0011	mg/Kg wet	0.0113		104		70-130	2.84	20		
1,2-Dichlorobenzene	0.0106	0.0011	mg/Kg wet	0.0113		93.3		70-130	2.33	20		
1,3-Dichlorobenzene	0.0109	0.0011	mg/Kg wet	0.0113		96.3		70-130	1.55	20		
1,4-Dichlorobenzene	0.0109	0.0011	mg/Kg wet	0.0113		96.5		70-130	3.16	20		

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QUALITY CONTROL

Volatile Organic Compounds by GC/MS - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC		%REC Limits	RPD	RPD Limit	Notes	
Batch B310614 - SW-846 5035												
LCS Dup (B310614-BSD1)				Prepared & Analyzed: 06/14/22								
Dichlorodifluoromethane (Freon 12)	0.0116	0.0023	mg/Kg wet	0.0113		103		40-160	0.0975	20		†
1,1-Dichloroethane	0.0119	0.0011	mg/Kg wet	0.0113		105		70-130	0.473	20		
1,2-Dichloroethane	0.0121	0.0011	mg/Kg wet	0.0113		107		70-130	2.49	20		
1,1-Dichloroethylene	0.0120	0.0011	mg/Kg wet	0.0113		106		70-130	0.0942	20		
cis-1,2-Dichloroethylene	0.0120	0.0011	mg/Kg wet	0.0113		106		70-130	0.284	20		
trans-1,2-Dichloroethylene	0.0127	0.0011	mg/Kg wet	0.0113		112		70-130	1.81	20		
1,2-Dichloropropane	0.0123	0.0011	mg/Kg wet	0.0113		109		70-130	3.18	20		
1,3-Dichloropropane	0.0120	0.00057	mg/Kg wet	0.0113		106		70-130	0.473	20		
2,2-Dichloropropane	0.0113	0.0011	mg/Kg wet	0.0113		99.9		70-130	0.502	20		
1,1-Dichloropropene	0.0121	0.0023	mg/Kg wet	0.0113		107		70-130	0.938	20		
cis-1,3-Dichloropropene	0.0114	0.00057	mg/Kg wet	0.0113		100		70-130	2.63	20		
trans-1,3-Dichloropropene	0.0111	0.00057	mg/Kg wet	0.0113		97.8		70-130	1.65	20		
Diethyl Ether	0.0108	0.0023	mg/Kg wet	0.0113		95.1		70-130	0.211	20		
Diisopropyl Ether (DIPE)	0.0111	0.00057	mg/Kg wet	0.0113		97.9		70-130	2.62	20		
1,4-Dioxane	0.0944	0.057	mg/Kg wet	0.113		83.3		40-160	8.30	20		†
Ethylbenzene	0.0117	0.0011	mg/Kg wet	0.0113		103		70-130	2.45	20		
Hexachlorobutadiene	0.00925	0.0011	mg/Kg wet	0.0113		81.6		70-130	2.86	20	V-05	
2-Hexanone (MBK)	0.107	0.011	mg/Kg wet	0.113		94.8		40-160	0.773	20		†
Isopropylbenzene (Cumene)	0.0118	0.0011	mg/Kg wet	0.0113		104		70-130	2.93	20		
p-Isopropyltoluene (p-Cymene)	0.0118	0.0011	mg/Kg wet	0.0113		104		70-130	2.57	20		
Methyl tert-Butyl Ether (MTBE)	0.0116	0.0011	mg/Kg wet	0.0113		102		70-130	2.79	20		
Methylene Chloride	0.0115	0.0057	mg/Kg wet	0.0113		101		70-130	2.54	20		
4-Methyl-2-pentanone (MIBK)	0.112	0.011	mg/Kg wet	0.113		98.7		40-160	1.99	20		†
Naphthalene	0.00745	0.0023	mg/Kg wet	0.0113		**65.7**	*	70-130	2.70	20	L-04, V-05	
n-Propylbenzene	0.0116	0.0011	mg/Kg wet	0.0113		102		70-130	1.08	20		
Styrene	0.0115	0.0011	mg/Kg wet	0.0113		102		70-130	0.295	20		
1,1,1,2-Tetrachloroethane	0.0125	0.0011	mg/Kg wet	0.0113		111		70-130	1.46	20		
1,1,2,2-Tetrachloroethane	0.0117	0.00057	mg/Kg wet	0.0113		103		70-130	3.54	20		
Tetrachloroethylene	0.0120	0.0011	mg/Kg wet	0.0113		106		70-130	4.46	20		
Tetrahydrofuran	0.0105	0.0045	mg/Kg wet	0.0113		92.8		70-130	5.65	20		
Toluene	0.0117	0.0011	mg/Kg wet	0.0113		103		70-130	4.86	20		
1,2,3-Trichlorobenzene	0.00719	0.0045	mg/Kg wet	0.0113		**63.4**	*	70-130	6.41	20	L-04, V-05	
1,2,4-Trichlorobenzene	0.00883	0.0011	mg/Kg wet	0.0113		77.9		70-130	1.91	20	V-05	
1,1,1-Trichloroethane	0.0124	0.0011	mg/Kg wet	0.0113		110		70-130	2.68	20		
1,1,2-Trichloroethane	0.0123	0.0011	mg/Kg wet	0.0113		109		70-130	2.01	20		
Trichloroethylene	0.0133	0.0011	mg/Kg wet	0.0113		118		70-130	4.78	20		
Trichlorofluoromethane (Freon 11)	0.0115	0.0023	mg/Kg wet	0.0113		102		70-130	9.49	20		
1,2,3-Trichloropropane	0.0124	0.0023	mg/Kg wet	0.0113		109		70-130	0.735	20		
1,2,4-Trimethylbenzene	0.0112	0.0011	mg/Kg wet	0.0113		99.1		70-130	0.303	20		
1,3,5-Trimethylbenzene	0.0115	0.0011	mg/Kg wet	0.0113		101		70-130	0.992	20		
Vinyl Chloride	0.0115	0.0023	mg/Kg wet	0.0113		102		70-130	1.48	20		
m+p Xylene	0.0240	0.0023	mg/Kg wet	0.0227		106		70-130	2.59	20		
o-Xylene	0.0117	0.0011	mg/Kg wet	0.0113		104		70-130	1.07	20		
Surrogate: 1,2-Dichloroethane-d4	*0.0257*		mg/Kg wet	0.0283		90.8		70-130				
Surrogate: Toluene-d8	*0.0284*		mg/Kg wet	0.0283		100		70-130				
Surrogate: 4-Bromofluorobenzene	*0.0284*		mg/Kg wet	0.0283		100		70-130				

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QUALITY CONTROL

Semivolatile Organic Compounds by GC/MS - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B310808 - SW-846 3546										
Blank (B310808-BLK1)				Prepared: 06/15/22 Analyzed: 06/17/22						
Acenaphthene	ND	0.17	mg/Kg wet							
Acenaphthylene	ND	0.17	mg/Kg wet							
Anthracene	ND	0.17	mg/Kg wet							
Benzo(a)anthracene	ND	0.17	mg/Kg wet							
Benzo(a)pyrene	ND	0.17	mg/Kg wet							
Benzo(b)fluoranthene	ND	0.17	mg/Kg wet							
Benzo(g,h,i)perylene	ND	0.17	mg/Kg wet							
Benzo(k)fluoranthene	ND	0.17	mg/Kg wet							
Chrysene	ND	0.17	mg/Kg wet							
Dibenz(a,h)anthracene	ND	0.17	mg/Kg wet							
Fluoranthene	ND	0.17	mg/Kg wet							
Fluorene	ND	0.17	mg/Kg wet							
Indeno(1,2,3-cd)pyrene	ND	0.17	mg/Kg wet							
2-Methylnaphthalene	ND	0.17	mg/Kg wet							
Naphthalene	ND	0.17	mg/Kg wet							
Phenanthrene	ND	0.17	mg/Kg wet							
Pyrene	ND	0.17	mg/Kg wet							
Surrogate: Nitrobenzene-d5	*3.15*		mg/Kg wet	3.33		94.6	30-130			
Surrogate: 2-Fluorobiphenyl	*2.59*		mg/Kg wet	3.33		77.8	30-130			
Surrogate: p-Terphenyl-d14	*2.86*		mg/Kg wet	3.33		85.7	30-130			
LCS (B310808-BS1)				Prepared: 06/15/22 Analyzed: 06/17/22						
Acenaphthene	1.15	0.17	mg/Kg wet	1.67		68.8	40-140			
Acenaphthylene	1.20	0.17	mg/Kg wet	1.67		71.8	40-140			
Anthracene	1.27	0.17	mg/Kg wet	1.67		76.2	40-140			
Benzo(a)anthracene	1.29	0.17	mg/Kg wet	1.67		77.2	40-140			
Benzo(a)pyrene	1.20	0.17	mg/Kg wet	1.67		72.0	40-140			
Benzo(b)fluoranthene	1.25	0.17	mg/Kg wet	1.67		75.1	40-140			
Benzo(g,h,i)perylene	1.22	0.17	mg/Kg wet	1.67		73.2	40-140			
Benzo(k)fluoranthene	1.31	0.17	mg/Kg wet	1.67		78.7	40-140			
Chrysene	1.24	0.17	mg/Kg wet	1.67		74.7	40-140			
Dibenz(a,h)anthracene	1.24	0.17	mg/Kg wet	1.67		74.3	40-140			
Fluoranthene	1.23	0.17	mg/Kg wet	1.67		73.8	40-140			
Fluorene	1.23	0.17	mg/Kg wet	1.67		73.6	40-140			
Indeno(1,2,3-cd)pyrene	1.21	0.17	mg/Kg wet	1.67		72.7	40-140			
2-Methylnaphthalene	1.24	0.17	mg/Kg wet	1.67		74.7	40-140			
Naphthalene	1.14	0.17	mg/Kg wet	1.67		68.4	40-140			
Phenanthrene	1.27	0.17	mg/Kg wet	1.67		76.0	40-140			
Pyrene	1.28	0.17	mg/Kg wet	1.67		76.6	40-140			
Surrogate: Nitrobenzene-d5	*3.28*		mg/Kg wet	3.33		98.5	30-130			
Surrogate: 2-Fluorobiphenyl	*2.70*		mg/Kg wet	3.33		81.0	30-130			
Surrogate: p-Terphenyl-d14	*2.83*		mg/Kg wet	3.33		84.8	30-130			

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QUALITY CONTROL

Semivolatile Organic Compounds by GC/MS - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B310808 - SW-846 3546										
LCS Dup (B310808-BSD1)				Prepared: 06/15/22 Analyzed: 06/17/22						
Acenaphthene	1.13	0.17	mg/Kg wet	1.67		67.8	40-140	1.58	30	
Acenaphthylene	1.21	0.17	mg/Kg wet	1.67		72.4	40-140	0.860	30	
Anthracene	1.27	0.17	mg/Kg wet	1.67		76.1	40-140	0.158	30	
Benzo(a)anthracene	1.26	0.17	mg/Kg wet	1.67		75.7	40-140	1.88	30	
Benzo(a)pyrene	1.18	0.17	mg/Kg wet	1.67		70.5	40-140	2.02	30	
Benzo(b)fluoranthene	1.24	0.17	mg/Kg wet	1.67		74.5	40-140	0.775	30	
Benzo(g,h,i)perylene	1.23	0.17	mg/Kg wet	1.67		73.7	40-140	0.735	30	
Benzo(k)fluoranthene	1.29	0.17	mg/Kg wet	1.67		77.6	40-140	1.46	30	
Chrysene	1.24	0.17	mg/Kg wet	1.67		74.1	40-140	0.753	30	
Dibenz(a,h)anthracene	1.24	0.17	mg/Kg wet	1.67		74.7	40-140	0.537	30	
Fluoranthene	1.25	0.17	mg/Kg wet	1.67		75.0	40-140	1.67	30	
Fluorene	1.23	0.17	mg/Kg wet	1.67		74.0	40-140	0.515	30	
Indeno(1,2,3-cd)pyrene	1.30	0.17	mg/Kg wet	1.67		78.2	40-140	7.29	30	
2-Methylnaphthalene	1.24	0.17	mg/Kg wet	1.67		74.4	40-140	0.429	30	
Naphthalene	1.11	0.17	mg/Kg wet	1.67		66.9	40-140	2.34	30	
Phenanthrene	1.26	0.17	mg/Kg wet	1.67		75.5	40-140	0.687	30	
Pyrene	1.27	0.17	mg/Kg wet	1.67		76.2	40-140	0.497	30	
Surrogate: Nitrobenzene-d5	*3.13*		mg/Kg wet	3.33		94.0	30-130			
Surrogate: 2-Fluorobiphenyl	*2.73*		mg/Kg wet	3.33		81.8	30-130			
Surrogate: p-Terphenyl-d14	*2.81*		mg/Kg wet	3.33		84.2	30-130			
Batch B311045 - SW-846 3546										
Blank (B311045-BLK1)				Prepared: 06/17/22 Analyzed: 06/20/22						
Acenaphthene	ND	0.17	mg/Kg wet							
Acenaphthylene	ND	0.17	mg/Kg wet							
Anthracene	ND	0.17	mg/Kg wet							
Benzo(a)anthracene	ND	0.17	mg/Kg wet							
Benzo(a)pyrene	ND	0.17	mg/Kg wet							
Benzo(b)fluoranthene	ND	0.17	mg/Kg wet							
Benzo(g,h,i)perylene	ND	0.17	mg/Kg wet							
Benzo(k)fluoranthene	ND	0.17	mg/Kg wet							
Chrysene	ND	0.17	mg/Kg wet							
Dibenz(a,h)anthracene	ND	0.17	mg/Kg wet							
Fluoranthene	ND	0.17	mg/Kg wet							
Fluorene	ND	0.17	mg/Kg wet							
Indeno(1,2,3-cd)pyrene	ND	0.17	mg/Kg wet							
2-Methylnaphthalene	ND	0.17	mg/Kg wet							
Naphthalene	ND	0.17	mg/Kg wet							
Phenanthrene	ND	0.17	mg/Kg wet							
Pyrene	ND	0.17	mg/Kg wet							
Surrogate: Nitrobenzene-d5	*3.31*		mg/Kg wet	3.33		99.3	30-130			
Surrogate: 2-Fluorobiphenyl	*2.64*		mg/Kg wet	3.33		79.1	30-130			
Surrogate: p-Terphenyl-d14	*2.87*		mg/Kg wet	3.33		86.1	30-130			

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QUALITY CONTROL

Semivolatile Organic Compounds by GC/MS - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B311045 - SW-846 3546										
LCS (B311045-BS1)				Prepared: 06/17/22 Analyzed: 06/20/22						
Acenaphthene	1.18	0.17	mg/Kg wet	1.67		70.9	40-140			
Acenaphthylene	1.19	0.17	mg/Kg wet	1.67		71.6	40-140			
Anthracene	1.37	0.17	mg/Kg wet	1.67		82.0	40-140			
Benzo(a)anthracene	1.35	0.17	mg/Kg wet	1.67		80.7	40-140			
Benzo(a)pyrene	1.24	0.17	mg/Kg wet	1.67		74.3	40-140			
Benzo(b)fluoranthene	1.33	0.17	mg/Kg wet	1.67		79.7	40-140			
Benzo(g,h,i)perylene	1.28	0.17	mg/Kg wet	1.67		76.7	40-140			
Benzo(k)fluoranthene	1.38	0.17	mg/Kg wet	1.67		82.7	40-140			
Chrysene	1.28	0.17	mg/Kg wet	1.67		76.8	40-140			
Dibenz(a,h)anthracene	1.32	0.17	mg/Kg wet	1.67		78.9	40-140			
Fluoranthene	1.35	0.17	mg/Kg wet	1.67		81.2	40-140			
Fluorene	1.29	0.17	mg/Kg wet	1.67		77.5	40-140			
Indeno(1,2,3-cd)pyrene	1.46	0.17	mg/Kg wet	1.67		87.7	40-140			
2-Methylnaphthalene	1.27	0.17	mg/Kg wet	1.67		76.4	40-140			
Naphthalene	1.20	0.17	mg/Kg wet	1.67		72.1	40-140			
Phenanthrene	1.35	0.17	mg/Kg wet	1.67		80.9	40-140			
Pyrene	1.32	0.17	mg/Kg wet	1.67		79.4	40-140			
Surrogate: Nitrobenzene-d5	*3.38*		mg/Kg wet	3.33		102	30-130			
Surrogate: 2-Fluorobiphenyl	*2.72*		mg/Kg wet	3.33		81.7	30-130			
Surrogate: p-Terphenyl-d14	*2.81*		mg/Kg wet	3.33		84.2	30-130			
LCS Dup (B311045-BSD1)				Prepared: 06/17/22 Analyzed: 06/20/22						
Acenaphthene	1.23	0.17	mg/Kg wet	1.67		73.9	40-140	4.14	30	
Acenaphthylene	1.30	0.17	mg/Kg wet	1.67		77.8	40-140	8.33	30	
Anthracene	1.36	0.17	mg/Kg wet	1.67		81.7	40-140	0.293	30	
Benzo(a)anthracene	1.38	0.17	mg/Kg wet	1.67		82.8	40-140	2.52	30	
Benzo(a)pyrene	1.29	0.17	mg/Kg wet	1.67		77.5	40-140	4.22	30	
Benzo(b)fluoranthene	1.32	0.17	mg/Kg wet	1.67		79.3	40-140	0.528	30	
Benzo(g,h,i)perylene	1.26	0.17	mg/Kg wet	1.67		75.8	40-140	1.26	30	
Benzo(k)fluoranthene	1.40	0.17	mg/Kg wet	1.67		84.0	40-140	1.54	30	
Chrysene	1.35	0.17	mg/Kg wet	1.67		80.8	40-140	5.05	30	
Dibenz(a,h)anthracene	1.32	0.17	mg/Kg wet	1.67		79.2	40-140	0.329	30	
Fluoranthene	1.42	0.17	mg/Kg wet	1.67		84.9	40-140	4.55	30	
Fluorene	1.32	0.17	mg/Kg wet	1.67		79.3	40-140	2.29	30	
Indeno(1,2,3-cd)pyrene	1.38	0.17	mg/Kg wet	1.67		82.7	40-140	5.87	30	
2-Methylnaphthalene	1.36	0.17	mg/Kg wet	1.67		81.3	40-140	6.27	30	
Naphthalene	1.27	0.17	mg/Kg wet	1.67		75.9	40-140	5.19	30	
Phenanthrene	1.34	0.17	mg/Kg wet	1.67		80.4	40-140	0.595	30	
Pyrene	1.36	0.17	mg/Kg wet	1.67		81.3	40-140	2.36	30	
Surrogate: Nitrobenzene-d5	*3.57*		mg/Kg wet	3.33		107	30-130			
Surrogate: 2-Fluorobiphenyl	*2.84*		mg/Kg wet	3.33		85.1	30-130			
Surrogate: p-Terphenyl-d14	*2.91*		mg/Kg wet	3.33		87.3	30-130			

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QUALITY CONTROL

Polychlorinated Biphenyls By GC/ECD - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B310797 - SW-846 3546										
Blank (B310797-BLK1)				Prepared: 06/15/22 Analyzed: 06/16/22						
Aroclor-1016	ND	0.020	mg/Kg wet							
Aroclor-1016 [2C]	ND	0.020	mg/Kg wet							
Aroclor-1221	ND	0.020	mg/Kg wet							
Aroclor-1221 [2C]	ND	0.020	mg/Kg wet							
Aroclor-1232	ND	0.020	mg/Kg wet							
Aroclor-1232 [2C]	ND	0.020	mg/Kg wet							
Aroclor-1242	ND	0.020	mg/Kg wet							
Aroclor-1242 [2C]	ND	0.020	mg/Kg wet							
Aroclor-1248	ND	0.020	mg/Kg wet							
Aroclor-1248 [2C]	ND	0.020	mg/Kg wet							
Aroclor-1254	ND	0.020	mg/Kg wet							
Aroclor-1254 [2C]	ND	0.020	mg/Kg wet							
Aroclor-1260	ND	0.020	mg/Kg wet							
Aroclor-1260 [2C]	ND	0.020	mg/Kg wet							
Aroclor-1262	ND	0.020	mg/Kg wet							
Aroclor-1262 [2C]	ND	0.020	mg/Kg wet							
Aroclor-1268	ND	0.020	mg/Kg wet							
Aroclor-1268 [2C]	ND	0.020	mg/Kg wet							
Surrogate: Decachlorobiphenyl	*0.196*		mg/Kg wet	0.200		98.1	30-150			
Surrogate: Decachlorobiphenyl [2C]	*0.207*		mg/Kg wet	0.200		103	30-150			
Surrogate: Tetrachloro-m-xylene	*0.187*		mg/Kg wet	0.200		93.7	30-150			
Surrogate: Tetrachloro-m-xylene [2C]	*0.186*		mg/Kg wet	0.200		93.1	30-150			
LCS (B310797-BS1)				Prepared: 06/15/22 Analyzed: 06/16/22						
Aroclor-1016	0.16	0.020	mg/Kg wet	0.200		82.4	40-140			
Aroclor-1016 [2C]	0.17	0.020	mg/Kg wet	0.200		82.7	40-140			
Aroclor-1260	0.16	0.020	mg/Kg wet	0.200		78.3	40-140			
Aroclor-1260 [2C]	0.16	0.020	mg/Kg wet	0.200		80.2	40-140			
Surrogate: Decachlorobiphenyl	*0.192*		mg/Kg wet	0.200		95.9	30-150			
Surrogate: Decachlorobiphenyl [2C]	*0.202*		mg/Kg wet	0.200		101	30-150			
Surrogate: Tetrachloro-m-xylene	*0.182*		mg/Kg wet	0.200		91.0	30-150			
Surrogate: Tetrachloro-m-xylene [2C]	*0.180*		mg/Kg wet	0.200		89.8	30-150			
LCS Dup (B310797-BSD1)				Prepared: 06/15/22 Analyzed: 06/16/22						
Aroclor-1016	0.17	0.020	mg/Kg wet	0.200		84.1	40-140	2.01	30	
Aroclor-1016 [2C]	0.17	0.020	mg/Kg wet	0.200		84.2	40-140	1.81	30	
Aroclor-1260	0.16	0.020	mg/Kg wet	0.200		78.3	40-140	0.0230	30	
Aroclor-1260 [2C]	0.16	0.020	mg/Kg wet	0.200		80.4	40-140	0.319	30	
Surrogate: Decachlorobiphenyl	*0.189*		mg/Kg wet	0.200		94.6	30-150			
Surrogate: Decachlorobiphenyl [2C]	*0.199*		mg/Kg wet	0.200		99.7	30-150			
Surrogate: Tetrachloro-m-xylene	*0.183*		mg/Kg wet	0.200		91.7	30-150			
Surrogate: Tetrachloro-m-xylene [2C]	*0.182*		mg/Kg wet	0.200		90.9	30-150			

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QUALITY CONTROL

Petroleum Hydrocarbons Analyses - EPH - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B310786 - SW-846 3546										
Blank (B310786-BLK1)				Prepared: 06/15/22 Analyzed: 06/17/22						
C9-C18 Aliphatics	ND	10	mg/Kg wet							
C19-C36 Aliphatics	ND	10	mg/Kg wet							
Unadjusted C11-C22 Aromatics	ND	10	mg/Kg wet							
C11-C22 Aromatics	ND	10	mg/Kg wet							
Acenaphthene	ND	0.10	mg/Kg wet							
Acenaphthylene	ND	0.10	mg/Kg wet							
Anthracene	ND	0.10	mg/Kg wet							
Benzo(a)anthracene	ND	0.10	mg/Kg wet							
Benzo(a)pyrene	ND	0.10	mg/Kg wet							
Benzo(b)fluoranthene	ND	0.10	mg/Kg wet							
Benzo(g,h,i)perylene	ND	0.10	mg/Kg wet							
Benzo(k)fluoranthene	ND	0.10	mg/Kg wet							
Chrysene	ND	0.10	mg/Kg wet							
Dibenz(a,h)anthracene	ND	0.10	mg/Kg wet							
Fluoranthene	ND	0.10	mg/Kg wet							
Fluorene	ND	0.10	mg/Kg wet							
Indeno(1,2,3-cd)pyrene	ND	0.10	mg/Kg wet							
2-Methylnaphthalene	ND	0.10	mg/Kg wet							
Naphthalene	ND	0.10	mg/Kg wet							
Phenanthrene	ND	0.10	mg/Kg wet							
Pyrene	ND	0.10	mg/Kg wet							
Naphthalene-aliphatic fraction	ND	0.10	mg/Kg wet							
2-Methylnaphthalene-aliphatic fraction	ND	0.10	mg/Kg wet							
Surrogate: Chlorooctadecane (COD)	*4.28*		mg/Kg wet	5.00		85.5	40-140			
Surrogate: o-Terphenyl (OTP)	*4.26*		mg/Kg wet	5.00		85.1	40-140			
Surrogate: 2-Bromonaphthalene	*4.03*		mg/Kg wet	5.00		80.6	40-140			
Surrogate: 2-Fluorobiphenyl	*3.92*		mg/Kg wet	5.00		78.4	40-140			
LCS (B310786-BS1)				Prepared: 06/15/22 Analyzed: 06/17/22						
C9-C18 Aliphatics	30.5	10	mg/Kg wet	30.0		102	40-140			
C19-C36 Aliphatics	45.4	10	mg/Kg wet	40.0		114	40-140			
Unadjusted C11-C22 Aromatics	97.4	10	mg/Kg wet	85.0		115	40-140			
Acenaphthene	4.93	0.10	mg/Kg wet	5.00		98.5	40-140			
Acenaphthylene	4.57	0.10	mg/Kg wet	5.00		91.4	40-140			
Anthracene	5.35	0.10	mg/Kg wet	5.00		107	40-140			
Benzo(a)anthracene	5.75	0.10	mg/Kg wet	5.00		115	40-140			
Benzo(a)pyrene	5.35	0.10	mg/Kg wet	5.00		107	40-140			
Benzo(b)fluoranthene	5.24	0.10	mg/Kg wet	5.00		105	40-140			
Benzo(g,h,i)perylene	4.82	0.10	mg/Kg wet	5.00		96.5	40-140			
Benzo(k)fluoranthene	5.68	0.10	mg/Kg wet	5.00		114	40-140			
Chrysene	5.47	0.10	mg/Kg wet	5.00		109	40-140			
Dibenz(a,h)anthracene	4.91	0.10	mg/Kg wet	5.00		98.2	40-140			
Fluoranthene	5.37	0.10	mg/Kg wet	5.00		107	40-140			
Fluorene	5.25	0.10	mg/Kg wet	5.00		105	40-140			
Indeno(1,2,3-cd)pyrene	5.04	0.10	mg/Kg wet	5.00		101	40-140			
2-Methylnaphthalene	4.57	0.10	mg/Kg wet	5.00		91.4	40-140			
Naphthalene	4.21	0.10	mg/Kg wet	5.00		84.2	40-140			
Phenanthrene	5.37	0.10	mg/Kg wet	5.00		107	40-140			
Pyrene	5.45	0.10	mg/Kg wet	5.00		109	40-140			
Naphthalene-aliphatic fraction	ND	0.10	mg/Kg wet	5.00			0-5			
2-Methylnaphthalene-aliphatic fraction	ND	0.10	mg/Kg wet	5.00			0-5			
Surrogate: Chlorooctadecane (COD)	*4.57*		mg/Kg wet	5.00		91.4	40-140			

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QUALITY CONTROL

Petroleum Hydrocarbons Analyses - EPH - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B310786 - SW-846 3546										
LCS (B310786-BS1)				Prepared: 06/15/22 Analyzed: 06/17/22						
Surrogate: o-Terphenyl (OTP)	*4.32*		mg/Kg wet	5.00		86.3	40-140			
Surrogate: 2-Bromonaphthalene	*4.31*		mg/Kg wet	5.00		86.1	40-140			
Surrogate: 2-Fluorobiphenyl	*4.37*		mg/Kg wet	5.00		87.3	40-140			
LCS Dup (B310786-BSD1)				Prepared: 06/15/22 Analyzed: 06/17/22						
C9-C18 Aliphatics	28.3	10	mg/Kg wet	30.0		94.2	40-140	7.58	25	
C19-C36 Aliphatics	41.0	10	mg/Kg wet	40.0		102	40-140	10.3	25	
Unadjusted C11-C22 Aromatics	84.6	10	mg/Kg wet	85.0		99.5	40-140	14.1	25	
Acenaphthene	4.53	0.10	mg/Kg wet	5.00		90.5	40-140	8.47	25	
Acenaphthylene	4.19	0.10	mg/Kg wet	5.00		83.9	40-140	8.64	25	
Anthracene	4.76	0.10	mg/Kg wet	5.00		95.1	40-140	11.7	25	
Benzo(a)anthracene	5.06	0.10	mg/Kg wet	5.00		101	40-140	12.7	25	
Benzo(a)pyrene	4.70	0.10	mg/Kg wet	5.00		94.0	40-140	12.9	25	
Benzo(b)fluoranthene	4.60	0.10	mg/Kg wet	5.00		91.9	40-140	13.1	25	
Benzo(g,h,i)perylene	4.23	0.10	mg/Kg wet	5.00		84.5	40-140	13.2	25	
Benzo(k)fluoranthene	4.83	0.10	mg/Kg wet	5.00		96.6	40-140	16.3	25	
Chrysene	4.82	0.10	mg/Kg wet	5.00		96.4	40-140	12.6	25	
Dibenz(a,h)anthracene	4.39	0.10	mg/Kg wet	5.00		87.9	40-140	11.1	25	
Fluoranthene	4.76	0.10	mg/Kg wet	5.00		95.2	40-140	12.0	25	
Fluorene	4.75	0.10	mg/Kg wet	5.00		95.0	40-140	10.0	25	
Indeno(1,2,3-cd)pyrene	4.44	0.10	mg/Kg wet	5.00		88.7	40-140	12.6	25	
2-Methylnaphthalene	4.13	0.10	mg/Kg wet	5.00		82.7	40-140	10.1	25	
Naphthalene	3.87	0.10	mg/Kg wet	5.00		77.4	40-140	8.43	25	
Phenanthrene	4.78	0.10	mg/Kg wet	5.00		95.6	40-140	11.6	25	
Pyrene	4.84	0.10	mg/Kg wet	5.00		96.7	40-140	11.9	25	
Naphthalene-aliphatic fraction	ND	0.10	mg/Kg wet	5.00			0-5			
2-Methylnaphthalene-aliphatic fraction	ND	0.10	mg/Kg wet	5.00			0-5			
Surrogate: Chlorooctadecane (COD)	*4.37*		mg/Kg wet	5.00		87.4	40-140			
Surrogate: o-Terphenyl (OTP)	*4.12*		mg/Kg wet	5.00		82.5	40-140			
Surrogate: 2-Bromonaphthalene	*4.72*		mg/Kg wet	5.00		94.5	40-140			
Surrogate: 2-Fluorobiphenyl	*4.77*		mg/Kg wet	5.00		95.4	40-140			

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QUALITY CONTROL

Metals Analyses (Total) - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B310537 - SW-846 3050B										
Blank (B310537-BLK1)				Prepared: 06/13/22 Analyzed: 06/15/22						
Antimony	ND	1.7	mg/Kg wet							
Arsenic	ND	3.3	mg/Kg wet							
Barium	ND	1.7	mg/Kg wet							
Beryllium	ND	0.17	mg/Kg wet							
Cadmium	ND	0.33	mg/Kg wet							
Chromium	ND	0.67	mg/Kg wet							
Copper	ND	0.67	mg/Kg wet							
Lead	ND	0.50	mg/Kg wet							
Nickel	ND	0.67	mg/Kg wet							
Selenium	ND	3.3	mg/Kg wet							
Silver	ND	0.33	mg/Kg wet							
Thallium	ND	1.7	mg/Kg wet							
Vanadium	ND	0.67	mg/Kg wet							
Zinc	ND	0.67	mg/Kg wet							
LCS (B310537-BS1)				Prepared: 06/13/22 Analyzed: 06/15/22						
Antimony	58.8	5.0	mg/Kg wet	129		45.6	0.6-199.2			
Arsenic	80.1	10	mg/Kg wet	84.5		94.8	82.8-117.2			
Barium	249	5.0	mg/Kg wet	249		100	82.7-117.3			
Beryllium	172	0.50	mg/Kg wet	163		105	82.8-117.2			
Cadmium	96.7	1.0	mg/Kg wet	99.0		97.7	83-117.2			
Chromium	122	2.0	mg/Kg wet	122		99.9	82.8-118			
Copper	61.7	2.0	mg/Kg wet	61.5		100	84.4-115.4			
Lead	116	1.5	mg/Kg wet	123		94.0	83.7-117.1			
Nickel	134	2.0	mg/Kg wet	135		99.2	83-117			
Selenium	113	10	mg/Kg wet	121		93.6	80.1-120.7			
Silver	39.8	1.0	mg/Kg wet	44.1		90.4	80.5-119.7			
Thallium	131	5.0	mg/Kg wet	144		91.2	81.3-118.8			
Vanadium	182	2.0	mg/Kg wet	186		97.8	79.6-120.4			
Zinc	292	2.0	mg/Kg wet	295		99.0	81.4-119			
LCS Dup (B310537-BSD1)				Prepared: 06/13/22 Analyzed: 06/15/22						
Antimony	48.3	5.0	mg/Kg wet	129		37.4	0.6-199.2	19.7	30	
Arsenic	71.1	10	mg/Kg wet	84.5		84.1	82.8-117.2	11.9	30	
Barium	223	5.0	mg/Kg wet	249		89.4	82.7-117.3	11.2	20	
Beryllium	147	0.50	mg/Kg wet	163		90.5	82.8-117.2	15.1	30	
Cadmium	86.2	1.0	mg/Kg wet	99.0		87.1	83-117.2	11.5	20	
Chromium	106	2.0	mg/Kg wet	122		86.8	82.8-118	14.0	30	
Copper	54.3	2.0	mg/Kg wet	61.5		88.4	84.4-115.4	12.7	30	
Lead	104	1.5	mg/Kg wet	123		84.8	83.7-117.1	10.2	30	
Nickel	117	2.0	mg/Kg wet	135		86.7	83-117	13.5	30	
Selenium	102	10	mg/Kg wet	121		84.5	80.1-120.7	10.2	30	
Silver	36.1	1.0	mg/Kg wet	44.1		81.8	80.5-119.7	9.90	30	
Thallium	122	5.0	mg/Kg wet	144		84.8	81.3-118.8	7.25	30	
Vanadium	160	2.0	mg/Kg wet	186		86.2	79.6-120.4	12.6	30	
Zinc	255	2.0	mg/Kg wet	295		86.5	81.4-119	13.5	30	

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QUALITY CONTROL

Metals Analyses (Total) - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC		%REC Limits	RPD	RPD Limit	Notes
Batch B310537 - SW-846 3050B											
Reference (B310537-SRM1) MRL CHECK				Prepared: 06/13/22 Analyzed: 06/16/22							
Lead	0.620	0.50	mg/Kg wet	0.496		**125**	*	80-120			M-10
Batch B310691 - SW-846 7471											
Blank (B310691-BLK1)				Prepared: 06/14/22 Analyzed: 06/15/22							
Mercury	ND	0.025	mg/Kg wet								
LCS (B310691-BS1)				Prepared: 06/14/22 Analyzed: 06/15/22							
Mercury	16.1	0.71	mg/Kg wet	18.9		85.4		68.8-131.2			
LCS Dup (B310691-BSD1)				Prepared: 06/14/22 Analyzed: 06/15/22							
Mercury	17.5	0.77	mg/Kg wet	18.9		92.5		68.8-131.2	7.99	20	
Batch B310773 - SW-846 7471											
Blank (B310773-BLK1)				Prepared: 06/15/22 Analyzed: 06/16/22							
Mercury	ND	0.025	mg/Kg wet								
LCS (B310773-BS1)				Prepared: 06/15/22 Analyzed: 06/16/22							
Mercury	23.7	0.77	mg/Kg wet	18.9		125		68.8-131.2			
LCS Dup (B310773-BSD1)				Prepared: 06/15/22 Analyzed: 06/16/22							
Mercury	22.2	0.79	mg/Kg wet	18.9		118		68.8-131.2	6.28	20	
Duplicate (B310773-DUP1)	**Source: 22F0701-08**			Prepared: 06/15/22 Analyzed: 06/16/22							
Mercury	0.0532	0.040	mg/Kg dry		0.0472				12.1	20	
Matrix Spike (B310773-MS1)	**Source: 22F0701-08**			Prepared: 06/15/22 Analyzed: 06/16/22							
Mercury	0.644	0.040	mg/Kg dry	0.529	0.0472	113		80-120			

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QUALITY CONTROL

Conventional Chemistry Parameters by EPA/APHA/SW-846 Methods (Total) - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B310495 - SW 846 9060A										
Blank (B310495-BLK1)				Prepared & Analyzed: 06/13/22						
Total Organic Carbon	ND	100	mg/Kg wet							
LCS (B310495-BS1)				Prepared & Analyzed: 06/13/22						
Total Organic Carbon	786	100	mg/Kg wet	750		105	73.7-110			
LCS Dup (B310495-BSD1)				Prepared & Analyzed: 06/13/22						
Total Organic Carbon	746	100	mg/Kg wet	750		99.5	73.7-110	5.17	18.6	
Batch B310544 - % Solids										
Duplicate (B310544-DUP2)	**Source: 22F0701-09**			Prepared: 06/13/22 Analyzed: 06/14/22						
% Solids	67.2		% Wt		67.3			0.138	5	

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QUALITY CONTROL

TCLP - Metals Analyses - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B310708 - SW-846 3010A										
Blank (B310708-BLK1)				Prepared: 06/14/22 Analyzed: 06/17/22						
Antimony	ND	0.050	mg/L							
Arsenic	ND	0.050	mg/L							
Beryllium	ND	0.0040	mg/L							
Nickel	ND	0.010	mg/L							
Thallium	ND	0.050	mg/L							
Vanadium	ND	0.010	mg/L							
Zinc	ND	0.50	mg/L							
Barium	ND	0.50	mg/L							
Cadmium	ND	0.010	mg/L							
Chromium	ND	0.050	mg/L							
Lead	ND	0.10	mg/L							
Selenium	ND	0.050	mg/L							
Silver	ND	0.050	mg/L							
LCS (B310708-BS1)				Prepared: 06/14/22 Analyzed: 06/17/22						
Antimony	0.488	0.050	mg/L	0.500		97.7	80-120			
Arsenic	0.474	0.050	mg/L	0.500		94.8	80-120			
Beryllium	0.542	0.0040	mg/L	0.500		108	80-120			
Nickel	0.511	0.010	mg/L	0.500		102	80-120			
Thallium	0.529	0.050	mg/L	0.500		106	80-120			
Vanadium	0.511	0.010	mg/L	0.500		102	80-120			
Zinc	1.03	0.50	mg/L	1.00		103	80-120			
Barium	0.504	0.50	mg/L	0.500		101	80-120			
Cadmium	0.490	0.010	mg/L	0.500		98.0	80-120			
Chromium	0.519	0.050	mg/L	0.500		104	80-120			
Lead	0.514	0.10	mg/L	0.500		103	80-120			
Selenium	0.506	0.050	mg/L	0.500		101	80-120			
Silver	0.514	0.050	mg/L	0.500		103	80-120			
LCS Dup (B310708-BSD1)				Prepared: 06/14/22 Analyzed: 06/17/22						
Antimony	0.520	0.050	mg/L	0.500		104	80-120	6.29	20	
Arsenic	0.503	0.050	mg/L	0.500		101	80-120	5.98	20	
Beryllium	0.576	0.0040	mg/L	0.500		115	80-120	6.09	20	
Nickel	0.542	0.010	mg/L	0.500		108	80-120	5.85	20	
Thallium	0.559	0.050	mg/L	0.500		112	80-120	5.53	20	
Vanadium	0.546	0.010	mg/L	0.500		109	80-120	6.74	20	
Zinc	1.09	0.50	mg/L	1.00		109	80-120	5.57	20	
Barium	0.536	0.50	mg/L	0.500		107	80-120	6.23	20	
Cadmium	0.516	0.010	mg/L	0.500		103	80-120	5.30	20	
Chromium	0.550	0.050	mg/L	0.500		110	80-120	5.81	20	
Lead	0.544	0.10	mg/L	0.500		109	80-120	5.67	20	
Selenium	0.531	0.050	mg/L	0.500		106	80-120	4.82	20	
Silver	0.543	0.050	mg/L	0.500		109	80-120	5.41	20	

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QUALITY CONTROL

TCLP - Metals Analyses - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B310749 - SW-846 7470A Prep										
Blank (B310749-BLK1)				Prepared & Analyzed: 06/15/22						
Mercury	0.00010	0.00010	mg/L							B-05
LCS (B310749-BS1)				Prepared & Analyzed: 06/15/22						
Mercury	0.00395	0.00010	mg/L	0.00402		98.2	80-120			B
LCS Dup (B310749-BSD1)				Prepared & Analyzed: 06/15/22						
Mercury	0.00392	0.00010	mg/L	0.00402		97.5	80-120	0.650	20	B

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IDENTIFICATION SUMMARY FOR SINGLE COMPONENT ANALYTES

SW-846 8082A

LCS

Lab Sample ID: B310797-BS1

Date(s) Analyzed: 06/16/2022 06/16/2022

Instrument ID (1): ECD10

Instrument ID (2): ECD10

GC Column (1): ID: (mm)

GC Column (2): ID: (mm)

ANALYTE	COL	RT	RT WINDOW		CONCENTRATION	%RPD
			FROM	TO		
Aroclor-1016	1	0.000	0.000	0.000	0.16	
	2	0.000	0.000	0.000	0.17	0.0
Aroclor-1260	1	0.000	0.000	0.000	0.16	
	2	0.000	0.000	0.000	0.16	0.0

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IDENTIFICATION SUMMARY FOR SINGLE COMPONENT ANALYTES

SW-846 8082A

LCS Dup

Lab Sample ID: B310797-BSD1 Date(s) Analyzed: 06/16/2022 06/16/2022

Instrument ID (1): ECD10 Instrument ID (2): ECD10

GC Column (1): ID: (mm) GC Column (2): ID: (mm)

ANALYTE	COL	RT	RT WINDOW		CONCENTRATION	%RPD
			FROM	TO		
Aroclor-1016	1	0.000	0.000	0.000	0.17	
	2	0.000	0.000	0.000	0.17	0.0
Aroclor-1260	1	0.000	0.000	0.000	0.16	
	2	0.000	0.000	0.000	0.16	0.0

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FLAG/QUALIFIER SUMMARY

*	QC result is outside of established limits.
†	Wide recovery limits established for difficult compound.
‡	Wide RPD limits established for difficult compound.
#	Data exceeded client recommended or regulatory level
ND	Not Detected
RL	Reporting Limit is at the level of quantitation (LOQ)
DL	Detection Limit is the lower limit of detection determined by the MDL study
MCL	Maximum Contaminant Level
	Percent recoveries and relative percent differences (RPDs) are determined by the software using values in the calculation which have not been rounded.
	No results have been blank subtracted unless specified in the case narrative section.
B	Analyte is found in the associated laboratory blank as well as in the sample.
B-05	Data is not affected by elevated level in laboratory blank since sample(s) result is "Not Detected".
L-04	Laboratory fortified blank/laboratory control sample recovery and duplicate recovery are outside of control limits. Reported value for this compound is likely to be biased on the low side.
L-07	Either laboratory fortified blank/laboratory control sample or duplicate recovery is outside of control limits, but the other is within limits. RPD between the two LFB/LCS results is within method specified criteria.
L-14	Compound classified by MA CAM as difficult with acceptable recoveries of 40-160%. Recovery does not meet 70-130% criteria but does meet difficult compound criteria.
M-10	The reporting limit verification for the AIHA lead program is outside of control limits for this element. Any reported result at or near the detection limit may be biased on the high side.
O-32	A dilution was performed as part of the standard analytical procedure.
RL-05	Elevated reporting limit due to high concentration of target compounds. MA CAM reporting limit not met.
RL-12	Elevated reporting limit due to matrix interference.
S-01	The surrogate recovery for this sample is not available due to sample dilution below the surrogate reporting limit required from high analyte concentration and/or matrix interferences.
V-05	Continuing calibration verification (CCV) did not meet method specifications and was biased on the low side for this compound.
V-16	Response factor is less than method specified minimum acceptable value. Reduced precision and accuracy may be associated with reported result.
V-20	Continuing calibration verification (CCV) did not meet method specifications and was biased on the high side. Data validation is not affected since sample result was "not detected" for this compound.
V-34	Initial calibration verification (ICV) did not meet method specifications and was biased on the low side for this compound. Reported result is estimated.
V-36	Initial calibration verification (ICV) did not meet method specifications and was biased on the high side. Data validation is not affected since sample result was "not detected" for this compound.

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CERTIFICATIONS

Certified Analyses included in this Report

Analyte	Certifications
MADEP EPH rev 2.1 in Soil	
C9-C18 Aliphatics	CT,NC,ME,NH-P
C19-C36 Aliphatics	CT,NC,ME,NH-P
Unadjusted C11-C22 Aromatics	CT,NC,ME,NH-P
C11-C22 Aromatics	CT,NC,ME,NH-P
Acenaphthene	CT,NC,ME,NH-P
Acenaphthylene	CT,NC,ME,NH-P
Anthracene	CT,NC,ME,NH-P
Benzo(a)anthracene	CT,NC,ME,NH-P
Benzo(a)pyrene	CT,NC,ME,NH-P
Benzo(b)fluoranthene	CT,NC,ME,NH-P
Benzo(g,h,i)perylene	CT,NC,ME,NH-P
Benzo(k)fluoranthene	CT,NC,ME,NH-P
Chrysene	CT,NC,ME,NH-P
Dibenz(a,h)anthracene	CT,NC,ME,NH-P
Fluoranthene	CT,NC,ME,NH-P
Fluorene	CT,NC,ME
Indeno(1,2,3-cd)pyrene	CT,NC,ME,NH-P
2-Methylnaphthalene	CT,NC,ME
Naphthalene	CT,NC,ME,NH-P
Phenanthrene	CT,NC,ME,NH-P
Pyrene	CT,NC,ME,NH-P
MADEP EPH rev 2.1 in Water	
C9-C18 Aliphatics	CT,NC,ME,NH-P
C19-C36 Aliphatics	CT,NC,ME,NH-P
Unadjusted C11-C22 Aromatics	CT,NC,ME,NH-P
C11-C22 Aromatics	CT,NC,ME,NH-P
Acenaphthene	CT,NC,ME,NH-P
Acenaphthylene	CT,NC,ME,NH-P
Anthracene	CT,NC,ME,NH-P
Benzo(a)anthracene	CT,NC,ME,NH-P
Benzo(a)pyrene	CT,NC,ME,NH-P
Benzo(b)fluoranthene	CT,NC,ME,NH-P
Benzo(g,h,i)perylene	CT,NC,ME,NH-P
Benzo(k)fluoranthene	CT,NC,ME,NH-P
Chrysene	CT,NC,ME,NH-P
Dibenz(a,h)anthracene	CT,NC,ME,NH-P
Fluoranthene	CT,NC,ME,NH-P
Fluorene	CT,NC,ME
Indeno(1,2,3-cd)pyrene	CT,NC,ME,NH-P
2-Methylnaphthalene	CT,NC,ME
Naphthalene	CT,NC,ME,NH-P
Phenanthrene	CT,NC,ME,NH-P
Pyrene	CT,NC,ME,NH-P
SW-846 6010D in Soil	
Antimony	CT,NH,NY,ME,VA,NC
Arsenic	CT,NH,NY,ME,VA,NC

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CERTIFICATIONS

Certified Analyses included in this Report

Analyte	Certifications
SW-846 6010D in Soil	
Barium	CT,NH,NY,ME,VA,NC
Beryllium	CT,NH,NY,ME,VA,NC
Cadmium	CT,NH,NY,ME,VA,NC
Chromium	CT,NH,NY,ME,VA,NC
Copper	CT,NH,NY,ME,VA,NC
Lead	CT,NH,NY,AIHA,ME,VA,NC
Nickel	CT,NH,NY,ME,VA,NC
Selenium	CT,NH,NY,ME,VA,NC
Silver	CT,NH,NY,ME,VA,NC
Thallium	CT,NH,NY,ME,VA,NC
Vanadium	CT,NH,NY,ME,VA,NC
Zinc	CT,NH,NY,ME,VA,NC
SW-846 6010D in Water	
Antimony	NY,CT,ME,NC,NH,VA
Arsenic	NY,CT,NC,ME,NH,VA
Beryllium	NY,CT,ME,NC,NH,VA
Nickel	CT,NC,NH,ME,NY,VA
Thallium	CT,ME,NC,NH,NY,VA
Vanadium	CT,ME,NC,NH,NY,VA
Zinc	CT,ME,NC,NY,NH,VA
Barium	NY,CT,ME,NC,NH,VA
Cadmium	NY,CT,ME,NC,NH,VA
Chromium	NY,CT,ME,NC,NH,VA
Lead	NY,CT,ME,NC,NH,VA
Selenium	CT,ME,NC,NH,NY,VA
Silver	CT,ME,NC,NH,NY,VA
SW-846 7470A in Water	
Mercury	CT,ME,NC,NH,NY,VA
SW-846 7471B in Soil	
Mercury	CT,NH,NY,NC,ME,VA
SW-846 8082A in Soil	
Aroclor-1016	CT,NH,NY,NC,ME,VA,PA
Aroclor-1016 [2C]	CT,NH,NY,NC,ME,VA,PA
Aroclor-1221	CT,NH,NY,NC,ME,VA,PA
Aroclor-1221 [2C]	CT,NH,NY,NC,ME,VA,PA
Aroclor-1232	CT,NH,NY,NC,ME,VA,PA
Aroclor-1232 [2C]	CT,NH,NY,NC,ME,VA,PA
Aroclor-1242	CT,NH,NY,NC,ME,VA,PA
Aroclor-1242 [2C]	CT,NH,NY,NC,ME,VA,PA
Aroclor-1248	CT,NH,NY,NC,ME,VA,PA
Aroclor-1248 [2C]	CT,NH,NY,NC,ME,VA,PA
Aroclor-1254	CT,NH,NY,NC,ME,VA,PA
Aroclor-1254 [2C]	CT,NH,NY,NC,ME,VA,PA
Aroclor-1260	CT,NH,NY,NC,ME,VA,PA
Aroclor-1260 [2C]	CT,NH,NY,NC,ME,VA,PA

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CERTIFICATIONS

Certified Analyses included in this Report

Analyte	Certifications
SW-846 8082A in Soil	
Aroclor-1262	NH,NY,NC,ME,VA,PA
Aroclor-1262 [2C]	NH,NY,NC,ME,VA,PA
Aroclor-1268	NH,NY,NC,ME,VA,PA
Aroclor-1268 [2C]	NH,NY,NC,ME,VA,PA
SW-846 8082A in Water	
Aroclor-1016	CT,NH,NY,NC,ME,VA,PA
Aroclor-1016 [2C]	CT,NH,NY,NC,ME,VA,PA
Aroclor-1221	CT,NH,NY,NC,ME,VA,PA
Aroclor-1221 [2C]	CT,NH,NY,NC,ME,VA,PA
Aroclor-1232	CT,NH,NY,NC,ME,VA,PA
Aroclor-1232 [2C]	CT,NH,NY,NC,ME,VA,PA
Aroclor-1242	CT,NH,NY,NC,ME,VA,PA
Aroclor-1242 [2C]	CT,NH,NY,NC,ME,VA,PA
Aroclor-1248	CT,NH,NY,NC,ME,VA,PA
Aroclor-1248 [2C]	CT,NH,NY,NC,ME,VA,PA
Aroclor-1254	CT,NH,NY,NC,ME,VA,PA
Aroclor-1254 [2C]	CT,NH,NY,NC,ME,VA,PA
Aroclor-1260	CT,NH,NY,NC,ME,VA,PA
Aroclor-1260 [2C]	CT,NH,NY,NC,ME,VA,PA
Aroclor-1262	NH,NY,NC,ME,VA,PA
Aroclor-1262 [2C]	NH,NY,NC,ME,VA,PA
Aroclor-1268	NH,NY,NC,ME,VA,PA
Aroclor-1268 [2C]	NH,NY,NC,ME,VA,PA
SW-846 8260D in Soil	
Benzene	CT,NH,NY,ME
Benzene	CT,NH,NY,ME
Bromobenzene	NH,NY,ME
Bromobenzene	NH,NY,ME
Bromochloromethane	NH,NY,ME
Bromochloromethane	NH,NY,ME
Bromodichloromethane	CT,NH,NY,ME
Bromodichloromethane	CT,NH,NY,ME
Bromoform	CT,NH,NY,ME
Bromoform	CT,NH,NY,ME
Bromomethane	CT,NH,NY,ME
Bromomethane	CT,NH,NY,ME
2-Butanone (MEK)	CT,NH,NY,ME
2-Butanone (MEK)	CT,NH,NY,ME
n-Butylbenzene	CT,NH,NY,ME
n-Butylbenzene	CT,NH,NY,ME
sec-Butylbenzene	CT,NH,NY,ME
sec-Butylbenzene	CT,NH,NY,ME
tert-Butylbenzene	CT,NH,NY,ME
tert-Butylbenzene	CT,NH,NY,ME
Carbon Disulfide	CT,NH,NY,ME
Carbon Disulfide	CT,NH,NY,ME

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CERTIFICATIONS

Certified Analyses included in this Report

Analyte	Certifications
SW-846 8260D in Soil	
Carbon Tetrachloride	CT,NH,NY,ME
Carbon Tetrachloride	CT,NH,NY,ME
Chlorobenzene	CT,NH,NY,ME
Chlorobenzene	CT,NH,NY,ME
Chlorodibromomethane	CT,NH,NY,ME
Chlorodibromomethane	CT,NH,NY,ME
Chloroethane	CT,NH,NY,ME
Chloroethane	CT,NH,NY,ME
Chloroform	CT,NH,NY,ME
Chloroform	CT,NH,NY,ME
Chloromethane	CT,NH,NY,ME
Chloromethane	CT,NH,NY,ME
2-Chlorotoluene	CT,NH,NY,ME
2-Chlorotoluene	CT,NH,NY,ME
4-Chlorotoluene	CT,NH,NY,ME
4-Chlorotoluene	CT,NH,NY,ME
1,2-Dibromo-3-chloropropane (DBCP)	NY
1,2-Dibromo-3-chloropropane (DBCP)	NY
1,2-Dibromoethane (EDB)	NY
1,2-Dibromoethane (EDB)	NY
Dibromomethane	NH,NY,ME
Dibromomethane	NH,NY,ME
1,2-Dichlorobenzene	CT,NH,NY,ME
1,2-Dichlorobenzene	CT,NH,NY,ME
1,3-Dichlorobenzene	CT,NH,NY,ME
1,3-Dichlorobenzene	CT,NH,NY,ME
1,4-Dichlorobenzene	CT,NH,NY,ME
1,4-Dichlorobenzene	CT,NH,NY,ME
Dichlorodifluoromethane (Freon 12)	NY,ME
Dichlorodifluoromethane (Freon 12)	NY,ME
1,1-Dichloroethane	CT,NH,NY,ME
1,1-Dichloroethane	CT,NH,NY,ME
1,2-Dichloroethane	CT,NH,NY,ME
1,2-Dichloroethane	CT,NH,NY,ME
1,1-Dichloroethylene	CT,NH,NY,ME
1,1-Dichloroethylene	CT,NH,NY,ME
cis-1,2-Dichloroethylene	CT,NH,NY,ME
cis-1,2-Dichloroethylene	CT,NH,NY,ME
trans-1,2-Dichloroethylene	CT,NH,NY,ME
trans-1,2-Dichloroethylene	CT,NH,NY,ME
1,2-Dichloropropane	CT,NH,NY,ME
1,2-Dichloropropane	CT,NH,NY,ME
1,3-Dichloropropane	NH,NY,ME
1,3-Dichloropropane	NH,NY,ME
2,2-Dichloropropane	NH,NY,ME
2,2-Dichloropropane	NH,NY,ME
1,1-Dichloropropene	NH,NY,ME

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CERTIFICATIONS

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Analyte	Certifications
SW-846 8260D in Soil	
1,1-Dichloropropene	NH,NY,ME
cis-1,3-Dichloropropene	CT,NH,NY,ME
cis-1,3-Dichloropropene	CT,NH,NY,ME
trans-1,3-Dichloropropene	CT,NH,NY,ME
trans-1,3-Dichloropropene	CT,NH,NY,ME
1,4-Dioxane	NY
Ethylbenzene	CT,NH,NY,ME
Ethylbenzene	CT,NH,NY,ME
Hexachlorobutadiene	NH,NY,ME
Hexachlorobutadiene	NH,NY,ME
2-Hexanone (MBK)	CT,NH,NY,ME
2-Hexanone (MBK)	CT,NH,NY,ME
Isopropylbenzene (Cumene)	CT,NH,NY,ME
Isopropylbenzene (Cumene)	CT,NH,NY,ME
p-Isopropyltoluene (p-Cymene)	NH,NY
p-Isopropyltoluene (p-Cymene)	NH,NY
Methyl tert-Butyl Ether (MTBE)	NH,NY
Methyl tert-Butyl Ether (MTBE)	NY
Methylene Chloride	CT,NH,NY,ME
Methylene Chloride	CT,NH,NY,ME
4-Methyl-2-pentanone (MIBK)	CT,NH,NY
4-Methyl-2-pentanone (MIBK)	CT,NH,NY
Naphthalene	NH,NY,ME
Naphthalene	NH,NY,ME
n-Propylbenzene	NH,NY
n-Propylbenzene	NH,NY
Styrene	CT,NH,NY,ME
Styrene	CT,NH,NY,ME
1,1,1,2-Tetrachloroethane	CT,NH,NY,ME
1,1,1,2-Tetrachloroethane	CT,NH,NY,ME
1,1,2,2-Tetrachloroethane	CT,NH,NY,ME
1,1,2,2-Tetrachloroethane	CT,NH,NY,ME
Tetrachloroethylene	CT,NH,NY,ME
Tetrachloroethylene	CT,NH,NY,ME
Toluene	CT,NH,NY,ME
Toluene	CT,NH,NY,ME
1,2,3-Trichlorobenzene	NY
1,2,3-Trichlorobenzene	ME
1,2,4-Trichlorobenzene	NH,NY,ME
1,2,4-Trichlorobenzene	NH,NY,ME
1,1,1-Trichloroethane	CT,NH,NY,ME
1,1,1-Trichloroethane	CT,NH,NY,ME
1,1,2-Trichloroethane	CT,NH,NY,ME
1,1,2-Trichloroethane	CT,NH,NY,ME
Trichloroethylene	CT,NH,NY,ME
Trichloroethylene	CT,NH,NY,ME
Trichlorofluoromethane (Freon 11)	CT,NH,NY,ME

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CERTIFICATIONS

Certified Analyses included in this Report

Analyte	Certifications
SW-846 8260D in Soil	
Trichlorofluoromethane (Freon 11)	CT,NH,NY,ME
1,2,3-Trichloropropane	NH,NY,ME
1,2,3-Trichloropropane	NH,NY,ME
1,2,4-Trimethylbenzene	CT,NH,NY,ME
1,2,4-Trimethylbenzene	CT,NH,NY,ME
1,3,5-Trimethylbenzene	CT,NH,NY,ME
1,3,5-Trimethylbenzene	CT,NH,NY,ME
Vinyl Chloride	CT,NH,NY,ME
Vinyl Chloride	CT,NH,NY,ME
m+p Xylene	CT,NH,NY,ME
m+p Xylene	CT,NH,NY,ME
o-Xylene	CT,NH,NY,ME
o-Xylene	CT,NH,NY,ME
SW-846 8270E in Product/Solid	
Acenaphthene	CT,NY,NH,ME,NC,VA
Acenaphthylene	CT,NY,NH,ME,NC,VA
Anthracene	CT,NY,NH,ME,NC,VA
Benzo(a)anthracene	CT,NY,NH,ME,NC,VA
Benzo(a)pyrene	CT,NY,NH,ME,NC,VA
Benzo(b)fluoranthene	CT,NY,NH,ME,NC,VA
Benzo(g,h,i)perylene	CT,NY,NH,ME,NC,VA
Benzo(k)fluoranthene	CT,NY,NH,ME,NC,VA
Chrysene	CT,NY,NH,ME,NC,VA
Dibenz(a,h)anthracene	CT,NY,NH,ME,NC,VA
Fluoranthene	CT,NY,NH,ME,NC,VA
Fluorene	CT,NY,NH,ME,NC,VA
Indeno(1,2,3-cd)pyrene	CT,NY,NH,ME,NC,VA
2-Methylnaphthalene	CT,NY,NH,ME,NC,VA
Naphthalene	CT,NY,NH,ME,NC,VA
Phenanthrene	CT,NY,NH,ME,NC,VA
Pyrene	CT,NY,NH,ME,NC,VA
SW-846 8270E in Soil	
Acenaphthene	CT,NY,NH,ME,NC,VA
Acenaphthylene	CT,NY,NH,ME,NC,VA
Anthracene	CT,NY,NH,ME,NC,VA
Benzo(a)anthracene	CT,NY,NH,ME,NC,VA
Benzo(a)pyrene	CT,NY,NH,ME,NC,VA
Benzo(b)fluoranthene	CT,NY,NH,ME,NC,VA
Benzo(g,h,i)perylene	CT,NY,NH,ME,NC,VA
Benzo(k)fluoranthene	CT,NY,NH,ME,NC,VA
Chrysene	CT,NY,NH,ME,NC,VA
Dibenz(a,h)anthracene	CT,NY,NH,ME,NC,VA
Fluoranthene	CT,NY,NH,ME,NC,VA
Fluorene	CT,NY,NH,ME,NC,VA
Indeno(1,2,3-cd)pyrene	CT,NY,NH,ME,NC,VA
2-Methylnaphthalene	CT,NY,NH,ME,NC,VA

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CERTIFICATIONS

Certified Analyses included in this Report

Analyte	Certifications
SW-846 8270E in Soil	
Naphthalene	CT,NY,NH,ME,NC,VA
Phenanthrene	CT,NY,NH,ME,NC,VA
Pyrene	CT,NY,NH,ME,NC,VA

Con-Test, a Pace Environmental Laboratory, operates under the following certifications and accreditations:

Code	Description	Number	Expires
AIHA	AIHA-LAP, LLC - ISO17025:2017	100033	03/1/2024
MA	Massachusetts DEP	M-MA100	06/30/2023
CT	Connecticut Department of Publilc Health	PH-0165	12/31/2022
NY	New York State Department of Health	10899 NELAP	04/1/2023
NH-S	New Hampshire Environmental Lab	2516 NELAP	02/5/2023
RI	Rhode Island Department of Health	LAO00373	12/30/2022
NC	North Carolina Div. of Water Quality	652	12/31/2022
NJ	New Jersey DEP	MA007 NELAP	06/30/2023
FL	Florida Department of Health	E871027 NELAP	06/30/2023
VT	Vermont Department of Health Lead Laboratory	LL720741	07/30/2023
ME	State of Maine	MA00100	06/9/2023
VA	Commonwealth of Virginia	460217	12/14/2022
NH-P	New Hampshire Environmental Lab	2557 NELAP	09/6/2022
VT-DW	Vermont Department of Health Drinking Water	VT-255716	06/12/2023
NC-DW	North Carolina Department of Health	25703	07/31/2022
PA	Commonwealth of Pennsylvania DEP	68-05812	06/30/2023
MI	Dept. of Env, Great Lakes, and Energy	9100	09/6/2022

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☐ 78 Interstate Drive, West Springfield, MA 01089
☒ 108 Myrtle Street, #502, North Quincy, MA 02171
☐ 317 Iron Horse Way, Suite 204, Providence, RI 02908
☐ 80 Washington Street, Suite 301, Poughkeepsie, NY
☐ Other 22F0701

CHAIN-OF-CUSTODY RECORD 41821

Turnaround
☐ 24-Hour* ☐ 72-Hour* ☐ Other ____ (days)
☐ 48-Hour* ☒ Standard (____ days) *Surcharge Applies

Project Name	Project Location	Project Number	Laboratory
Haverhill Sediment	Haverhill, MA	20170390.430	Pace

Report To: Matt Kissane mkissane@fando.com
Invoice To: Matt Kissane "
P.O. No.: 170820170390.430
Sampler's Signature: Evan K. Date: 6/8/22

Source Codes:
MW=Monitoring Well PW=Potable Water T=Treatment Facility S=Soil B=Sediment
SW=Surface Water ST=Stormwater W=Waste A=Air C=Concrete
X=Other Trip Blank

Analysis Request / **Containers**

Item No.	Transfer Check 1	2	3	4	Sample Number	Source Code	Date Sampled	Time Sampled	MCP 14 Metals	PAHs	Soil VOA Vial, ☐ methanol	Soil VOA Vial, ☐ water	Glass Soil Container (2) ☐ $Na(SO_4)_2$ oz	Other:	Other:	Water VOA Vial, ☐ As is ☐ HCl	Glass Amber ( ) ml, ☐ As is ☐ H_2SO_4	Plastic - As is, ☐ 250 ml ☐ 500 ☐ 1000 ml	Plastic - H_2SO_4, ☐ 250 ml ☐ 500 ml	Plastic - HNO_3, 250 ml ☐ Filtered ☐ 0.45µ ☐ 10µ	Plastic - NaOH, 250 ml	Comments
1	X	X			170822060 8-01	B	6/8/22	0945	X	X								X				SED-18
2	X	X			170822060 8-02			1050	X	X								X				SED-19
3	X	X			-03			1110	X	X								X				SED-20
4	X	X			-04			1125	X	X								X				SED-21
5	X	X			-05			1135	X	X								X				SED-22
6	X	X			-06			1225	X	X								X				SED-17
7	X	X			-07			1235	X	X								X				SED-16
8	X	X			-08			1245	X	X								X				SED-15
9	X	X			-09			1315	X	X								X				SED-14
10	X	X			-10			1350	X	X								X				SED-13

per client on sample 01-10 run As, Cd, Cr, Cup, Pb, Hg, Ni, Zn. on samples 11 and 12 run MCP 14 metals. jlh 6/14/22

Transfer Number	Relinquished By	Accepted By	Date	Time
1	Evan Konawicz	FED Agency office	6/8/22	1700
2	Evan Konawicz	Chad Lug	6/10/22	1030
3	Chad Lug	Cp 2.0	6/10/22	1805
4				

Charge Exceptions: ☐ CT Tax Exempt ☐ QA/QC ☐ Other ____
____ Duplicates 1 Blanks (Item Nos:)
Reporting and Detection Limit Requirements: ☐ RCP Deliverables ☐ MCP CAM Cert.
Consensus-based probable effects concentrations
Additional Comments:

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☐ 56 Quarry Road, Trumbull, CT 06611
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☐ 78 Interstate Drive, West Springfield, MA 01089
☒ 108 Myrtle Street, #502, North Quincy, MA 02171
☐ 317 Iron Horse Way, Suite 204, Providence, RI 02908
☐ 80 Washington Street, Suite 301, Poughkeepsie, NY
☐ Other 2250701

CHAIN-OF-CUSTODY RECORD 41822

Turnaround
☐ 24-Hour* ☐ 72-Hour* ☐ Other ____ (days)
☐ 48-Hour* ☒ Standard (____ days) *Surcharge Applies

Project Name	Project Location	Project Number	Laboratory
Haverhill Sediment	Haverhill, MA	20170390.430	Pace

Report To: Matt Kissane mkissane@fando.com
Invoice To:
P.O. No.: 1708201703 90.430
Sampler's Signature: Evan Koncevicz Date: 6/8/22

Source Codes:
MW=Monitoring Well PW=Potable Water T=Treatment Facility S=Soil B=Sediment
SW=Surface Water ST=Stormwater W=Waste A=Air C=Concrete
X=Other Trip Blank

Analysis Request / **Containers**

Item No.	Transfer Check 1	2	3	4	Sample Number	Source Code	Date Sampled	Time Sampled	Total Metals	PAHs	PCBs	EPH Ranges	VOCs	1 Water	TCLP Metals	Total Organic Carbon	Soil VOA Vial, ☐ methanol ☒ $NaHSO_4$	Soil VOA Vial, ☐ water ☒ $Na_2(SO_4)_2$	Glass Soil Container (8) oz	Other: Glass Soil Container 2 oz	Other: Glass Soil Container 4 oz	Water VOA Vial, ☐ As is ☐ HCl	Glass Amber ( ) ml, ☐ As is ☐ H_2SO_4	Plastic - As is, ☐ 250 ml ☐ 500 ml ☐ 1000 ml	Plastic - H_2SO_4, ☐ 250 ml ☐ 500 ml	Plastic - HNO_3, 250 ml ☐ Filtered ☐ 0.45µ ☐ 10µ	Plastic - NaOH, 250 ml	Comments
11	X	X			170822060 8-11	B	6/8/22	1400	X	X	X	X	X	X	X	X	1	2	1	1	1							Below
12	X	X			-12	B	↓	1430	X	X	X	X	X	X	X	X	1	2	1	1	1							Above
13	X	X			-13	X	↓	—					X				1	2	NA	NA	NA							TB

Transfer Number	Relinquished By	Accepted By	Date	Time
1	Evan Koncevicz	FAO Dunkin Office	6/8/22	1700
2	Evan Koncevicz	Chad Lugo	6/10/22	1030
3	Chad Lugo	2.0	6/10/22	1805
4				

Charge Exceptions: ☐ CT Tax Exempt ☐ QA/QC ☐ Other ____
____ Duplicates 1 Blanks (Item Nos:)
Reporting and Detection Limit Requirements: ☐ RCP Deliverables ☐ MCP CAM Cert.
Consensus-Based probable effects concentrations
Additional Comments:
13 just 1 VOA meth. & 2 VOA $Na_2(SO_4)_2$

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I Have Not Confirmed Sample Container Numbers With Lab Staff Before Relinquishing Over Samples_____

Pace Pace

Doc# 277 Rev 5 2017

Login Sample Receipt Checklist - (Rejection Criteria Listing - Using Acceptance Policy) Any False Statement will be brought to the attention of the Client - State True or False

Client Fuss & O'Neill

Received By RLF Date 6/10/20 Time 1805

How were the samples received? In Cooler T No Cooler _____ On Ice T No Ice _____ Direct from Sampling _____ Ambient _____ Melted Ice _____

Were samples within Temperature? 2-6°C T By Gun # 5 Actual Temp - 2°C By Blank # _____ Actual Temp - _____

Was Custody Seal Intact? NA Were Samples Tampered with? NA

Was COC Relinquished ? T Does Chain Agree With Samples? T

Are there broken/leaking/loose caps on any samples? F

Is COC in ink/ Legible? T Were samples received within holding time? T

Did COC include all pertinent Information? Client T Analysis T Sampler Name T Project T ID's T Collection Dates/Times T

Are Sample labels filled out and legible? T

Are there Lab to Filters? F Who was notified? _____

Are there Rushes? F Who was notified? _____

Are there Short Holds? F Who was notified? _____

Is there enough Volume? T

Is there Headspace where applicable? NA MS/MSD? F

Proper Media/Containers Used? T Is splitting samples required? F

Were trip blanks received? F On COC? F

Do all samples have the proper pH? Acid NA Base NA

Vials	#	Containers:	#		#		#
Unp-		1 Liter Amb.		1 Liter Plastic		16 oz Amb.	2
HCL-		500 mL Amb.		500 mL Plastic		8oz Amb/Clear	12
Meoh-	3	250 mL Amb.		250 mL Plastic		4oz Amb/Clear	
Bisulfate-	6	Flashpoint		Col./Bacteria		2oz Amb/Clear	2
DI-		Other Glass		Other Plastic		Encore	
Thiosulfate-		SOC Kit		Plastic Bag		Frozen:	
Sulfuric-		Perchlorate		Ziplock			

Unused Media

Vials	#	Containers:	#		#		#
Unp-		1 Liter Amb.		1 Liter Plastic		16 oz Amb.	
HCL-		500 mL Amb.		500 mL Plastic		8oz Amb/Clear	
Meoh-		250 mL Amb.		250 mL Plastic		4oz Amb/Clear	
Bisulfate-		Col./Bacteria		Flashpoint		2oz Amb/Clear	
DI-		Other Plastic		Other Glass		Encore	
Thiosulfate-		SOC Kit		Plastic Bag		Frozen:	
Sulfuric-		Perchlorate		Ziplock			

Comments:

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July 11, 2022

Matt Kissane
Fuss & O'Neill EnviroScience, LLC - MA
108 Myrtle St,
Quincy, MA 02171

Project Location: Haverhill, MA
Client Job Number:
Project Number: 20170390.U30
Laboratory Work Order Number: 22F1765

Enclosed are results of analyses for samples as received by the laboratory on June 27, 2022. If you have any questions concerning this report, please feel free to contact me.

Sincerely,

Jessica L. Hoffman
Project Manager

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Fuss & O'Neill EnviroScience, LLC - MA
108 Myrtle St,
Quincy, MA 02171
ATTN: Matt Kissane

REPORT DATE: 7/11/2022

PURCHASE ORDER NUMBER: 170820170390.U30

PROJECT NUMBER: 20170390.U30

ANALYTICAL SUMMARY

WORK ORDER NUMBER: 22F1765

The results of analyses performed on the following samples submitted to CON-TEST, a Pace Analytical Laboratory, are found in this report.

PROJECT LOCATION: Haverhill, MA

FIELD SAMPLE #	LAB ID:	MATRIX	SAMPLE DESCRIPTION	TEST	SUB LAB
1708220608-01	22F1765-01	Sediment	SED-18	SM 2540G	
				SW-846 6010D	
1708220608-02	22F1765-02	Sediment	SED-19	SM 2540G	
				SW-846 6010D	
1708220608-03	22F1765-03	Sediment	SED-20	SM 2540G	
				SW-846 6010D	

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CASE NARRATIVE SUMMARY

All reported results are within defined laboratory quality control objectives unless listed below or otherwise qualified in this report.

The results of analyses reported only relate to samples submitted to Con-Test, a Pace Analytical Laboratory, for testing.
I certify that the analyses listed above, unless specifically listed as subcontracted, if any, were performed under my direction according to the approved methodologies listed in this document, and that based upon my inquiry of those individuals immediately responsible for obtaining the information, the material contained in this report is, to the best of my knowledge and belief, accurate and complete.

Lisa A. Worthington
Technical Representative

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Project Location: Haverhill, MA | Sample Description: SED-18 | Work Order: 22F1765

Date Received: 6/27/2022

Field Sample #: 1708220608-01 | Sampled: 6/8/2022 09:45

Sample ID: 22F1765-01

Sample Matrix: Sediment

Conventional Chemistry Parameters by EPA/APHA/SW-846 Methods (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
% Solids	37.6		% Wt	1		SM 2540G	6/13/22	6/13/22 16:33	AV

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Project Location: Haverhill, MA | Sample Description: SED-18 | Work Order: 22F1765

Date Received: 6/27/2022

Field Sample #: 1708220608-01 | Sampled: 6/8/2022 09:45

Sample ID: 22F1765-01

Sample Matrix: Sediment

TCLP - Metals Analyses

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Lead	0.25	0.10	mg/L	1		SW-846 6010D	7/5/22	7/9/22 6:26	QNW

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Project Location: Haverhill, MA | Sample Description: SED-19 | Work Order: 22F1765

Date Received: 6/27/2022

Field Sample #: 1708220608-02 | Sampled: 6/8/2022 10:50

Sample ID: 22F1765-02

Sample Matrix: Sediment

Conventional Chemistry Parameters by EPA/APHA/SW-846 Methods (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
% Solids	69.6		% Wt	1		SM 2540G	6/13/22	6/13/22 16:33	AV

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Project Location: Haverhill, MA | Sample Description: SED-19 | Work Order: 22F1765

Date Received: 6/27/2022

Field Sample #: 1708220608-02 | Sampled: 6/8/2022 10:50

Sample ID: 22F1765-02

Sample Matrix: Sediment

TCLP - Metals Analyses

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Lead	0.33	0.10	mg/L	1		SW-846 6010D	7/5/22	7/9/22 6:34	QNW

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Project Location: Haverhill, MA | Sample Description: SED-20 | Work Order: 22F1765

Date Received: 6/27/2022

Field Sample #: 1708220608-03 | Sampled: 6/8/2022 11:10

Sample ID: 22F1765-03

Sample Matrix: Sediment

Conventional Chemistry Parameters by EPA/APHA/SW-846 Methods (Total)

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
% Solids	63.6		% Wt	1		SM 2540G	6/13/22	6/13/22 16:33	AV

39 Spruce Street * East Longmeadow, MA 01028 * FAX 413/525-6405 * TEL. 413/525-2332

Project Location: Haverhill, MA | Sample Description: SED-20 | Work Order: 22F1765

Date Received: 6/27/2022

Field Sample #: 1708220608-03 | Sampled: 6/8/2022 11:10

Sample ID: 22F1765-03

Sample Matrix: Sediment

TCLP - Metals Analyses

Analyte	Results	RL	Units	Dilution	Flag/Qual	Method	Date Prepared	Date/Time Analyzed	Analyst
Lead	0.37	0.10	mg/L	1		SW-846 6010D	7/5/22	7/9/22 6:42	QNW

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Sample Extraction Data

Prep Method: % Solids **Analytical Method: SM 2540G**

Lab Number [Field ID]	Batch	Date
22F1765-01 [1708220608-01]	B310544	06/13/22
22F1765-02 [1708220608-02]	B310544	06/13/22
22F1765-03 [1708220608-03]	B310544	06/13/22

Prep Method: SW-846 3010A **Analytical Method: SW-846 6010D** **Leachates were extracted on 7/1/2022 per SW-846 1311 in Batch B312100**

Lab Number [Field ID]	Batch	Initial [mL]	Final [mL]	Date
22F1765-01 [1708220608-01]	B312253	50.0	50.0	07/05/22
22F1765-02 [1708220608-02]	B312253	50.0	50.0	07/05/22
22F1765-03 [1708220608-03]	B312253	50.0	50.0	07/05/22

39 Spruce Street * East Longmeadow, MA 01028 * FAX 413/525-6405 * TEL. 413/525-2332

QUALITY CONTROL

TCLP - Metals Analyses - Quality Control

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch B312253 - SW-846 3010A										
Blank (B312253-BLK1)				Prepared: 07/05/22 Analyzed: 07/08/22						
Lead	ND	0.10	mg/L							
LCS (B312253-BS1)				Prepared: 07/05/22 Analyzed: 07/08/22						
Lead	0.574	0.10	mg/L	0.500		115	80-120			
LCS Dup (B312253-BSD1)				Prepared: 07/05/22 Analyzed: 07/08/22						
Lead	0.566	0.10	mg/L	0.500		113	80-120	1.43	20	

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FLAG/QUALIFIER SUMMARY

*	QC result is outside of established limits.
†	Wide recovery limits established for difficult compound.
‡	Wide RPD limits established for difficult compound.
#	Data exceeded client recommended or regulatory level
ND	Not Detected
RL	Reporting Limit is at the level of quantitation (LOQ)
DL	Detection Limit is the lower limit of detection determined by the MDL study
MCL	Maximum Contaminant Level

Percent recoveries and relative percent differences (RPDs) are determined by the software using values in the calculation which have not been rounded.

No results have been blank subtracted unless specified in the case narrative section.

39 Spruce Street * East Longmeadow, MA 01028 * FAX 413/525-6405 * TEL. 413/525-2332

CERTIFICATIONS

Certified Analyses included in this Report

Analyte	Certifications
SW-846 6010D in Water	
Lead	NY,CT,ME,NC,NH,VA

Con-Test, a Pace Environmental Laboratory, operates under the following certifications and accreditations:

Code	Description	Number	Expires
AIHA	AIHA-LAP, LLC - ISO17025:2017	100033	03/1/2024
MA	Massachusetts DEP	M-MA100	06/30/2023
CT	Connecticut Department of Publilc Health	PH-0165	12/31/2022
NY	New York State Department of Health	10899 NELAP	04/1/2023
NH-S	New Hampshire Environmental Lab	2516 NELAP	02/5/2023
RI	Rhode Island Department of Health	LAO00373	12/30/2022
NC	North Carolina Div. of Water Quality	652	12/31/2022
NJ	New Jersey DEP	MA007 NELAP	06/30/2023
FL	Florida Department of Health	E871027 NELAP	06/30/2023
VT	Vermont Department of Health Lead Laboratory	LL720741	07/30/2023
ME	State of Maine	MA00100	06/9/2023
VA	Commonwealth of Virginia	460217	12/14/2022
NH-P	New Hampshire Environmental Lab	2557 NELAP	09/6/2022
VT-DW	Vermont Department of Health Drinking Water	VT-255716	06/12/2023
NC-DW	North Carolina Department of Health	25703	07/31/2022
PA	Commonwealth of Pennsylvania DEP	68-05812	06/30/2023
MI	Dept. of Env, Great Lakes, and Energy	9100	09/6/2022

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☐ 1419 Richland Street, Columbia, SC 29201
☐ 78 Interstate Drive, West Springfield, MA 01089
☒ 108 Myrtle Street, #502, North Quincy, MA 02171
☐ 317 Iron Horse Way, Suite 204, Providence, RI 02908
☐ 80 Washington Street, Suite 301, Poughkeepsie, NY
☐ Other _____

22F1765

CHAIN-OF-CUSTODY RECORD 41821

Turnaround
☐ 24-Hour* ☐ 72-Hour* ☐ Other _____ (days)
☐ 48-Hour* ☒ Standard (____ days) *Surcharge Applies

PROJECT NAME	PROJECT LOCATION	PROJECT NUMBER	LABORATORY
Haverhill Sediment	Haverhill, MA	20170390.430	Pace

REPORT TO: Matt Kissane mkissane@fando.com
INVOICE TO: Matt Kissane " "
P.O. No.: 17082017-0390.430
Sampler's Signature: Evan K. Date: 6/8/22

Source Codes:
MW=Monitoring Well PW=Potable Water T=Treatment Facility S=Soil B=Sediment
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Item No.	Transfer Check 1	2	3	4	Sample Number	Source Code	Date Sampled	Time Sampled	Analysis Request: MCP 14 Metals	PAHs	Containers: Soil VOA Vial, ☐ methanol	Soil VOA Vial, ☐ water	Glass Soil Container (8) oz ☐ $Na(SO_3)_2$	Other:	Other:	Water VOA Vial, ☐ As is ☐ HCl	Glass Amber ( ) mL, ☐ As is ☐ H_2SO_4	Plastic - As is, ☐ 250 ml ☐ 500 ☐ 1000 ml	Plastic - H_2SO_4, ☐ 250 ml ☐ 500 ml	Plastic - HNO_3, 250 ml ☐ Filtered ☐ 0.45µ ☐ 10µ	Plastic - NaOH, 250 ml	Comments
1	X	X			17082220608-01	B	6/8/22	0945	X	X								X				SED-18
2	X	X			17082220608-02			1050	X	X								X				SED-19
3	X	X			-03			1110	X	X								X				SED-20
4	X	X			-04			1125	X	X								X				SED-21
5	X	X			-05			1135	X	X								X				SED-22
6	X	X			-06			1225	X	X								X				SED-17
7	X	X			-07			1235	X	X								X				SED-16
8	X	X			-08			1245	X	X								X				SED-15
9	X	X			-09			1315	X	X								X				SED-14
10	X	X			-10			1350	X	X								X				SED-13

per client on sample 01-10 run As, Cd, Cr, Cup, Pb, Hg, Ni, Zn. on samples 11 and 12 run MCP 14 metals. jlh 6/14/22

client chose to reactivate samples 01-03 for TCLP Lead. JLH 6/27/22

Transfer Number	Relinquished By	Accepted By	Date	Time
1	Evan Konawicz	FedEx Agency office	6/8/22	1700
2	Evan Konawicz	Chad Lug	6/10/22	1030
3	Chad Lug	Cooler 2.0	6/10/22	1805
4				

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Consensus-based probable effects concentrations
Additional Comments:

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☐ 317 Iron Horse Way, Suite 204, Providence, RI 02908
☐ 80 Washington Street, Suite 301, Poughkeepsie, NY
☐ Other 2250701

CHAIN-OF-CUSTODY RECORD 41822

Turnaround
☐ 24-Hour* ☐ 72-Hour* ☐ Other ____ (days)
☐ 48-Hour* ☒ Standard (____ days) *Surcharge Applies

Project Name	Project Location	Project Number	Laboratory
Haverhill Sediment	Haverhill, MA	20170390.430	Pace

Report To: Matt Kissane mkissane@fando.com
Invoice To:
P.O. No.: 1708201703 90.430
Sampler's Signature: Evan Koncevicz Date: 6/8/22

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Analysis Request / **Containers**

Item No.	Transfer Check 1	2	3	4	Sample Number	Source Code	Date Sampled	Time Sampled	Total Metals	PAHs	PCBs	EPH Ranges	VOCs	1 Water	TCLP Metals	Total Organic Carbon	Soil VOA Vial, ☐ methanol ☒ $Na(SO_4)_2$	Soil VOA Vial, ☐ water ☒ $Na(SO_4)_2$	Glass Soil Container (8) oz	Other: Glass Soil Container 2 oz	Other: Glass Soil Container ½ oz	Water VOA Vial, ☐ As is ☐ HCl	Glass Amber ( ) ml, ☐ As is ☐ H_2SO_4	Plastic - As is, ☐ 250 ml ☐ 500 ml ☐ 1000 ml	Plastic - H_2SO_4, ☐ 250 ml ☐ 500 ml	Plastic - HNO_3, 250 ml ☐ Filtered ☐ 0.45µ ☐ 10µ	Plastic - NaOH, 250 ml	Comments
11	X	X			170822060 8-11	B	6/8/22	1400	X	X	X	X	X	X	X	X	1	2	1	1	1							Below
12	X	X			-12	B	↓	1430	X	X	X	X	X	X	X	X	1	2	1	1	1							Above
13	X	X			-13	X	↓	—					X				1	2	NA	NA	NA							TB

Transfer Number	Relinquished By	Accepted By	Date	Time
1	Evan Koncevicz	FAO Dunkin Office	6/8/22	1700
2	Evan Koncevicz	Chul Lugo	6/10/22	1030
3	Chul Lugo	2.0	6/10/22	1805
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Pace Pace

Doc# 277 Rev 5 2017

Login Sample Receipt Checklist - (Rejection Criteria Listing - Using Acceptance Policy) Any False Statement will be brought to the attention of the Client - State True or False

Client Fuss & O'Neill

Received By RLF Date 6/10/20 Time 1805

How were the samples received? In Cooler T No Cooler _____ On Ice T No Ice _____

Direct from Sampling _____ Ambient _____ Melted Ice _____

Were samples within Temperature? 2-6°C T By Gun # 5 Actual Temp - 2°C

By Blank # _____ Actual Temp - _____

Was Custody Seal Intact? UA Were Samples Tampered with? UA

Was COC Relinquished ? T Does Chain Agree With Samples? T

Are there broken/leaking/loose caps on any samples? F

Is COC in ink/ Legible? T Were samples received within holding time? T

Did COC include all pertinent Information? Client T Analysis T Sampler Name T

Project T ID's T Collection Dates/Times T

Are Sample labels filled out and legible? T

Are there Lab to Filters? F Who was notified? _____

Are there Rushes? F Who was notified? _____

Are there Short Holds? F Who was notified? _____

Is there enough Volume? T

Is there Headspace where applicable? UA MS/MSD? F

Proper Media/Containers Used? T Is splitting samples required? F

Were trip blanks received? F On COC? F

Do all samples have the proper pH? Acid UA Base UA

Vials	#	Containers:	#		#		#
Unp-		1 Liter Amb.		1 Liter Plastic		16 oz Amb.	2
HCL-		500 mL Amb.		500 mL Plastic		8oz Amb/Clear	12
Meoh-	3	250 mL Amb.		250 mL Plastic		4oz Amb/Clear	
Bisulfate-	6	Flashpoint		Col./Bacteria		2oz Amb/Clear	2
DI-		Other Glass		Other Plastic		Encore	
Thiosulfate-		SOC Kit		Plastic Bag		Frozen:	
Sulfuric-		Perchlorate		Ziplock			

Unused Media

Vials	#	Containers:	#		#		#
Unp-		1 Liter Amb.		1 Liter Plastic		16 oz Amb.	
HCL-		500 mL Amb.		500 mL Plastic		8oz Amb/Clear	
Meoh-		250 mL Amb.		250 mL Plastic		4oz Amb/Clear	
Bisulfate-		Col./Bacteria		Flashpoint		2oz Amb/Clear	
DI-		Other Plastic		Other Glass		Encore	
Thiosulfate-		SOC Kit		Plastic Bag		Frozen:	
Sulfuric-		Perchlorate		Ziplock			

Comments:

5 DEP Sampling Analysis Plan Approval

5.1 MassDEP Correspondence

During the multi-phase sediment quality assessment sampling program for the Little River Dam project, the MassDEP 401 Water Quality Certification Program was frequently consulted to discuss the project, which included any new data and proposed subsequent sampling locations and events. The consultation between Fuss & O'Neill and MassDEP included e-mails providing sediment quality assessment data, as well as calls.

The proposed project, including sediment sampling and management were discussed during calls on the following dates:

- January 11 and March 4, 2022: Fuss & O'Neill sediment team and Dr. David Wong
- May 7, July 20, and October 18, 2022: Fuss & O'Neill sediment team and Mr. Derek Standish

5.2 Field Investigations

Field investigations were performed in November 2020, September 2021, and June 2022. Each investigation involved the collection of sediment samples for field characterization and laboratory analysis. The 2021 sampling activities included two separate mobilizations, to evaluate the breadth of sediment conditions along the reach, and to perform a more focused evaluation of sediment quality near the dam at the southern end of the project. The 2022 sampling activities included sampling of the Little River, and sampling of the Merrimack River. The field activities are summarized below.

5.2.1 November 2020

A preliminary sediment quality investigation was conducted on November 17, 2020, and focused on the reach of the Little River north of Winter Street, in Haverhill, Massachusetts and extending approximately 3,500 feet northward, upstream to a bend in the Little River just south of the railroad overpass. During the November 2020 field investigation, the sediment cores were advanced through the presumed ponded sediment until the native substrate was identified by TG&B Marine Services, using increases in material resistance as an indicator of underlying native material. Fuss & O'Neill personnel logged the conditions of the recovered material, including recovery amount, texture (gradation), moisture content, color, odors, and observations of anthropogenic material. Samples at one (1) foot intervals were field-screened for total organic vapors (TOV) using a photoionization detector (PID).

The sediment evaluation was performed on three "transect" locations, with samples collected at the left and right banks and center of channel in each transect location. Grab samples were collected at three locations per transect across a total of three (3) sampling transects (Transect #1, Transect #2, and Transect #3) to provide an initial assessment of sediment quality along the lower reach of the Little River that is ponded by the Little River Dam. Transect locations are depicted on the attached *Figures 1 and 2*.

Three (3) composite sediment samples, each consisting of sediment from the left, right and center of the river channel at the respective transect, were submitted to Con-Test Analytical Laboratory (Con-Test,

now Pace Analytical) in East Longmeadow, Massachusetts, and Thielsch Engineering in Cranston, Rhode Island, for the following parameters:

- Extractable petroleum hydrocarbons (EPHs) with Target Polycyclic Aromatic Hydrocarbons (PAHs) via MassDEP Method EPH rev 2.1,
- Total metals (Arsenic, Barium, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, Selenium, Silver, and Zinc) via United States Environmental Protection Agency (USEPA) Method 6010D/7471B[8],
- Polychlorinated biphenyls (PCBs) via USEPA Method 8082A,
- Herbicides via USEPA Method 8151A,
- Pesticides via USEPA Method 8081B,
- Volatile organic compounds (VOCs) via USEPA Method 8260C,
- Polycyclic aromatic hydrocarbons (PAHs) by the USEPA semi-volatile organic compound (SVOC) method, USEPA Method 8270 D-E,
- Total organic carbon (TOC) via USEPA Method 9060A, and
- Leachable lead via the Toxicity Characteristic Leaching Procedure (TCLP), USEPA Methods 1311 and 6010D; for one of three samples.[9]
- Particle size distribution report via sieve analysis (gradation test).
- A trip blank was collected to detect and identify any VOC contamination between samples during travel to and from the laboratory.

Detailed findings were included in a December 2020 summary report, and are summarized below. The analytical data set from the 2020 sampling is included as *Table 2-3*. Sediment analytical data were compared to the Consensus-Based Probable Effects Concentrations (PECs), per DD MacDonald et. al.[10] The data were further compared to MassDEP's Maximum Allowable Contaminant Levels (MACLs) for sediment reuse at lined Massachusetts landfills.[11] As a result of the November 2020 field investigation, Fuss & O'Neill developed the following preliminary conclusions regarding the sediment conditions:

- Sediment accumulation was observed at a lesser thickness in the vicinity of the dam (Transect #1) when compared to upstream transects (Transect #2 and Transect #3).
- The total concentrations of PCBs and VOCs for the samples collected at Transect #2 exceeded the MACL for reuse at a lined landfill.

[8] Metals list includes RCRA 8 Metals and Copper, Nickel, and Zinc applicable to the 314 CMR 9: 401 WQC

[9] A material may exhibit a characteristic of toxicity by leaching action if a total concentration exceeds 20-times the numerical characteristic levels for hazardous wastes per 40 CFR 261.24. TCLP analysis is performed to determine the actual leaching potential to demonstrate whether a material exhibits a toxicity characteristic and warrants management as hazardous waste.

[10] MacDonald et al., *Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems*, 2000.

[11] MassDEP, 1994. *Interim Policy #COMM-94-007, Interim Policy for Sampling, Analysis, Handling and Tracking Requirements for Dredged Sediment Reused or Disposed at Massachusetts Permitted Landfills.*

- Levels of contaminants, specifically PAHs, identified in Transect #1 and Transect #2, which exceeded the respective PECs, warranted further assessment and delineation to determine the extent of impacted sediment and the overall stability of the material.

Following the November 2020 investigation, it was determined that additional investigation was warranted to further refine the conceptual site model.

5.2.2 September 2021

Utilizing the data and information collected during the November 2020 field investigation, Fuss & O'Neill developed a supplemental investigation to gather additional data to evaluate the nature and extent of PCB- and PAH-impacted sediment, and to complete the dataset required for future 401 WQC permitting. Additionally, the field investigation intended to provide more precise estimates of impacted sediment volume within the impounded portion of the Little River to better understand the level of effort that would be required for sediment removal and disposal. The 2021 investigation activities were generally divided into two phases, with the following objectives:

- The "Breadth" phase involved the advancement of additional transects within the study area, to as far north as Interstate 495 (approximately 1.5 miles north and upstream of the dam), in order to gather additional data on the general sediment quality in the river. For the first phase, samples were collected at six (6) additional transects. The review of analytical data collected was used to inform the additional locations selected for more strategic sampling during the subsequent phase.
- The subsequent "Detail" phase involved the collection of grab samples of sediment in targeted areas, where contaminants of concern were identified during the Breadth phase and/or the 2020 investigation. These sampling activities were performed to determine the concentrations of contaminants of concern in greater detail and to further support an evaluation of contaminant mobility in the event of a sediment release.

The September 2021 field investigation focused upstream of Little River Dam just north of Winter Street, extending to near the I-495 bridge in Haverhill, Massachusetts. The Little River Dam forms the southern boundary of the study. A site location map is included in *Figure 1*.

Prior to the field investigation, due diligence was performed to assess the presence of known environmentally impacted sites in the surrounding area and potential preferential pathways for petroleum or other hazardous material (OHM) impacts (outfalls and other stormwater runoff entry points). In addition, in September 2021, Fuss & O'Neill reached out to National Grid USA Service Company, LLC (National Grid) to discuss the historical and current status of multiple known environmental conditions along the reach of the impounded section of the Little River, for which they are the Responsible Party (RP). The results of this due diligence and these discussions were used to better inform transect location selection for sediment quality analysis.

5.2.2.1 Breadth Phase

The first phase of the supplemental field investigation of the pond sediment was conducted on September 7 and 8, 2021, during which the sediment was measured, sampled, and observed at six locations between Winter Street and I-495. A total of six (6) transect locations (Transect #4, Transect #5, Transect #6, Transect #7, Transect #8, and Transect #9) were designated along the river upstream of the dam. These specified sample locations above were selected to provide a representative assessment of sediment quality along the reach of the Little River that is impounded by the Little River Dam, as sediment at these locations could become mobilized as a result of increased river velocity following dam removal.

At all transect locations, three sediment borings (i.e. river left, right, and center) were advanced by TG&B Marine Services, Inc. Borings were advanced using a slide hammer method under the supervision of Fuss & O'Neill. A site plan is included in *Figure 2*. Generally, TG&B Marine Services advanced the sediment cores through the presumed ponded sediment until the native substrate was identified based off of material resistance. Fuss & O'Neill personnel logged the sediment conditions, including depth and thickness of sediment, recovery amount, texture (gradation), moisture content, color, odors, and observations of anthropogenic material. Samples at one (1) foot intervals were field-screened for total organic vapors (TOV) using a photoionization detector (PID).

At each of the upstream transect locations, the three cores of recovered pond sediment were composited into one sample. A total of six (6) composite sediment samples were submitted to Pace Analytical (Pace, previously Con-Test) in East Longmeadow, Massachusetts, and Thielsch Engineering in Braintree, Massachusetts, for the following parameters:

- EPH via MassDEP Method EPH rev 2.1,
- Total metals (Arsenic, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, and Zinc) via United States Environmental Protection Agency (USEPA) Method 6010D/7471B[12],
- PCBs via USEPA Method 8082A,
- Herbicides via USEPA Method 8151A,
- Pesticides via USEPA Method 8081B,
- VOCs via USEPA Method 8260C,
- PAHs by USEPA Method 8270 D-E,
- TOC via USEPA Method 9060A, and
- Leachable lead by TCLP via USEPA Method 6010D; for one of six samples.
- Particle size distribution report via ASTM D-6913
- Moisture content via ASTM – D2216
- A trip blank was collected to detect and identify any VOC contamination between samples during travel to and from the laboratory.

[12] Metals list applicable to 314 CMR 9: 401 Water Quality Certification

A summary of the sediment samples submitted for laboratory analysis is included below in *Table 5-1*.

Table 5-1
Summary of Sediment Samples – Breadth Sampling Program

Location	Sample Date	Sample Number	Composite Sample Depth Range (fbws)	TOV Result (ppmv)	Analysis
Transect #4	09/07/21	0907-04	4.0-14.1	0.2	EPH, Total Metals, PCB, Herbicides, Pesticides, VOC, PAH, TOC, Sieve, Moisture Content
Transect #5		0907-03	2.5-8.9	1.0	
Transect #6		0907-02	3.1-12	34.4	
Transect #7		0907-05	5.2-13.4	5.2	
Transect #8	09/08/21	0908-07	1.0-5.9	ND	
Transect #9		0908-08	1.0-4.5	0.7	

Notes: Only the last six digits of the sample identification number are listed.
ppmv: parts per million by volume
fbws: feet below water surface
ND: Below equipment detection limits

The general sediment conditions as observed in the borings included organic silt, occasionally overlain by fine gravel, which was observed to be underlain by a native horizon consisting of sandy silt. The borings observed at Transect #4, located immediately upstream from the dam, consisted of a shallow horizon of pond sediment of approximately one-half foot in depth. Similar sediment thickness of about one-half foot in depth was observed at Transect #7, Transect #8, and Transect #9 located further upstream from the Hilldale Cemetery to approximately 1,100 south of the I-495 bridge. The borings observed at Transect #5 and Transect #6, located approximately 1,500 feet upstream from the Little River Dam, were observed to have a greater accumulation of sediment from approximately 0.5 to 4.0 feet in thickness. More detailed information regarding water and sediment depth can be found in the sediment boring logs.

The TOV readings ranged from below the instrument detection limit (0.1 ppmv) to a maximum of 34.4 ppmv. The highest PID reading was recorded within the sediment material at Transect #6, river center. Petroleum odor was observed at the river right, left and center of Transect #6.

5.2.2.2 Detail Phase

The second phase of the supplemental field investigation of the pond sediment was conducted on September 17, 2021. Sediment conditions were measured, sampled, and observed within the context of the site. Specifically, samples were collected from areas between and around transects where hazardous materials had been identified during the earlier phases of work, in order to provide a more granular data set with respect to sediment conditions in those areas. As such, sample locations and parameters were targeted to conditions identified in the earlier phases, rather than the broad-based sampling guidance of the 401 Water Quality Certification regulations.

A total of ten (10) grab locations (SED-1, SED-2, SED-3, SED-4, SED-5, SED-6, SED-7, SED-8, SED-9, and SED-10) were designated along the river upstream of the dam. The grab samples were collected from individual points in the river sediment, and were submitted to the laboratory on a point-basis, in contrast to the composite samples submitted for each transect under the 2020 and 2021 Breadth phases of investigation. These specified sample locations above were selected to further delineate areas of concern identified during the previous sampling activities to provide more accurate estimate of impacted sediment quantity(s).

At all grab locations, sediment borings were advanced by TG&B Marine Services, Inc. Borings were advanced using a slide hammer method under the supervision of Fuss & O'Neill. A site plan is included as *Figure 2*.

At each of the ten upstream grab locations, up to 2.5 feet of each core of recovered pond sediment was composited into one sample. A total of ten (10) composite sediment samples were submitted to Pace in East Longmeadow, Massachusetts, and Thielsch Engineering in Braintree, Massachusetts, for the following parameters:

- EPHs via MassDEP Method EPH rev 2.1,
- Total metals (Arsenic and Lead) via USEPA Method 6010D,
- PCBs via USEPA Method 8082A,
- PAHs by USEPA Method 8270 D-E,
- Particle size distribution report via ASTM D-6913
- Moisture content via ASTM – D2216

A summary of the sediment samples submitted for laboratory analysis is included below in *Table 5-2*.

Table 5-2
Summary of Sediment Samples – Detailed Sampling Program

Location	Sample Date	Sample Number	Composite Sample Depth Range (fbws)	TOV Result (ppmv)	Analysis
SED-1	09/17/21	0917-01	0-2	1.5	Total Metals, PCBs, Sieve, Moisture Content
SED-2		0917-03	0-2	0.6	
SED-3		0917-02	0-2.5	2.5	
SED-4		0917-05	0-2	ND	Total Metals, PCB, PAHs, EPH fractions, Sieve, Moisture Content
SED-5		0917-06	0-2	0.1	
SED-6		0917-07	0-2	0.2	
SED-7		0917-04	0-2	ND	
SED-8		0917-10	0-1.6	0.1	
SED-9		0917-09	0-1	1.0	
SED-10		0917-08	0-0.9	ND	

Notes: Only the last six digits of the sample identification number are listed.

ppmv: parts per million by volume
fbws: feet below water surface
ND: Below equipment detection limits

The general subsurface conditions as observed in the borings included organic silt, occasionally overlain by fine gravel, which was observed to be underlain by a native horizon consisting of sandy silt. Sediment thickness observed were consistent with the observations described above at the transect locations.

The TOV readings ranged from below the instrument detection limit (0.1 ppmv) to 2.5 ppmv. The highest PID reading was recorded within the sediment material at SED-3, river right. Petroleum odors were observed at sediment locations SED-2, SED-3, SED-8, SED-9, SED-10. In addition, a sheen was observed at SED-2. Sediment locations SED-2 and SED-3 were located in the immediate vicinity of Transect #2, while SED-8, SED-9 and SED-10 were located immediately upstream of the dam.

5.2.3 June 2022

Additional investigation was conducted in June 2022 to better characterize the extent and magnitude of constituents observed in the Little River, and to better understand how sediments in the Merrimack River may be impacted by mobilized sediments from the Little River. Ten (10) sediment samples were collected from the Little River (SED-13 through SED-22) upstream of Little River Dam just north of Winter Street, extending to near the I-495 bridge in Haverhill, Massachusetts, and two (2) sediment samples were collected from the Merrimack River, Above the Confluence and Below the Confluence of where the Little River and Merrimack River join.

The ten sediment samples collected from the Little River were submitted to Pace in East Longmeadow, Massachusetts, for analysis of the following parameters:

- Total metals (Arsenic, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, and Zinc) via United States Environmental Protection Agency (USEPA) Method 6010D/7471B,
- PCBs via USEPA Method 8082A; three of ten samples,
- PAHs by USEPA Method 8270 D-E,

The two sediment samples collected from the Merrimack River were submitted to Pace in East Longmeadow, Massachusetts, and Thielsch Engineering in Braintree, Massachusetts, for analysis of the following parameters:

- EPH via MassDEP Method EPH rev 2.1,
- Total metals (Arsenic, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, and Zinc) via United States Environmental Protection Agency (USEPA) Method 6010D/7471B,
- PCBs via USEPA Method 8082A,
- VOCs via USEPA Method 8260C,
- PAHs by USEPA Method 8270 D-E,
- TOC via USEPA Method 9060A, and
- Leachable lead, nickel, and zinc by TCLP via USEPA Method 6010D.
- Particle size distribution report via ASTM D-6913

- A trip blank was collected to detect and identify any VOC contamination between samples during travel to and from the laboratory.

A summary of the sediment samples submitted for laboratory analysis is included below in *Table 5-3*.

Table 5-3
Summary of Sediment Samples – June 2022

Location	Sample Date	Sample Number	Composite Sample Depth Range (fbws)	TOV Result (ppmv)	Analysis
SED-13	06/08/22	0608-10	3.4-6.1	0.2	Total Metals, PAH, TOC, Sieve, Moisture Content
SED-14		0608-09	8.3-8.7	ND	
SED-15		0608-08	8.7-9.0	0.1	
SED-16		0608-07	6.0-6.6	0.5	
SED-17		0608-06	5.9-7.4	4.6	
SED-18		0608-01	3.2-4.4	0.1	
SED-19		0608-02	10.9-12.3	0.1	
SED-20		0608-03	9.8-12.0	0.8	
SED-21		0608-04	5.8-7.0	0.3	
SED-22		0608-05	6.9-7.5	ND	
Above Confluence	06/08/22	0608-12	10.0-10.5	ND	EPH, Total Metals, PCB, VOC, PAH, TOC, Sieve
Below Confluence		0608-11	10.1-10.6	25.5	

Notes: Only the last six digits of the sample identification number are listed.
ppmv: parts per million by volume
fbws: feet below water surface
ND: Below equipment detection limits

General sediment conditions observed during sample collection included generally silt and sand, with trace organics and occasional evidence of fill (e.g., glass, metal cans). TOV readings ranged from below the instrument detection limit to a maximum of 25.5 ppmv. The highest TOV reading was recorded within the sediment from the Merrimack River, below the confluence. See sediment boring logs for additional details.

6 Dredging and Disposal Operation

The proposed project will be mechanically dredged. Dredged material will be managed in three different ways:

- Re-used within the existing river channel for creation of a new channel and banks
- Removed for off-site disposal
- Allowed to naturally migrate downstream

The sections below include descriptions of dredging material handling. No contractors have been selected at this time. Contractors will be selected closer to construction.

6.1 Sediment Management

Based on the results of the November 2020, September 2021, and June 2022 sediment sampling and characterization, the majority of the accumulated sediment in the impoundment does not represent a hazard to humans or the aquatic environment and is reflective of background conditions within the highly industrialized corridor of the Little River and the Merrimack River. It is anticipated that at least one area sampled and characterized contains concentrations of hazardous materials, specifically Polychlorinated Biphenyls (PCBs), that will require removal and offsite disposal:

- Within the vicinity of Transect #2 (2020)
    - Refer to Sheet CP-102 in *Appendix A* for the area of contaminated sediment to be removed

The proposed project is anticipated to result in a total of 10,680 cubic yards of dredging within Little River. Off-site management and redistribution within the site are discussed below.

6.1.1 Off-Site Disposal

A total of approximately 5,500 cubic yards of sediment will be disposed off-site as hazardous or regulated waste in accordance with local, state, and/or federal regulations.

- Approximately 1,000 cubic yards (approx. 1,500 dry tons) of PCB-impacted material from the area around Transect #2 will be excavated and disposed of offsite as hazardous waste.
- Approximately 4,500 cubic yards of sediment that is not suitable for reuse onsite will be disposed of in lined landfills within the State or at another approved disposal facility.

6.1.2 Redistribution and Downstream Migration

The remaining sediment upstream of the dam, can be redistributed within the site.

- Approximately 4,820 cubic yards of non-hazardous sediment is anticipated to be reused within the (former) impoundment area.

The levels of metals, Polycyclic Aromatic Hydrocarbons (PAH) and petroleum hydrocarbons are broadly consistent with urban background conditions and do not pose a unique ecological risk to the receiving waterways.

According to the Hydrologic and Hydraulic Modelling Analysis, approximately 360 cubic yards of sediment that exists within the section of the River between the Dam and the MBTA Railroad could potentially become mobile following dam removal.

7 Grain Size Analysis

Refer to Thielsch Engineer Laboratory Testing Data Sheets.

THIELSCH ENGINEERING

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Let's Build a Solid Foundation

Client Information:
Fuss & O'Neill
North Quincy, MA
PM: Matt Kissane
Assigned By: Matt Kissane
Collected By: Client

Project Information:
MUP Grant FY 22/23
Haverhill, MA
F&O Project Number: 20170390.U30
Summary Page: 1 of 1
Report Date: 09.15.21

LABORATORY TESTING DATA SHEET, Report No.: 7421-J-B004

Source Code	Sample No.	Depth (Ft)	Laboratory No.	Identification Tests								Proctor / CBR / Permeability Tests								Laboratory Log and Soil Description
				As Received Water Content %	LL %	PL %	Gravel %	Sand %	Fines %	Org. %	G_s	Dry unit wt. pcf	Test Water Content %	γ_d MAX (pcf) W_{opt} (%)	γ_d MAX (pcf) W_{opt} (%) (Corr.)	Target Test Setup as % of Proctor	CBR @ 0.1"	CBR @ 0.2"	Permeability cm/sec	
				D2216	D4318		D6913			D2974	D854			D1557						
B	1543210907-02	N/A	21-S-B201	75.2			0.5	55.4	44.1											Grey clayey sand (SC)
B	1543210907-03	N/A	21-S-B202	50.4			1.6	68.2	30.2											Grey clayey sand (SC)
B	1543210907-04	N/A	21-S-B203	67.1			0.1	45.6	54.3											Grey clay (CL)
B	1543210907-05	N/A	21-S-B204	50.9			0.9	63.9	35.2											Grey clayey sand (SC)
B	1543210908-07	N/A	21-S-B205	36.3			3.8	73.4	22.8											Grey clayey sand (SC)
B	1543210908-08	N/A	21-S-B206	23.3			0.6	76.3	23.1											Grey clayey sand (SC)

Date Received: *09.08.21*

Reviewed By: Christine M Cohen

Date Reviewed: *09.15.21*

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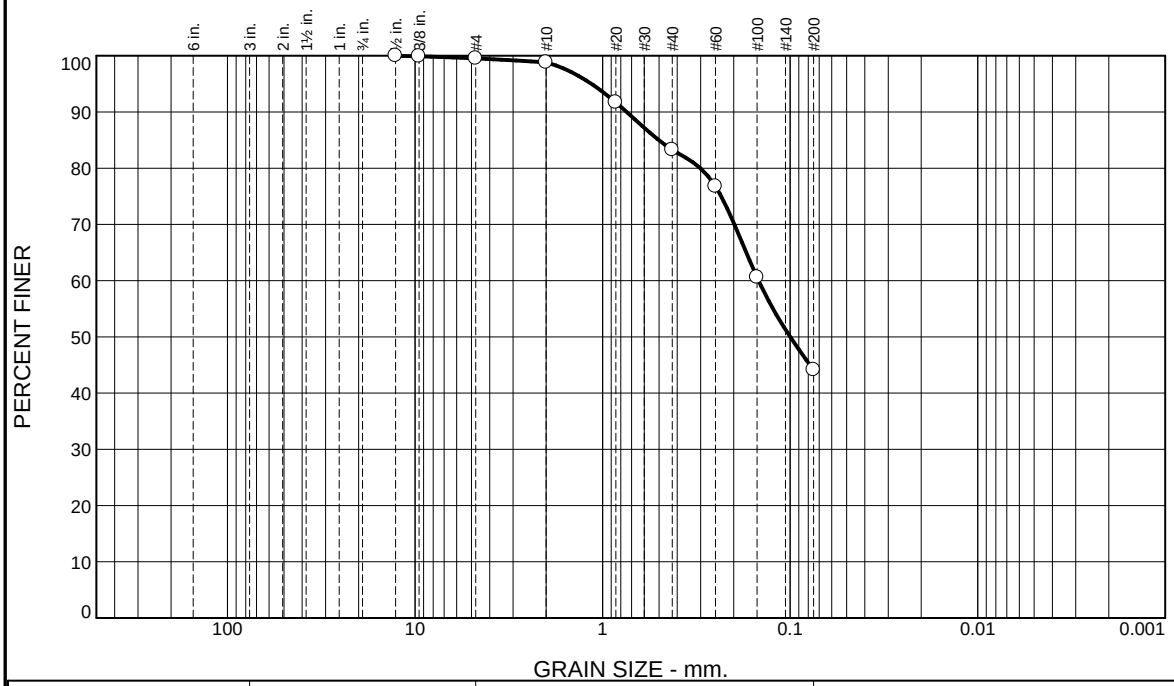
Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.5	0.7	15.5	39.2	44.1	

Test Results (D6913 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1/2"	100.0		
3/8"	99.9		
#4	99.5		
#10	98.8		
#20	91.7		
#40	83.3		
#60	76.8		
#100	60.6		
#200	44.1		

* (no specification provided)

Material Description

Grey clayey sand (SC)

Atterberg Limits (ASTM D 4318)

PL= **LL=** **PI=**

Classification

USCS (D 2487)= **AASHTO (M 145)=**

Coefficients

D_{90}= 0.7438 D_{85}= 0.5015 D_{60}= 0.1472
D_{50}= 0.0999 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Sample visually classified as plastic. Sample rolled to 1/8".

Date Received: 9/8/21 **Date Tested:** 9/14/21

Tested By: CC

Checked By: Christina Colman

Title: Laboratory Coordinator

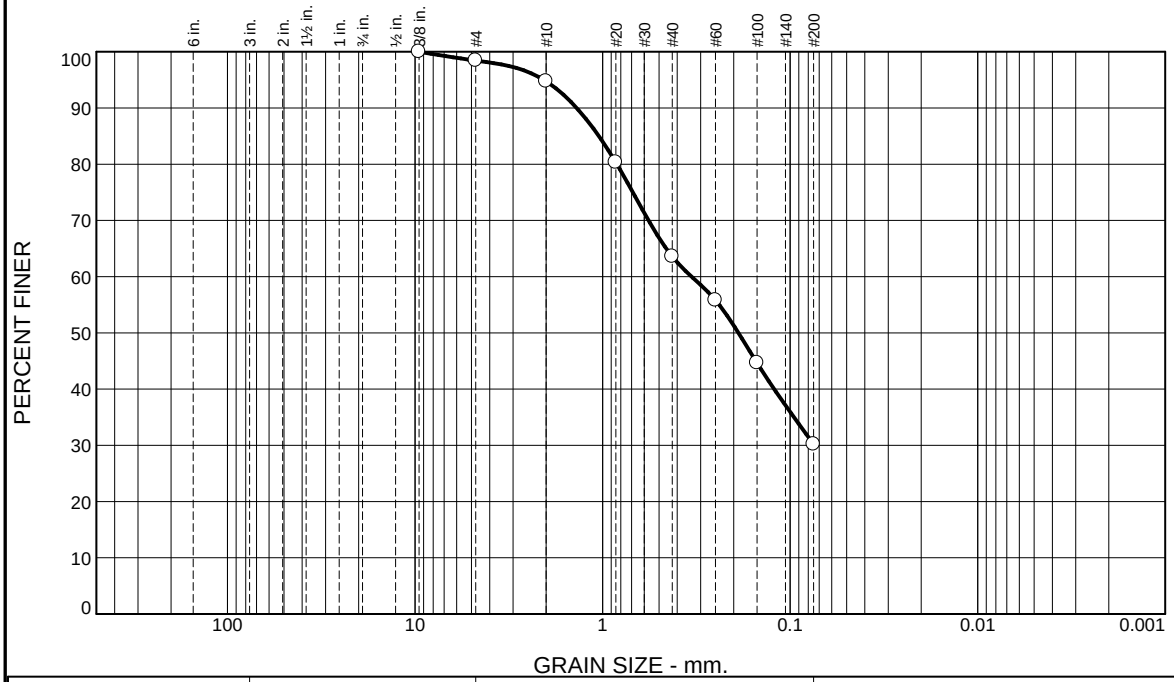
Source of Sample: B **Depth:** Unknown **Date Sampled:** 9/7/21
Sample Number: 1543210907-02

Thielsch Engineering Inc.

Cranston, RI

Client: Fuss & O'Neill
Project: MUP Grant FY 22/23
Haverhill, MA
Project No: 20170390.U30 **Figure** 21-S-B201

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	1.6	3.6	31.2	33.4	30.2	

Test Results (D6913 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3/8"	100.0		
#4	98.4		
#10	94.8		
#20	80.3		
#40	63.6		
#60	55.8		
#100	44.6		
#200	30.2		

* (no specification provided)

Material Description

Grey clayey sand (SC)

Atterberg Limits (ASTM D 4318)

PL= **LL=** **PI=**

Classification

USCS (D 2487)= **AASHTO (M 145)=**

Coefficients

D_{90}= 1.3742 D_{85}= 1.0467 D_{60}= 0.3350
D_{50}= 0.1887 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Sample visually classified as plastic. Sample rolled to 1/8".

Date Received: 9/8/21 **Date Tested:** 9/14/21

Tested By: CC

Checked By: Christina Colman

Title: Laboratory Coordinator

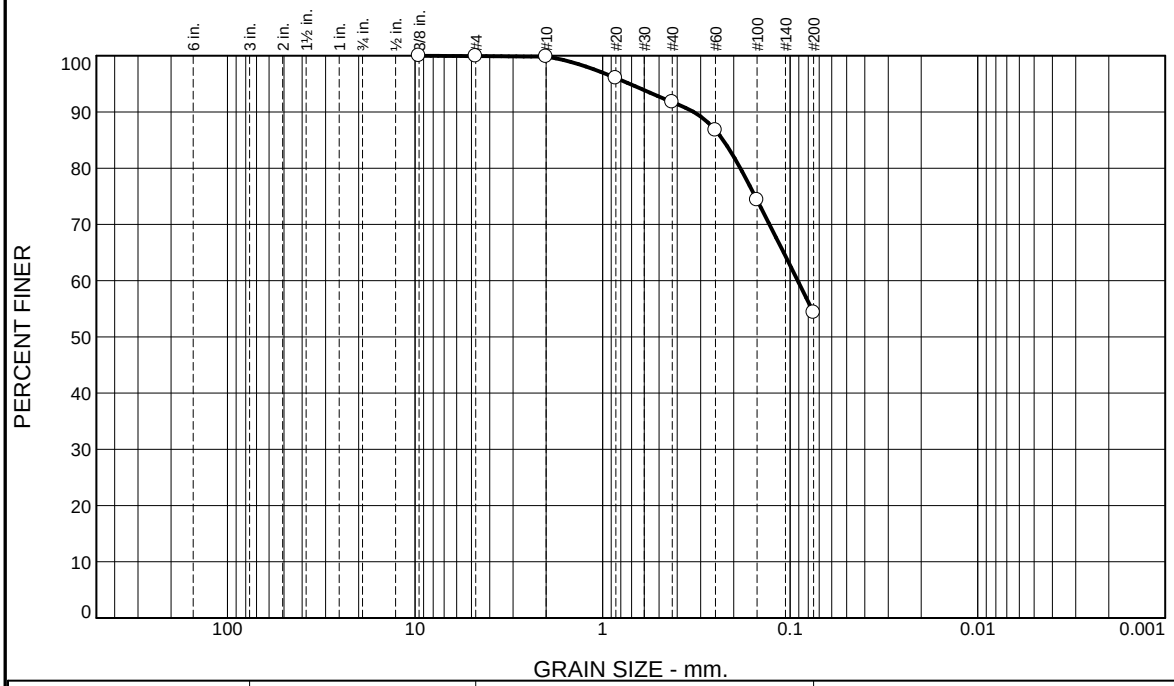
Source of Sample: B **Depth:** Unknown **Date Sampled:** 9/7/21
Sample Number: 1543210907-03

Thielsch Engineering Inc.

Cranston, RI

Client: Fuss & O'Neill
Project: MUP Grant FY 22/23
Haverhill, MA
Project No: 20170390.U30 **Figure** 21-S-B202

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.1	0.1	8.0	37.5	54.3	

Test Results (D6913 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3/8"	100.0		
#4	99.9		
#10	99.8		
#20	96.0		
#40	91.8		
#60	86.8		
#100	74.3		
#200	54.3		

* (no specification provided)

Material Description

Grey clay (CL)

Atterberg Limits (ASTM D 4318)

PL= **LL=** **PI=**

Classification

USCS (D 2487)= **AASHTO (M 145)=**

Coefficients

D_{90}= 0.3267 D_{85}= 0.2276 D_{60}= 0.0911
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Sample visually classified as plastic. Sample rolled to 1/8".

Date Received: 9/8/21 **Date Tested:** 9/14/21

Tested By: CC

Checked By: Christina Colman

Title: Laboratory Coordinator

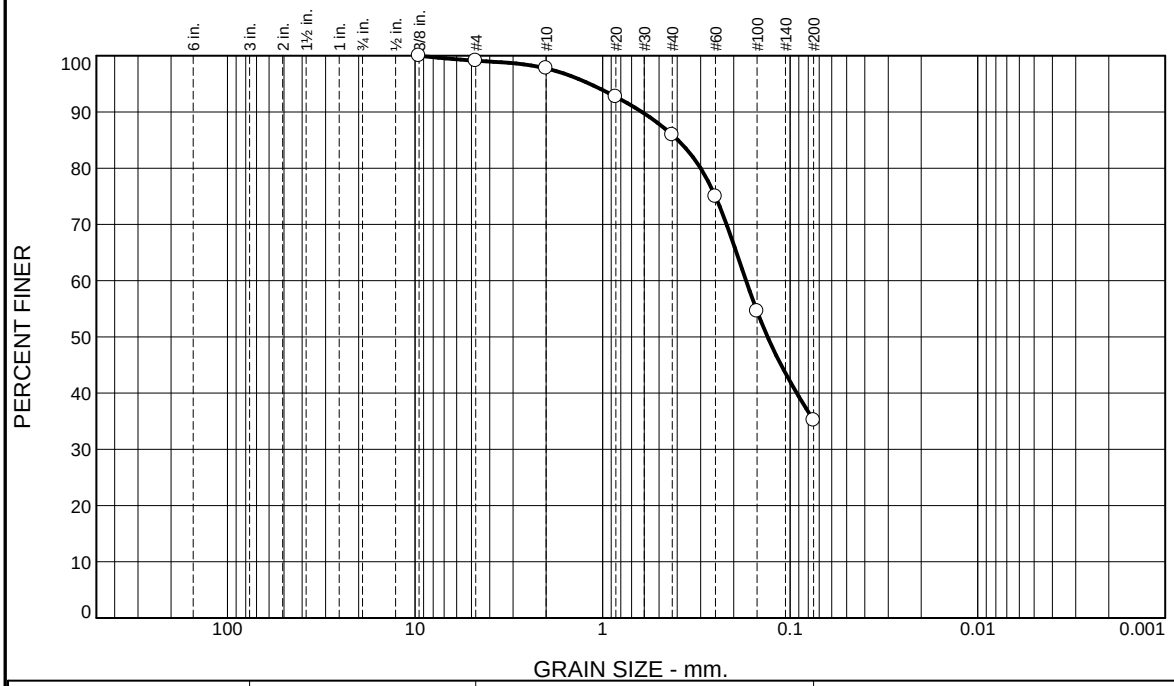
Source of Sample: B **Depth:** Unknown **Date Sampled:** 9/7/21
Sample Number: 1543210907-04

Thielsch Engineering Inc.

Cranston, RI

Client: Fuss & O'Neill
Project: MUP Grant FY 22/23
Haverhill, MA
Project No: 20170390.U30 **Figure** 21-S-B203

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.9	1.3	11.9	50.7	35.2	

Test Results (D6913 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
3/8"	100.0		
#4	99.1		
#10	97.8		
#20	92.7		
#40	85.9		
#60	75.0		
#100	54.6		
#200	35.2		

* (no specification provided)

Material Description

Grey clayey sand (SC)

Atterberg Limits (ASTM D 4318)

PL= **LL=** **PI=**

Classification

USCS (D 2487)= **AASHTO (M 145)=**

Coefficients

D_{90}= 0.6164 D_{85}= 0.3966 D_{60}= 0.1717
D_{50}= 0.1318 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Sample visually classified as plastic. Sample rolled to 1/8".

Date Received: 9/8/21 **Date Tested:** 9/14/21

Tested By: CC

Checked By: Christina Colman

Title: Laboratory Coordinator

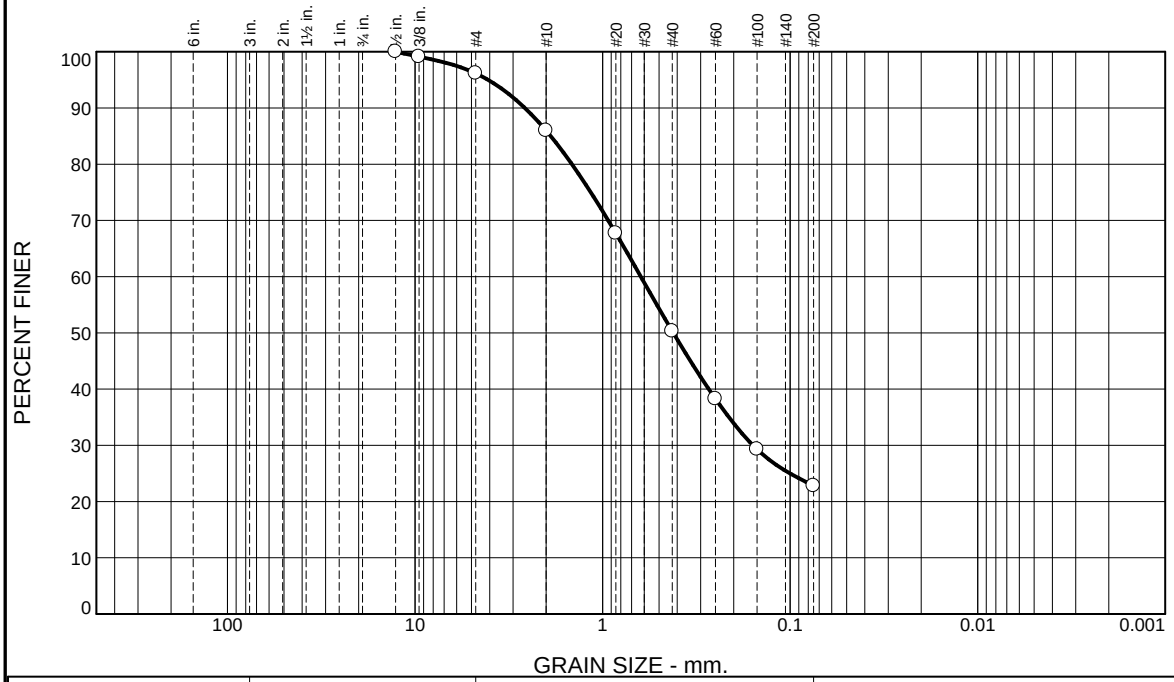
Source of Sample: B **Depth:** Unknown **Date Sampled:** 9/7/21
Sample Number: 1543210907-05

Thielsch Engineering Inc.

Cranston, RI

Client: Fuss & O'Neill
Project: MUP Grant FY 22/23
Haverhill, MA
Project No: 20170390.U30 **Figure** 21-S-B204

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	3.8	10.2	35.7	27.5	22.8	

Test Results (D6913 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1/2"	100.0		
3/8"	99.1		
#4	96.2		
#10	86.0		
#20	67.7		
#40	50.3		
#60	38.3		
#100	29.3		
#200	22.8		

* (no specification provided)

Material Description

Grey clayey sand (SC)

Atterberg Limits (ASTM D 4318)

PL= **LL=** **PI=**

Classification

USCS (D 2487)= **AASHTO (M 145)=**

Coefficients

D_{90}= 2.5966 D_{85}= 1.8897 D_{60}= 0.6255
D_{50}= 0.4199 D_{30}= 0.1577 D_{15}=
D_{10}= C_u= C_c=

Remarks

Sample visually classified as plastic. Sample rolled to 1/8".

Date Received: 9/8/21 **Date Tested:** 9/14/21

Tested By: CC

Checked By: Christina Colman

Title: Laboratory Coordinator

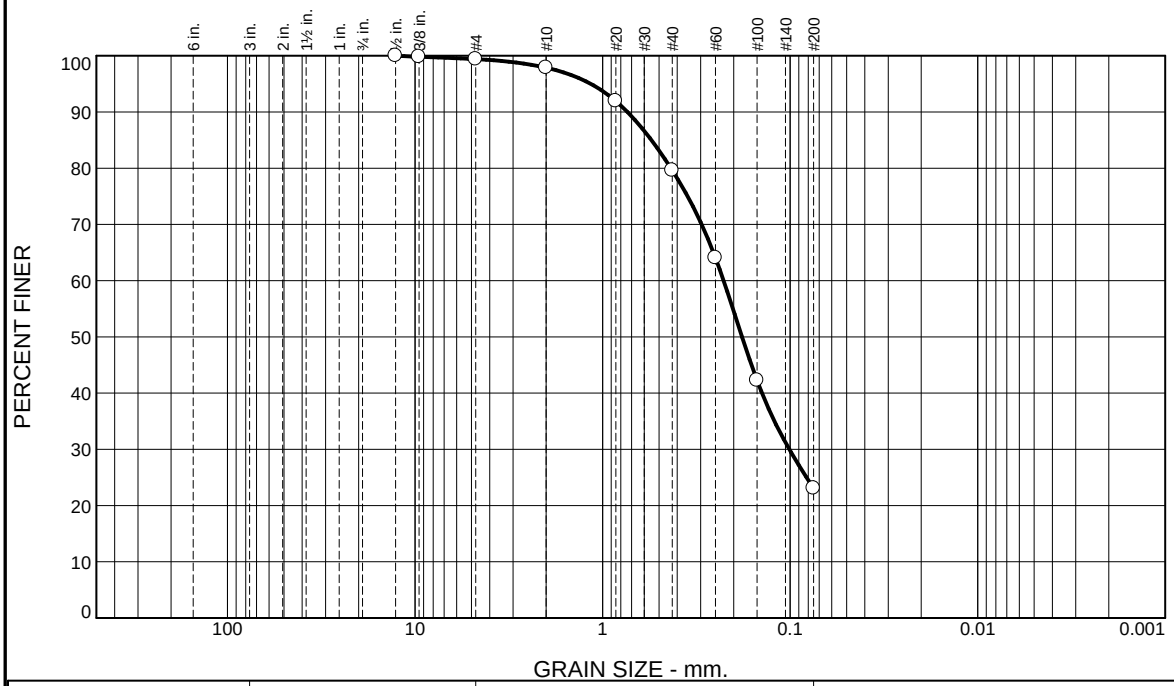
Source of Sample: B **Depth:** Unknown **Date Sampled:** 9/8/21
Sample Number: 1543210908-07

Thielsch Engineering Inc.

Cranston, RI

Client: Fuss & O'Neill
Project: MUP Grant FY 22/23
Haverhill, MA
Project No: 20170390.U30 **Figure** 21-S-B205

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.6	1.5	18.3	56.5	23.1	

Test Results (D6913 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1/2"	100.0		
3/8"	99.8		
#4	99.4		
#10	97.9		
#20	91.9		
#40	79.6		
#60	64.1		
#100	42.3		
#200	23.1		

* (no specification provided)

Material Description

Grey clayey sand (SC)

Atterberg Limits (ASTM D 4318)

PL= **LL=** **PI=**

Classification

USCS (D 2487)= **AASHTO (M 145)=**

Coefficients

D_{90}= 0.7371 D_{85}= 0.5491 D_{60}= 0.2263
D_{50}= 0.1804 D_{30}= 0.1011 D_{15}=
D_{10}= C_u= C_c=

Remarks

Sample visually classified as plastic. Sample rolled to 1/8".

Date Received: 9/8/21 **Date Tested:** 9/14/21

Tested By: CC

Checked By: Christina Colman

Title: Laboratory Coordinator

Source of Sample: B **Depth:** Unknown **Date Sampled:** 9/8/21
Sample Number: 1543210908-08

Thielsch Engineering Inc.

Cranston, RI

Client: Fuss & O'Neill
Project: MUP Grant FY 22/23
Haverhill, MA
Project No: 20170390.U30 **Figure** 21-S-B206

THIELSCH ENGINEERING

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Let's Build a Solid Foundation

Client Information:
Fuss & O'Neill
North Quincy, MA
PM: Matt Kissane
Assigned By: Matt Kissane
Collected By: Client

Project Information:
MUP Grant FY 22/23
Haverhill, MA
F&O Project Number: 20170390.U30
Summary Page: 1 of 1
Report Date: 09.29.21

LABORATORY TESTING DATA SHEET, Report No.: 7421-J-B008

Source Code	Sample No.	Depth (Ft)	Laboratory No.	Identification Tests								Proctor / CBR / Permeability Tests								Laboratory Log and Soil Description
				As Received Water Content %	LL %	PL %	Gravel %	Sand %	Fines %	Org. %	G_s	Dry unit wt. pcf	Test Water Content %	γ_d MAX (pcf) W_{opt} (%)	γ_d MAX (pcf) W_{opt} (%) (Corr.)	Target Test Setup as % of Proctor	CBR @ 0.1"	CBR @ 0.2"	Permeability cm/sec	
				D2216	D4318		D6913			D2974	D854			D1557						
B	1543210917-06	N/A	21-S-B240	28.7			0.0	65.8	34.2											Dark Brown clayey sand (SC)
B	1543210917-07	N/A	21-S-B241	56.0			0.0	22.0	78.0											Dark Brown clay (CL)

Date Received: *09.21.21*

Reviewed By: Christine M Cahoon

Date Reviewed: *09.29.21*

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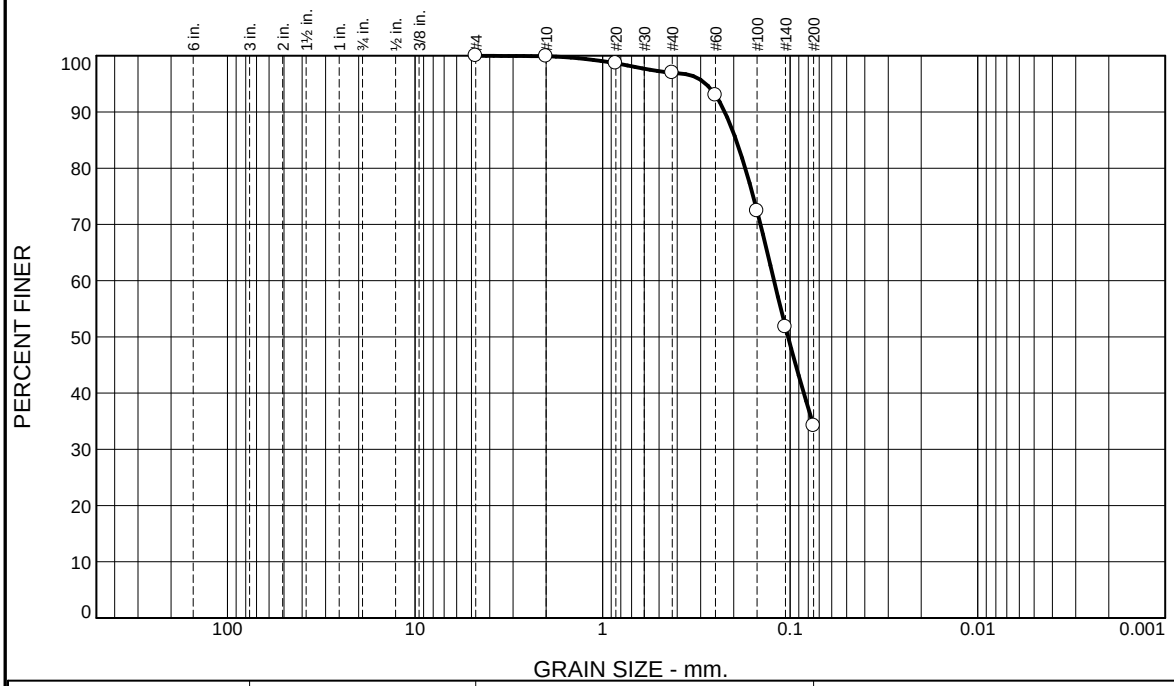
Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.1	2.9	62.8	34.2	

Test Results (D6913 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#4	100.0		
#10	99.9		
#20	98.7		
#40	97.0		
#60	93.0		
#100	72.4		
#140	51.8		
#200	34.2		

* (no specification provided)

Material Description

Dark Brown clayey sand (SC)

Atterberg Limits (ASTM D 4318)

PL= **LL=** **PI=**

Classification

USCS (D 2487)= **AASHTO (M 145)=**

Coefficients

D_{90}= 0.2230 D_{85}= 0.1940 D_{60}= 0.1218
D_{50}= 0.1027 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Sample visually classified as plastic. Sample rolled to 1/8".

Date Received: 9/20/21 **Date Tested:** 9/27/21

Tested By: DN / CC

Checked By: Christina Colman

Title: Laboratory Coordinator

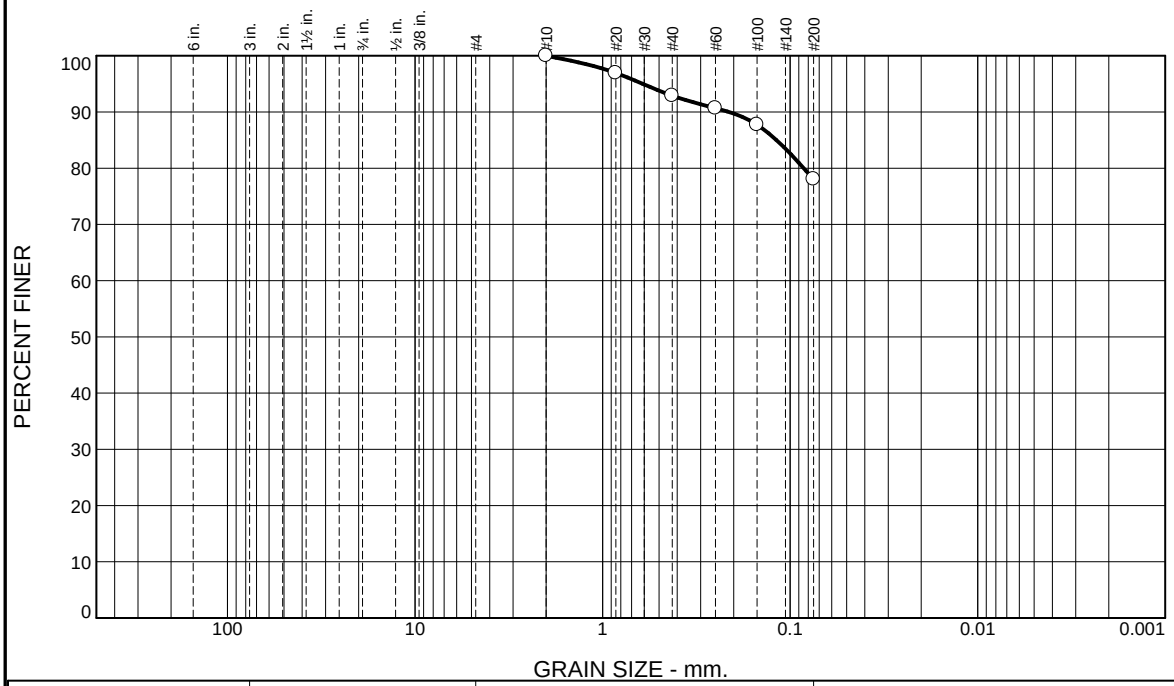
Source of Sample: B **Depth:** Unknown **Date Sampled:** 9/17/21
Sample Number: 1543210917-06

Thielsch Engineering Inc.

Cranston, RI

Client: Fuss & O'Neill
Project: MUP Grant FY 22/23
Haverhill, MA
Project No: 20170390.U30 **Figure** 21-S-B240

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	7.1	14.9	78.0	

Test Results (D6913 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#10	100.0		
#20	96.9		
#40	92.9		
#60	90.7		
#100	87.7		
#200	78.0		

* (no specification provided)

Material Description

Dark Brown clay (CL)

Atterberg Limits (ASTM D 4318)

PL= **LL=** **PI=**

Classification

USCS (D 2487)= **AASHTO (M 145)=**

Coefficients

D_{90}= 0.2119 D_{85}= 0.1182 D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Sample visually classified as plastic. Sample rolled to 1/16".

Date Received: 9/20/21 **Date Tested:** 9/27/21

Tested By: DN / CC

Checked By: Christina Colman

Title: Laboratory Coordinator

Source of Sample: B **Depth:** Unknown **Date Sampled:** 9/17/21
Sample Number: 1543210917-07

Thielsch Engineering Inc.

Cranston, RI

Client: Fuss & O'Neill
Project: MUP Grant FY 22/23
Haverhill, MA
Project No: 20170390.U30 **Figure** 21-S-B241

THIELSCH ENGINEERING
195 Frances Avenue
Cranston RI, 02910
Phone: (401)-467-6454
Fax: (401)-467-2398
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Let's Build a Solid Foundation

Client Information:
Fuss & O'Neill
Providence, RI
PM: Matt Kissane
Assigned By: Matt Kissane
Collected By: Fuss & O'Neill

Project Information:
Little River
Haverhill, MA
F&O Project Number: 20170390.V20
Summary Page: 1 of 1
Report Date: 06.16.22

LABORATORY TESTING DATA SHEET, Report No.: 7422-F-143

Source	Sample No.	Depth (ft)	Laboratory No.	Identification Tests								Proctor / CBR / Permeability Tests								Laboratory Log and Soil Description
				As Received Moisture Content %	LL %	PL %	Gravel %	Sand %	Fines %	Org. %	pH	Dry unit wt. (pcf)	Test Moisture Content %	γ_d MAX (pcf) W_{opt} (%)	γ_d MAX (pcf) W_{opt} (%) (Corr.)	Target Test Setup as % of Proctor	CBR @ 0.1"	CBR @ 0.2"	Permeability cm/sec	
				D2216	D4318		D6913			D2974	D4792			D1557						
Sediment	1708220608-11	-	22-S-1355	10.3			46.6	51.6	1.8											Dark Olive-Brown poorly graded sand with gravel
Sediment	1708220608-12	-	22-S-1356	5.5			63.2	36.2	0.6											Olive-Brown well-graded gravel with sand

Date Received: *06.09.22*

Reviewed By:

Date Reviewed: *06.17.22*

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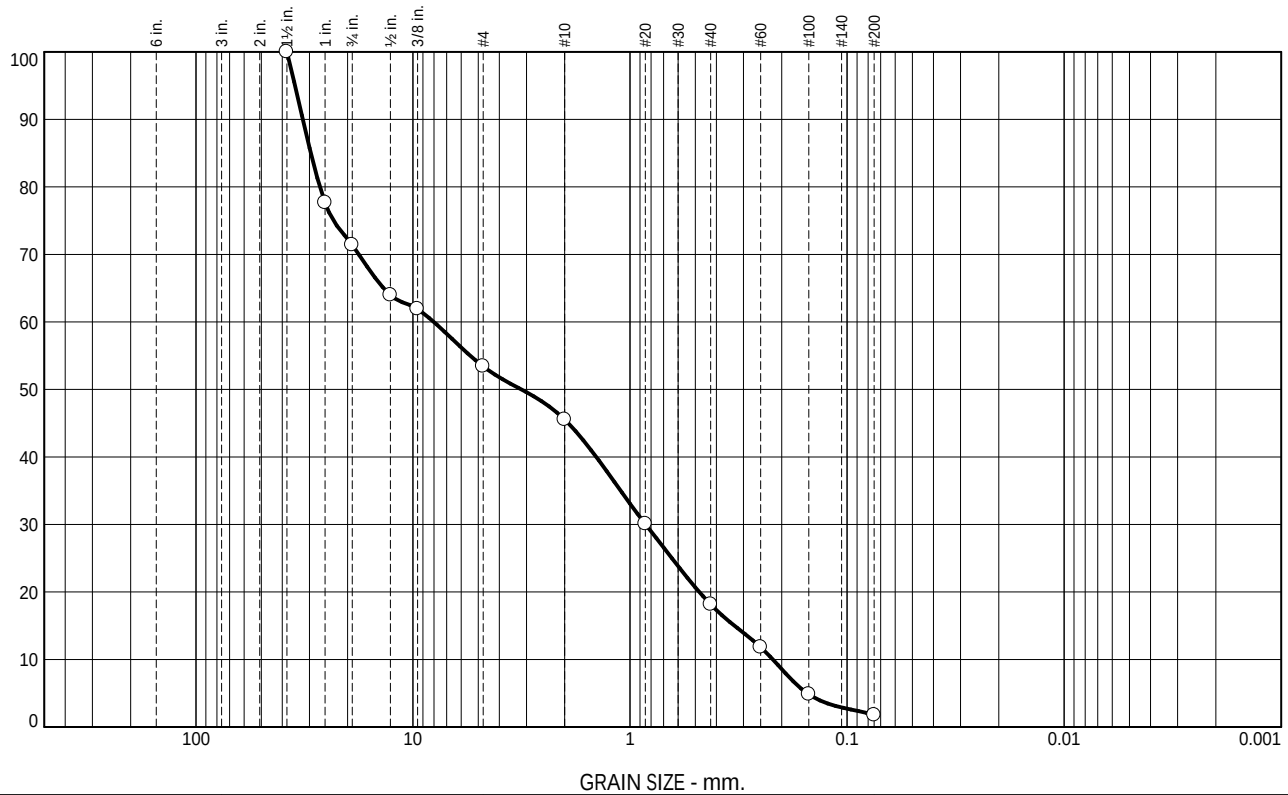
Particle Size Distribution Report

ASTM D6913



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	28.6	18.0	7.9	27.4	16.3	1.8	

Test Results (ASTM D6913)

Sieve Size or Diam. (mm.)	Finer (%)	Spec.* (%)	Out of Spec. (%)	Pct. of Fines
1 1/2"	100.0			
1"	77.7			
3/4"	71.4			
1/2"	64.0			
3/8"	61.9			
#4	53.4			
#10	45.5			85.2
#20	30.1			56.3
#40	18.1			34.0
#60	11.8			22.1
#100	4.8			9.0
#200	1.8			3.3

* (no specification provided)

Material Description

Dark Olive-Brown poorly graded sand with gravel

Atterberg Limits

PL= NP LL= NV PI= NP

Coefficients

D_{90}= 32.1757 D_{85}= 29.5491 D_{60}= 8.0238
D_{50}= 3.1699 D_{30}= 0.8470 D_{15}= 0.3302
D_{10}= 0.2198 C_u= 36.50 C_c= 0.41

Classification

USCS= SP AASHTO= A-1-a

Test Remarks

Source of Sample: Sediment Depth: -
Sample Number: 1708220608-11 Sample Date: 06.15.22

Thielsch Engineering Inc.

Cranston, RI

Client: Fuss & O'Neill
Project: Little River
Haverhill, MA
Project No: 20170390.V20

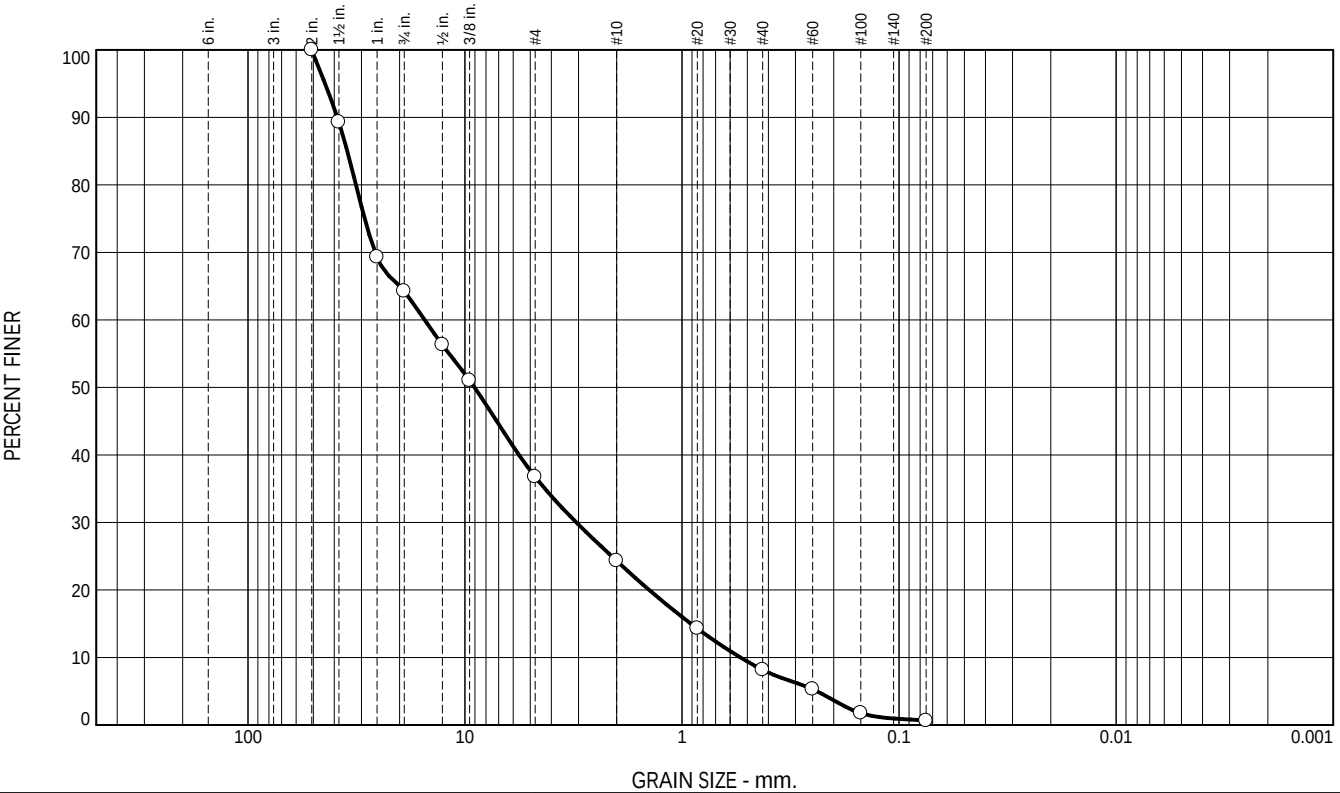
Figure 22-S-2175

Tested By: AV / FR Checked By:

These results are for the exclusive use of the client for whom they were obtained. They apply only to the samples tested and are not indicative of apparently identical samples.

Particle Size Distribution Report

ASTM D6913



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	35.8	27.4	12.5	16.1	7.6	0.6	

Test Results (ASTM D6913)

Sieve Size or Diam. (mm.)	Finer (%)	Spec.* (%)	Out of Spec. (%)	Pct. of Fines
2"	100.0			
1 1/2"	89.3			
1"	69.3			
3/4"	64.2			
1/2"	56.3			
3/8"	51.0			
#4	36.8			
#10	24.3			66.1
#20	14.3			38.9
#40	8.2			22.2
#60	5.3			14.4
#100	1.8			4.8
#200	0.6			1.7

* (no specification provided)

Material Description

Olive-Brown well-graded gravel with sand

Atterberg Limits

PL= NP LL= NV PI= NP

Coefficients

D_{90}= 38.7286 D_{85}= 34.8556 D_{60}= 15.3311
D_{50}= 9.0439 D_{30}= 3.0690 D_{15}= 0.9097
D_{10}= 0.5382 C_u= 28.49 C_c= 1.14

Classification

USCS= GW AASHTO= A-1-a

Test Remarks

Source of Sample: Sediment Depth: -
Sample Number: 1708220608-12 Sample Date: 06.15.22

Thielsch Engineering Inc.

Cranston, RI

Client: Fuss & O'Neill
Project: Little River
Haverhill, MA
Project No: 20170390.V20

Figure 22-S-2176

Tested By: AV / FR Checked By:

These results are for the exclusive use of the client for whom they were obtained. They apply only to the samples tested and are not indicative of apparently identical samples.

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Let's Build a Solid Foundation

Client Information:
Fuss & O'Neil
North Quincy, MA
PM: Matt Kissane
Assigned By: Matt Kissane
Collected By: Client

Project Information:
MVP Action Grant RY21
Haverhill, MA
F&ON Project Number: 201703901.V20
Summary Page: 1 of 1
Report Date: 11.23.2020

LABORATORY TESTING DATA SHEET, Report No.: 7420-L-155

Source	Sample No.	Depth (Ft)	Laboratory No.	Identification Tests								Proctor / CBR / Permeability Tests								Laboratory Log and Soil Description
				As Received Water Content %	LL %	PL %	Gravel %	Sand %	Fines %	Org. %	G_s	Dry unit wt. pcf	Test Water Content %	γ_d MAX (pcf) W_{opt} (%)	γ_d MAX (pcf) W_{opt} (%) (Corr.)	Target Test Setup as % of Proctor	CBR @ 0.1"	CBR @ 0.2"	Permeability cm/sec	
				D2216	D4318		D6913			D2974	D854			D1557						
Boring	1543201117-02	-	20-S-3562	106.9			9.4	67.3	23.3											Brown silty sand
Boring	1543201117-03	-	20-S-3563	50.1			22.0	71.3	6.7											Brown poorly graded sand with silt and gravel
Boring	1543201117-04	-	20-S-3564	91.0			2.3	53.0	44.7											Brown silty sand

Date Received: *11.19.2020*

Reviewed By: SH

Date Reviewed: *11.23.2020*

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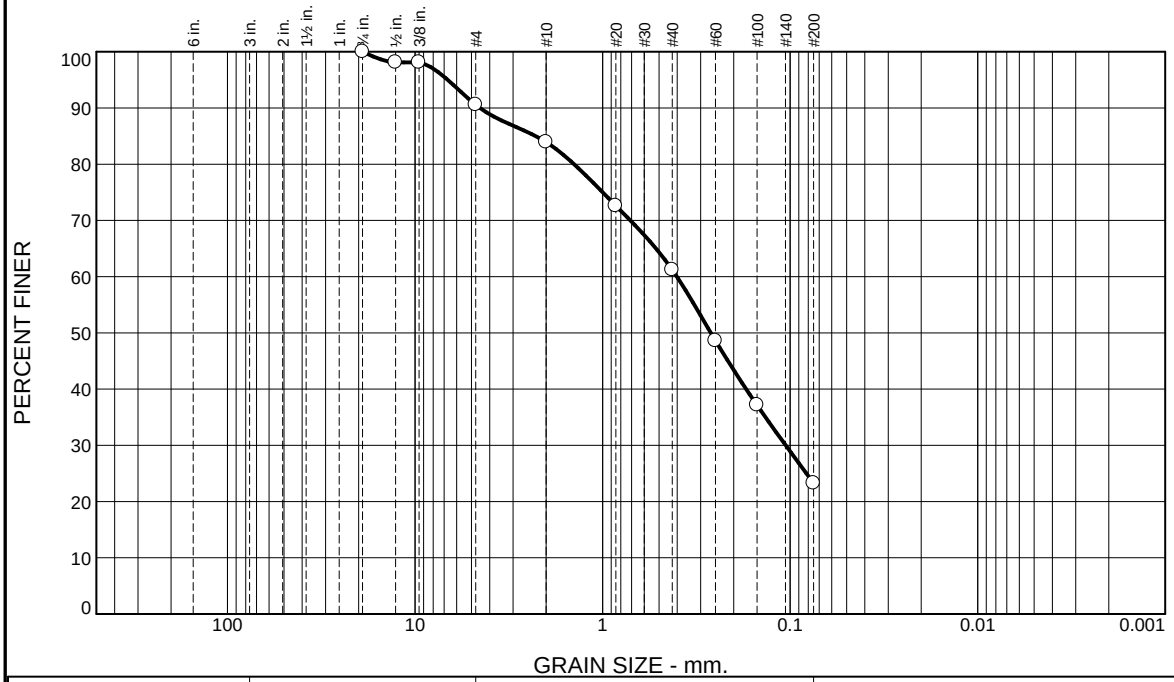
Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	9.4	6.7	22.7	37.9	23.3	

Test Results (C136 & ASTM C 117)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
0.75"	100.0		
0.5"	98.1		
0.375"	98.1		
#4	90.6		
#10	83.9		
#20	72.6		
#40	61.2		
#60	48.6		
#100	37.1		
#200	23.3		

* (no specification provided)

Material Description

Brown silty sand

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-2-4(0)

Coefficients

D_{90}= 4.5071 D_{85}= 2.2730 D_{60}= 0.4016
D_{50}= 0.2647 D_{30}= 0.1056 D_{15}=
D_{10}= C_u= C_c=

Remarks

Date Received: 11.19.2020 **Date Tested:** 11.23.2020

Tested By: AV

Checked By: Steven Accetta

Title: Laboratory Coordinator

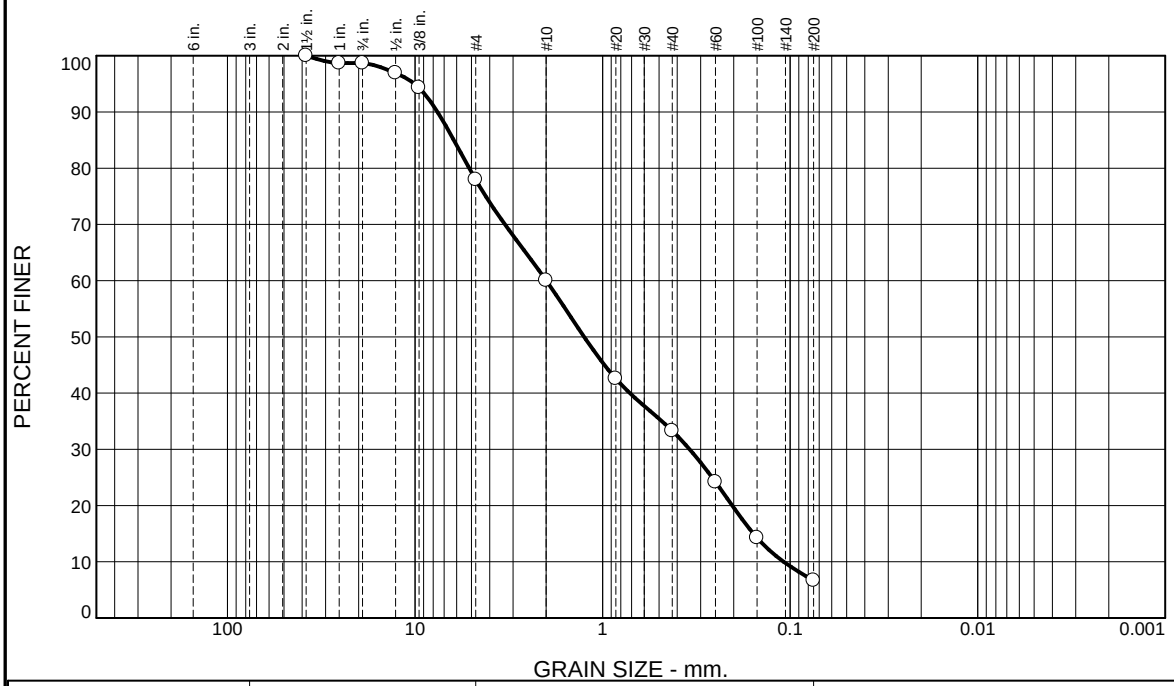
Source of Sample: Borings **Date Sampled:**
Sample Number: 1543201117-02

Thielsch Engineering Inc.

Cranston, RI

Client: Fuss & O'Neil
Project: MVP Action Grant RY21
Haverhill, MA
Project No: 20170390.V20 **Figure** 20-S-3562

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	1.3	20.7	18.0	26.7	26.6	6.7	

Test Results (C136 & ASTM C 117)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1.5"	100.0		
1"	98.7		
0.75"	98.7		
0.5"	96.9		
0.375"	94.3		
#4	78.0		
#10	60.0		
#20	42.6		
#40	33.3		
#60	24.2		
#100	14.3		
#200	6.7		

* (no specification provided)

Material Description

Brown poorly graded sand with silt and gravel

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SP-SM **AASHTO (M 145)=** A-1-b

Coefficients

D_{90}= 7.5833 D_{85}= 6.2094 D_{60}= 1.9954
D_{50}= 1.2535 D_{30}= 0.3433 D_{15}= 0.1567
D_{10}= 0.1083 C_u= 18.42 C_c= 0.55

Remarks

Date Received: 11.19.2020 **Date Tested:** 11.23.2020

Tested By: AV

Checked By: Rebecca Roth

Title: Laboratory Coordinator

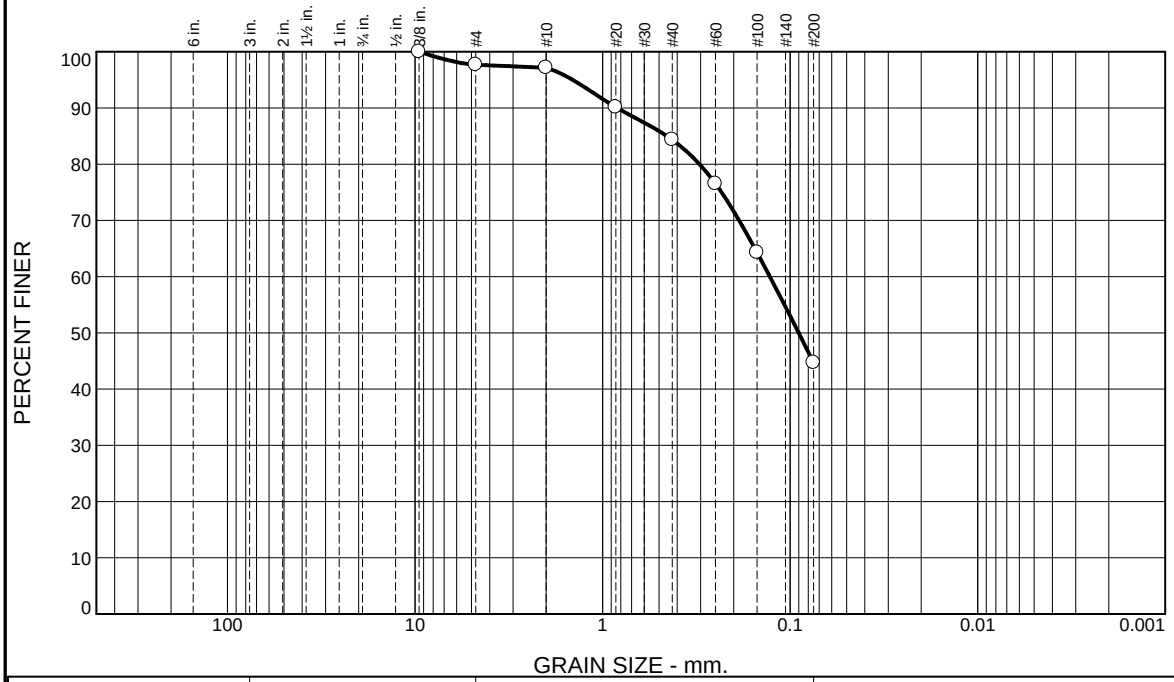
Source of Sample: Borings **Date Sampled:**
Sample Number: 1543201117-03

Thielsch Engineering Inc.

Cranston, RI

Client: Fuss & O'Neil
Project: MVP Action Grant RY21
Haverhill, MA
Project No: 20170390.V20 **Figure** 20-S-3563

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	2.3	0.5	12.9	39.6	44.7	

Test Results (C136 & ASTM C 117)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
0.375"	100.0		
#4	97.7		
#10	97.2		
#20	90.1		
#40	84.3		
#60	76.5		
#100	64.3		
#200	44.7		

* (no specification provided)

Material Description

Brown silty sand

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-4(0)

Coefficients

D_{90}= 0.8363 D_{85}= 0.4536 D_{60}= 0.1282
D_{50}= 0.0901 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Date Received: 11.19.2020 **Date Tested:** 11.23.2020

Tested By: AV

Checked By: Rebecca Roth

Title: Laboratory Coordinator

Source of Sample: Borings **Date Sampled:**
Sample Number: 1543201117-04

Thielsch Engineering Inc.

Cranston, RI

Client: Fuss & O'Neil
Project: MVP Action Grant RY21
Haverhill, MA
Project No: 20170390.V20 **Figure** 20-S-3564

LITTLE RIVER DAM

PHASE I
INSPECTION / EVALUATION REPORT

Dam Name:	Little River Dam
NID ID #	MA00739
Owner:	Unknown
Town:	Haverhill
Consultant:	Pare Corporation
Date of Inspection:	June 19, 2019

PARE
CORPORATION

Dam Evaluation Summary Detail Sheet

1. NID ID:	MA00739	4. Inspection Date:	June 19, 2019
2. Dam Name:	Little River Dam	5. Last Insp. Date:	June 19, 2013
3. Dam Location:	Haverhill, MA	6. Next Inspection:	June 19, 2024
7. Inspector:	David R. Caouette, P.E.		
8. Consultant:	Pare Corporation		
9. Hazard Code:	Significant	9a. Is Hazard Code Change Requested?:	No
10. Insp. Frequency:	5 Years	11. Overall Physical Condition of Dam:	FAIR
12. Spillway Capacity (% SDF)	N/A		

E1. Design Methodology:	2	E7. Low-Level Discharge Capacity:	1
E2. Level of Maintenance:	1	E8. Low-Level Outlet Physical Condition:	1
E3. Emergency Action Plan:	1	E9. Spillway Design Flood Capacity:	5
E4. Embankment Seepage:	N/A	E10. Overall Physical Condition of the Dam:	3
E5. Embankment Condition:	N/A	E11. Estimated Repair Cost:	$85k-$203k
E6. Concrete Condition:	4		

Evaluation Description

E1: DESIGN METHODOLOGY
1. Unknown Design – no design records available
2. No design or post-design analyses
3. No analyses, but dam features appear suitable
4. Design or post design analysis show dam meets most criteria
5. State of the art design – design records available & dam meets all criteria

E2: LEVEL OF MAINTENANCE
1. Dam in disrepair, no evidence of maintenance, no O&M manual
2. Dam in poor level of upkeep, very little maintenance, no O&M manual
3. Dam in fair level of upkeep, some maintenance and standard procedures
4. Adequate level of maintenance and standard procedures
5. Dam well maintained, detailed maintenance plan that is executed

E3: EMERGENCY ACTION PLAN
1. No plan or idea of what to do in the event of an emergency
2. Some idea but no written plan
3. No formal plan but well thought out
4. Available written plan that needs updating
5. Detailed, updated written plan available and filed with MADCR, annual training

E4: SEEPAGE (Embankments, Foundations, & Abutments)
1. Severe piping and/or seepage with no monitoring
2. Evidence of monitored piping and seepage
3. No piping but uncontrolled seepage
4. Minor seepage or high volumes of seepage with filtered collection
5. No seepage or minor seepage with filtered collection

E5: EMBANKMENT CONDITION (See Note 1)
1. Severe erosion and/or large trees
2. Significant erosion or significant woody vegetation
3. Brush and exposed embankment soils, or moderate erosion
4. Unmaintained grass, rodent activity and maintainable erosion
5. Well maintained healthy uniform grass cover

E6: CONCRETE CONDITION (See Note 2)
1. Major cracks, misalignment, discontinuities causing leaks, seepage or stability concerns
2. Cracks with misalignment inclusive of transverse cracks with no misalignment but with potential for significant structural degradation
3. Significant longitudinal cracking and minor transverse cracking
4. Spalling and minor surface cracking
5. No apparent deficiencies

E7: LOW-LEVEL OUTLET DISCHARGE CAPACITY
1. No low level outlet, no provisions (e.g. pumps, siphons) for emptying pond
2. No operable outlet, plans for emptying pond, but no equipment
3. Outlet with insufficient drawdown capacity, pumping equipment available
4. Operable gate with sufficient drawdown capacity
5. Operable gate with capacity greater than necessary

E8: LOW-LEVEL OUTLET PHYSICAL CONDITION
1. Outlet inoperative needs replacement, non-existent or inaccessible
2. Outlet inoperative needs repair
3. Outlet operable but needs repair
4. Outlet operable but needs maintenance
5. Outlet and operator operable and well maintained

E9: SPILLWAY DESIGN FLOOD CAPACITY
1. 0 - 50% of the SDF or unknown
2. 50-90% of the SDF
3. 90 - 100% of the SDF
4. >100% of the SDF with actions required by caretaker (e.g. open outlet)
5. >100% of the SDF with no actions required by caretaker

E10: OVERALL PHYSICAL CONDITION OF DAM
1. UNSAFE – Major structural, operational, and maintenance deficiencies exist under normal operating conditions
2. POOR - Significant structural, operation and maintenance deficiencies are clearly recognized under normal loading conditions
3. FAIR - Significant operational and maintenance deficiencies, no structural deficiencies. Potential deficiencies exist under unusual loading conditions that may realistically occur. Can be used when uncertainties exist as to critical parameters
4. SATISFACTORY - Minor operational and maintenance deficiencies. Infrequent hydrologic events would probably result In deficiencies.
5. GOOD - No existing or potential deficiencies recognized. Safe performance is expected under all loading including SDF

E11: ESTIMATED REPAIR COST
Estimation of the total cost to address all identified structural, operational, maintenance deficiencies. Cost shall be developed utilizing standard estimating guides and procedures

Changes/Deviations to Database Information since Last Inspection

EXECUTIVE SUMMARY

This Phase I Inspection/Evaluation Report details the inspection and evaluation of the Little River Dam located in Haverhill, Massachusetts. The inspection of Little River Dam was conducted on June 19, 2019 by Pare Corporation (Pare) of Foxboro, Massachusetts. The dam has a total length of approximately 75-feet and a maximum height of 12 feet. The Little River Dam is considered a Small size, Significant hazard (Class II) potential structure.

A formal Operations and Maintenance Manual is not available for the dam.

An Emergency Action Plan has not been prepared for this dam. On February 10, 2017, MADCR regulations require owners of significant hazard dams to prepare an emergency action plan for their dam. This requirement became effective when the Department of Conservation and Recreation, Office of Dam Safety promulgated regulatory changes mandated by amended General Laws Part 1-Title II, Chapter 21, Section 65 (b)-Emergency Action Plans for high and significant hazard dams.

Little River Dam was found to be in **Fair** condition. The following deficiencies were noted during this inspection:

1. The dam is currently inaccessible due to excessive vegetation along the right abutment and an abandoned mill structure on the left abutment;
2. Spalling/cracking of concrete along the left training wall upstream of spillway;
3. Encroaching vegetation along the left approach of the primary spillway;
4. Dense vegetation and tree growth along the top of wall along the right abutment;
5. No dam Owner or Caretaker;
6. No Operations & Maintenance (O&M) Manual;
7. No Emergency Action Plan (EAP).

More detailed descriptions, additional deficiencies, recommended repairs, and opinions of probable repair costs are provided within this report.

Based upon the size and hazard potential of this structure, the spillway design flood (SDF) for a dam of this size and hazard potential is the 100-year storm event. No H&H analyses are known to exist for this structure. Therefore, it is unknown if the dam can accommodate the SDF.

Pare Corporation recommends the following actions be taken to address the deficiencies found at the dams during this inspection and evaluation:

1. Provide accessibility to the dam; reinspect the dam during a period of low flow.
2. Clear vegetation from the right abutment.
3. Clear encroaching vegetation along the upstream shorelines on the left and right side of the spillway.
4. Determine ownership of the dam.
5. Develop an O&M Manual
6. Develop an EAP
7. Complete a detailed H&H analysis
8. Perform regular maintenance, monitoring, and inspections of the dam and associated appurtenant structures.
9. Complete additional evaluations, repairs, and remedial measures as recommended herein.

These repairs should be made in accordance to standard design practices, specifications, and construction methods. Design of the repairs, analyses to confirm the extent of the work, and observation to verify materials/methods used should be completed by a qualified engineer experienced in the design and rehabilitation of earthen dams throughout the evaluation, design, and construction process.

Prior to undertaking recommended maintenance, repairs and remedial measures, the applicability of environmental permits needs to be determined for activities that may occur within resource areas under the jurisdiction of local conservation commissions, Massachusetts Department of Environmental Protection (MADEP), or other regulatory agencies.

PREFACE

The assessment of the general condition of the dam system is based upon available data and visual inspections. Detailed investigations and analyses involving topographic mapping, subsurface investigations, testing and detailed computational evaluations are beyond the scope of this report.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection, along with data available to the inspection team. In cases where an impoundment is lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions, which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is critical to note that the condition of the dam depends on numerous and constantly changing internal and external conditions and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Allen R. Orsi, P.E.
Vice President
Massachusetts License No.: 46904
License Type: Civil
Pare Corporation

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FIGURES

Figure 1:	Locus Plan
Figure 2:	Aerial Plan
Figure 3:	Drainage Area Map
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APPENDICES

Appendix A:	Photographs
Appendix B:	Inspection Checklists
Appendix C:	Previous Reports and References
Appendix D:	Common Dam Safety Definitions
Appendix E:	Visual Dam Inspection Limitations

SECTION 1

1.0 DESCRIPTION OF PROJECT

1.1 General

1.1.1 Authority

The Massachusetts Department of Conservation and Recreation Office of Dam Safety has retained Pare Corporation (Pare) to perform a visual inspection and develop a report of conditions for the Little River Dam (MA00739) in Haverhill, Massachusetts. This inspection and report were performed in accordance with MGL Chapter 253, Sections 44-50 of the Massachusetts General Laws.

1.1.2 Purpose of Work

The purpose of this investigation is to inspect and evaluate the present condition of the dam and appurtenant structures in accordance with 302 CMR10.00 to provide information that will assist in both prioritizing dam repair needs and planning/conducting maintenance and operation.

The investigation is divided into four parts: 1) obtain and review available reports, investigations, and data previously submitted to the owner pertaining to the dam and appurtenant structures; 2) perform a visual inspection of the site; 3) evaluate the status of and need for an emergency action plan for the site and; 4) prepare and submit a final report presenting the evaluation of the structure, including recommendations for remedial actions, and an opinion of probable costs.

1.1.3 Definitions

To provide the reader with a better understanding of the report, definitions of commonly used terms associated with dams are provided in Appendix D. Many of these terms may be included in this report. The terms are presented under common categories associated with dams which include: 1) orientation; 2) dam components; 3) size classification; 4) hazard classification; 5) general; and, 6) condition rating.

1.2 Description of Project

1.2.1 General

Sections of this report are based upon available documentation, including previous inspection reports and other available information as identified in Appendix C. Other information obtained during the inspection and during preparation of this report has also been incorporated into this report. This material is intended to provide general information. The accuracy of this referenced information was not verified as it was outside the scope of work for this inspection.

The completion of detailed hydrologic/hydraulic studies, stability analyses, subsurface investigations, and underwater investigations are beyond the scope of this evaluation.

1.2.2 Location

Little River Dam is located within Essex County, in the City of Haverhill, Massachusetts. The dam impounds water along Little River to form a run-of-the-river dam. Flow from the river is impounded at the dam to form the Little River Reservoir. Discharges from the dam continue downriver and eventually flow into the Merrimack River approximately 2,400 feet southeast of the dam. The structure and the impoundment are shown on the Haverhill, Massachusetts USGS quadrangle map near coordinates 42.77764°N\71.08868°W. The dam is located along the southern side of the impoundment as indicated on Figure 1: Locus Plan.

To reach the dam from Interstate 495, Take Exit 50 for Route 97 South for Downtown Haverhill and follow for approximately 1.3 miles. The dam will be approached from the downstream side via Winter Street. The right abutment can be accessed via a parking lot for a convenience store (Sam's Food Stores). To reach the left abutment continue on Winter Street and take the first left (after crossing over the Little River) onto Stevens Street. The dam can be accessed through an abandoned mill structure located on the left immediately after turning onto Stevens Street. Note that steep walls on the right side and an abandoned mill structure limit access to the dam from both the left and right abutments.

1.2.3 Owner/Operator

The MADCR Office of Dam Safety database indicates that currently ownership is unknown. Operational and maintenance responsibilities for the dam remain undetermined.

1.2.4 Purpose of the Dam

Historically, the dam was built to support the Hale's / Stevens Mills along the left abutment of the dam. A historical photo dates the dam to the early 19th century. However, at this time, the impoundment is used for passive recreational purposes.

1.2.5 Description of the Dam System and Appurtenances

As indicated in the 2013 Phase I Inspection/Evaluation Report:

> The Little River Dam is a run-of-the-river dam located adjacent to a historic mill complex about 70 feet upstream of a public bridge. The dam has no embankment, but consists entirely of a cascading, granite block masonry, gravity structure. According to a 2000 inspection report, the structural height of the dam is 12 feet and the granite block crest is 75 feet long and 18 inches wide. A mill channel race way was reportedly sealed off with cement and is no longer used. The dam does not appear to have a low-level outlet.
>
> At its right end, the dam abuts a vertical channel wall, which extends up approximately 6 feet above the dam crest. This wall is stone masonry except for the top 2.5 feet or so, which is concrete. A chain link fence is located behind the top of the wall, and a parking lot associated with a local business sits on the right abutment. The left end of the dam abuts a brick mill building. A concrete training wall runs along the building upstream of the dam up to a height of about 3 feet above the spillway elevation. The building juts left at the dam, so a short length of stone masonry is exposed at its left end, beyond the end of the spillway.

The downstream face of the dam consists of granite blocks or cobbles, over which the spillway flow cascades to dissipate energy before continuing into the downstream channel.

Based upon external geometry, it appears that the dam may extend behond the left training into and beneath the mill building at the left end of the spillway; access to determine actual geometry was not available at the time of the inspection.

1.2.6 Operations and Maintenance

The dam is self-regulating with no operations completed. There were no observable operable components present. There were no apparent maintenance activities completed at this site.

1.2.7 DCR Size Classification

The Little River Dam has a maximum structural height of 12 feet and a reported storage capacity of 25 acre-feet at maximum pool. Therefore, in accordance with Department of Conservation and Recreation Office of Dam Safety classification, under Commonwealth of Massachusetts dam safety rules and regulations stated in 302 CMR 10.00, the Little River Dam is a **Small** sized structure.

1.2.8 DCR Hazard Classification

The Little River Dam is located upstream of residential and commercial properties, MA-97, Haverhill Train Station, several secondary roadways, and a culvert that diverts flow under the city into the Merrimack River. It appears that a failure of the dam at maximum pool may cause damage to home(s), industrial or commercial facilities, secondary highway(s) or railroad(s), or cause the interruption of the use or service of relatively important facilities. Therefore, in accordance with Department of Conservation and Recreation classification procedures, under Commonwealth of Massachusetts dam safety rules and regulations stated in 302 CMR 10.00, Little River Dam is currently classified as a **Significant (Class II)** hazard potential structure.

It appears that the bridge downstream of the dam is lower in elevation that the top of dam; as such, the bridge may not be impacted by a failure of the dam. Based upon performance of the river crossing and the culvert system during a dam failure event, the dam may be more appropriately considered a low hazard potential structure.

1.3 Engineering Data

1.3.1 Drainage Area

Based upon Massachusetts Streamstats[1] drainage area data, the contributing watershed was delineated to approximately 28 square miles.

In general, the watershed extends to the north approximately 8.3 miles into East Hampstead, NH, 2.8 miles to the west into Atkinson NH, and 3.7 miles to the east into Newton, NH. The drainage area

[1] http://streamstats.usgs.gov/ss/

consists of undeveloped forest, areas of open water, areas of wetland, and areas of urban development. The slope of the watershed varies from mild to moderate terrain.

1.3.2 Reservoir

The following table of reservoir properties is generally based upon previous reports and scaled dimensions from available aerial imagery.

Table 1.1: Reservoir Properties

	Elevation (ft)	Length (feet)	Width (feet)	Surface Area (acres)	Storage Volume (acre-feet)
Normal Pool	15	Unknown	75	4 ±	11 ±
Maximum Pool	22	Unknown	75 ±	5 ±	25 ±
SDF Pool	19.1	Unknown	Unknown	Unknown	Unknown

1.3.3 Discharges at the Dam Site

No records of discharges from the dam were made available during the preparation of this report.

1.3.4 General Elevations

No relative elevation survey was able to be performed during the current inspection. Elevations within this report referenced the 2013 Phase I Inspection/Evaluation Report.

A. Top of Dam	
1. Spillway Crest	15 ft
2. Right Abutment	22 ft ±
3. Left Abutment	19.1 ft ±
B. Spillway Design Flood (SDF)	100-year / 1930[1] CFS
C. SDF Elevation	19.1 ft ±
D. Normal Pool	15 ft
E. Spillway Crest	15 ft
F. Upstream Water at Time of Survey	15.3 ft

1.3.5 Spillway

A. Type	Uncontrolled Broad Crested Weir
B. Length	75 ft
C. Crest Elevation	15 ft
D. Downstream Toe of Dam	3 ft

1.3.6 Design and Construction Records

There were no construction records or information regarding the original construction of the structure available during the preparation of this report. According to previous reports, the dam was built

[1] USGS StreamStats, Peak-Flow Statistics Flow Report, 100-year Peak Flood, Regression

ca. 1870. Photographs found at the Haverhill Public Library indicate that the dam may have been originally constructed in the 19th century to support shoe manufacturing and other manufacturing in this era.

1.3.7 Operating Records

No records were made available during the preparation of this report, nor are any known to exist.

1.4 Summary Data Tables

Table 1.2 - Summary Data Table

National ID #	MA00739
Dam Name	Little River Dam
Dam Name (Alternate)	N/A
River Name	Little River
Impoundment Name	Little River
Hazard Class	Significant
Size Class	Small
Dam Type	Stone Embankment
Dam Purpose	Recreation (Formerly mill power)
Structural Height of Dam (feet)	12
Hydraulic Height of Dam (feet)	12
Drainage Area (sq. mi.)	28
Reservoir Surface Area (acres)	57
Normal Impoundment Volume (acre-feet)	11
Max Impoundment Volume ((top of dam) acre-feet)	Unknown
SDF Impoundment Volume (acre-feet)	1720 (current) / 1850 (proposed)
Spillway Type	Uncontrolled broad crested weir
Spillway Length (feet)	75
Freeboard at Normal Pool (feet)	3.7
Principal Spillway Capacity (cfs)	1940 +/-
Auxiliary Spillway Capacity (cfs)	N/A
Low-Level Outlet Capacity (cfs)	N/A
Spillway Design Flood (flow rate - cfs)	100-year / 1,930 CFS (Regression)
Winter Drawdown (feet below normal pool)	5 to 6 feet
Drawdown Impoundment Vol. (acre-feet)	~1000
Latitude	42.77764°N
Longitude	71.08868°W
City/Town	Haverhill
County Name	Essex
Public Road on Crest	No
Public Bridge over Spillway	No
EAP Date (if applicable)	None.
Owner Name	Unknown
Owner Address	Unknown
Owner Town	Unknown
Owner Phone	Unknown
Owner Emergency Phone	978-360-9146
Owner Type	Other State Agencies
Caretaker Name	Unknown
Caretaker Address	Unknown
Caretaker Town	Unknown
Caretaker Phone	Unknown
Caretaker Emergency Phone	Unknown
Date of Field Inspection	6/19/2019
Consultant Firm Name	Pare Corporation
Inspecting Engineer	David R. Caouette, P.E.
Engineer Phone Number	508-543-1755

SECTION 2

2.0 INSPECTION

2.1 Visual Inspection

The Little River Dam was inspected on June 19, 2019. At the time of the inspection, the weather was overcast with temperatures near 70°F. The level of the impoundment was approximately 2-3 inches above the spillway crest. Photographs to document the conditions during the inspection were taken and are included in Appendix A. Underwater areas were not inspected. A copy of the inspection checklist is included in Appendix B.

During the current inspection, there was no access to the dam. Abutting the right side of the dam exists an abandoned mill building. Abutting the left side of the dam is a concrete retaining wall that is blocked off by a chain link fence. The inspection was visually performed from the Winter Street Bridge approximately 80 feet downstream of the dam.

A baseline could not be established along the dam; therefore, observations were made with approximate relation to their location along the dam.

2.1.1 General Findings

Based upon limited observations made during the inspection due to inaccessibility, the dam appears to be in **Fair** condition. The specific concerns are identified in more detail in the sections below:

2.1.2 Little River Dam

Little River Dam is a "run-of-the-river" dam with no accessible embankment sections or appurtenant structures. However, based upon external geometry, a short section of embankment may exist left of the spillway within the lower level of the adjacent mill complex; access to confirm the presence of an embankment section in this area or complete an inspection was not provided during the inspection.

2.1.3 Appurtenant Structures

Crest/Spillway

- Contact with the left and right abutment appeared normal with no unusual movement apparent.
- The crest appeared to be an uncontrolled broad crested weir.
  - A historical photo shows a timber flashboards/stoplogs spanning the crest in late 19th century. No evidence of flashboards/stoplogs were found during the current inspection.
- The spillway is reported to be a granite block masonry structure.
- At the time of inspection, water flow appeared to be uniform over the spillway crest.

- Immediately downstream of the spillway crest, 2 to 5-foot diameter stones sloped from approximately 1 to 2 feet below the crest to the downstream channel.
  - The rock apron appeared in good condition with no unusual movement observed.
  - Energy from overtopping waters appeared to be uniformly dissipated within the sloped rock apron downstream of the spillway crest.
- Minor debris (including small sticks and herbaceous matter) appeared to be caught on the spillway.
- The spillway approach was mostly clear; however, vegetation including trees, brush, and leafy aquatic vegetation, was observed to be growing along the upstream shoreline on the left side of the channel. Vegetation extended less than 10 feet into the channel.
- The discharge area was clear of debris.

Right Training/Channel Wall

- The right training and channel walls between the Winter Street bridge and upstream of the dam were overgrown with dense vegetation, including knotweed, poison ivy, briars, and other leafy vegetation. Vegetative growth limited inspection and access to the dam and spillway.
  - Vegetation extended from the top of the wall to a paved parking lot (approximately 5 to 10 feet behind the top of the wall)
  - Contact with the parking lot appeared normal.
- Downstream of the spillway, below the spillway crest elevation, the downstream wall is a dry set stone masonry wall; above the spillway crest elevation, the wall is a concrete wall.
  - Stone to stone contact within stone masonry section appeared normal.
  - Vegetation including trees (up to 4-inches diameter), weeds, and grasses were observed growing from the joints between stones.
  - The condition of the concrete portions of the wall was not able to be assessed due to overhanging vegetation.
  - At the contact with the Winter Street bridge (approximately 60-feet downstream of the dam), the concrete portion of the downstream wall was separated approximately 12-inches from the right bridge abutment of the Winter Street Bridge.
    - From the upstream sidewalk, there appears to be approximately 3-inches of separation between the granite block and the asphalt sidewalk.
    - This is reportedly an historical ongoing issue and is caused from stormwater erosion.

Left Training Wall

- Contact with left abutment appeared normal with no unusual movement observed.
- The spillway abuts a brick mill structure along the left side. The left abutment below the spillway crest elevation is stone masonry and also serves as the foundation for the adjacent mill structure.
  - Knotweed and other leafy vegetation were observed growing in the masonry joints.

- Above the spillway crest elevation is the brick mill structure with a concrete facing along the Mill river. Scouring, cracked concrete, and exposed aggregate was observed along the left concrete training wall upstream of the spillway. along the apparent normal high-water line
- Dense vegetation growth appeared along the left abutment, upstream of the spillway. Vegetation extended up to 10 feet into the impoundment/river, partially blocking the spillway approach.
- Between the spillway and the Winter Street bridge the downstream channel is lined by a brick mill building with a stone masonry foundation.
    - The stone masonry foundation is exposed for approximately 3 feet between the channel bottom and the brick structure.
    - Stone to stone contact along the foundation appears normal; however, missing mortar and missing chinking stones is typical.

2.1.4 Downstream Area

The area downstream of the dam continues flow along the Little River. The existing mill building directs flow along the left side of the river and a concrete retaining wall directs flow along the right side of the river. Flow then passes under Winter Street Bridge approximately 70 feet downstream of the dam. Beyond the bridge the Little River continues in a south southeasterly direction (confined by stone masonry and concrete walls) and then enters a culvert beneath the MBTA Haverhill Line rail road tracks, (approximately 650 feet downstream). According to 1947 USGS Topography maps, the river continues to flow south-southeast and discharges into the Merrimack River through a flood wall at the end of Wall Street, approximately 2,500 feet downstream of the dam. The surrounding area becomes urbanized closer to the surrounding area of downtown Haverhill.

2.1.5 Reservoir Area

The shoreline and surrounding area of the river is overgrown with dense vegetation followed immediately by residential structures on the right (west) and industrial mill buildings or gravel parking areas to the left (east). Upstream of the industrial facilities (which extend approximately 1,400 feet upstream) the MBTA Haverhill Line railroad is located adjacent to the impoundment. The rail line crosses over the impoundment approximately 3,300 feet upstream of the dam. Upstream of the rail crossing, the rail line abuts the right shore while the left shore is densely wooded and abuts several wetlands. Slopes on both the left and right shore lines are moderate to mild.

2.2 Caretaker Interview

No caretaker was available for interview at the time of the current inspection.

2.3 Operation and Maintenance Procedures

2.3.1 Operational Procedures

A formal operations and maintenance manual is not known to exist for this structure. There are no known operable components at the dam.

2.3.2 Maintenance of Dam and Operating Facilities

No maintenance procedures, formal or informal, are known to exist for this structure. It does not appear that any maintenance is performed at the dam.

2.4 Emergency Warning System

A detailed Emergency Action Plan has not been developed for this structure. As the dam is currently classified as a significant hazard dam, preparation of an emergency action plan is required by current state regulations.

2.5 Hydrologic/Hydraulic Data

The Little River Dam is a Small size, Class II (Significant) hazard potential structure and in accordance with Massachusetts Law, the spillway design flood (SDF) for this site is the 100-year storm event. According to the USGS StreamStats regression equations, the estimated peak 100-year flood flow is 1930 cfs.

No hydraulic and hydrologic (H&H) analysis was made available during the preparation of this report nor is one known to exist; therefore, the dam's ability to pass the SDF is unknown. No H&H was performed during the preparation of this report as it is beyond the scope of this project; however, based upon weir geometries and LiDAR elevation information, rough capacities for the primary spillway was estimated to be approximately 1940 cfs before the right abutment wall would be overtopped.

2.6 Embankment and Seepage Stability

2.6.1 Embankment Stability

No embankment stability analyses were made available during the preparation of this report nor is one known to exist; therefore, stability of the dam is unknown. No embankment stability calculations were performed during the preparation of this report as it is beyond the scope of this project; however, based upon visual observation of the dam, no immediate stability concerns were observed throughout the dam.

Note that during the inspection a section of the concrete portion of the downstream channel right wall adjacent to the Winter Street Bridge was rotated and leaning into the downstream channel by approximately 6-inches. While failure of this wall section would not affect the dam, it may cause a partial blockage of the downstream channel and cause a tailwater to develop prematurely during increased flow conditions.

2.6.2 Seepage Stability

No seepage stability analyses were made available during the preparation of this report nor is one known to exist; therefore, seepage stability of the dam is unknown. No seepage stability calculations were performed during the preparation of this report as it is beyond the scope of this project; however, based upon visual observation of the dam, no immediate seepage stability concerns were observed throughout the dam.

SECTION 3

3.0 ASSESSMENTS AND RECOMMENDATIONS

3.1 Assessments

In general, the overall condition of the Little River Dam is **Fair** with the following deficiencies identified:

TABLE 3.1: Deficiency Summary

Deficiency Number	*Description*
1	The dam is currently inaccessible due to excessive vegetation along the right abutment and an abandoned mill structure on the left abutment.
2	Spalling/cracking of concrete along left training wall upstream of spillway
3	Encroaching vegetation along the left approach of the primary spillway.
4	Dense vegetation and tree growth along the top of wall along the right abutment
5	No dam Owner or Caretaker
6	No Operation & Maintenance (O&M) Manual
7	No Emergency Action Plan (EAP)

The following table provides a summary of the previously reported deficiencies and the current condition:

Table 3.2: Summary of Previous Recommendations

Previously Identified Deficiency/Recommendation	*Resolution or Current Condition*
Minor debris build-up in spillway approach area	No Change
Significant erosion at downstream right bridge abutment from stormwater runoff	No Change / Condition Worsening

The following recommendations and remedial measures generally describe the recommended approach to address current deficiencies at the dams. Prior to undertaking recommended maintenance, repairs and remedial measures, the applicability of environmental permits needs to be determined for activities that may occur within resource areas under the jurisdiction of local conservation commissions, MADEP, or other regulatory agencies.

3.2 Studies and Analyses

It is recommended that the owner of the dam arrange for the following investigations to be performed by a qualified registered professional engineer experienced with embankment dams and hydrology, maintenance and monitoring activities.

1. Determine ownership of the dam and educate the owner of the responsibilities of dam ownership.

2. Develop an Operations and Maintenance (O&M) Manual for the dam. This manual should include procedures for maintaining the level of the impoundment, periodic inspection schedules, and

operational and maintenance procedures required to ensure satisfactory operation and to minimize deterioration of the facility.

3. Develop an Emergency Action Plan (EAP) and complete routine review and updates the document with complete periodic training of involved personnel. Currently no EAP is known to exist for this structure. In accordance to recent changes to CMR 302, significant hazard potential dam owners are now required to maintain an EAP following the required format (available on the MADCR website).

4. Complete a detailed H&H analysis for the dam to determine if the dam can safely accommodate the Spillway Design Flood Event (100-Year Storm). If verified to be hydraulically inadequate, develop and implement means of increasing the hydraulic capacity of the dam.

5. Once vegetation has been cleared from the right abutment and access can be established via the left abutment, reinspect the dam. This should preferably occur during a period of low/no flow when the dam could be accessed via the upstream side by boat and minimal flow is passing over the spillway allowing a clear view of the downstream face.

6. Determine ownership of the adjacent mill building on the left abutment and develop an easement agreement to allow access through the building to inspect the dam as needed.

7. Complete a review of the current hazard potential classification. Based on a review of the structures, impoundment, and hazards downstream of the dam, it may be justifiable to reduce the hazard classification of the dam to Low.

8. Investigate the presence of a low-level outlet based upon the previously reported abandoned mill raceway within the existing mill building. If an outlet is located, develop a means to restore operability or restore low level discharge capacity.

3.3 Yearly & Recurrent Maintenance Recommendations

The following recommendations should be performed on a regular schedule and allotted for within yearly operational budgets for the structures:

1. Perform regular monitoring and inspections of the dams and associated appurtenant structures, including areas of seepage, depressions, erosion, or other areas of suspected movement, to check for increases in flow rate or other signs of deteriorating conditions. Complete formal inspections in accordance with current state regulations. As the dam is currently classified as Significant hazard potential, formal inspections are required every 5 years.

2. Once a healthy stand of grass has been developed on the right abutment, regular maintenance activities should be implemented to control and prevent further growth of unwanted vegetation, as was noted in many areas of the dam. Mowing grass and cutting brush / leaning trees should be performed at least twice per year (i.e., late spring and fall).

3. Periodically remove vegetation and other debris that collects within the approach and discharge areas of the spillway. Clearing debris from the spillway helps to allow for the full capacity of the spillway to be realized during storm events.

4. Once developed complete routine reviews and updates of the Emergency Action Plan. Complete periodic training of involved personnel.

3.4 Repair Recommendations

The repairs presented below should be implemented to help maintain the integrity of the structure. If deferred, these maintenance items could develop into larger deficiencies that are more costly to address.

1. Clear vegetation from the right abutment to allow for the clear viewing of the dam and remove excess load from the right abutment wall. Once cleared, establish a stand of maintainable grass growth. If a stand of grass is not a preferred cover (due to required maintenance), cover the area with a durable material that will deter continued vegetative growth (i.e. pavement or dense grade fill.

2. Clear encroaching vegetation along the upstream shorelines on the left and right side of the spillway.

3. Implement concrete crack and patch repairs along the training walls of the dam, most focusing on the left training wall of the dam where concrete deterioration is observed. If certain areas of deterioration persist and/or worsen, more substantial repairs may be warrants.

3.5 Remedial Modification Recommendations

Based on the conditions observed during this report, there are no remedial modifications recommended at this time. However, subsequent to reinspection or completion of recommended studies, the need to implement remedial actions at the dam may become apparent.

3.6 Alternatives

All Recommendations: As an alternative to implementing the repairs noted above, breaching of the dam is a viable alternative to addressing safety and stability concerns at the dam. While this alternative will address the safety concerns, it will result in the loss of at least a portion of the environmental resource created by the dam. It should be noted that while this will result in elimination of yearly operating and maintenance expenses, the permitting and construction costs associated with dam removal could also be substantial depending upon site specific historic or environmental concerns related to the sediment within the impounded area, or the flora and fauna supported by the system

3.7 Opinion of Probable Costs

The conceptual opinions of probable costs have been developed for the recommendations and remedial measures noted above. The costs shown herein are based on a limited investigation and are provided for general information only. This should not be considered an engineer's estimate, as actual construction costs may be somewhat less or considerably more than indicated.

Studies and Analyses

1.	Determine Dam Ownership	*by MADCR*	
2.	Develop an O&M Manual	$ 5,000 -	$ 8,000
3.	Develop an EAP	$ 5,000 -	$ 8,000
4.	Complete H&H analysis	$ 5,000 -	$ 8,000
5.	Reinspect the Dam after Vegetation Removal and Low-flow	$ 2,500 -	$ 3,500
6.	Mill Ownership Determination / Easement	$ 2,500 -	$ 5,500
7.	Review Hazard Potential Classification	$ 3,000 -	$ 5,000
8.	Investigate the Presence of a Low-Level Outlet	$ 5,000 -	$ 10,000
	Subtotal	**$ 28,000 -**	**$ 48,000**

Yearly Recommendations

1.	Regular Monitoring and Inspection	$ 2,000 -	$ 4,000/yr.
2.	Regular Abutment Maintenance	$ 500 -	$ 2,000/yr.
3.	Regular Spillway Maintenance	$ 500 -	$ 3,000/yr.
4.	Review, Update, Exercise EAP	$ 1,000 -	$ 2,000/yr.
	Subtotal	**$ 4,000 -**	**$ 11,000/yr.**

Repair Recommendations

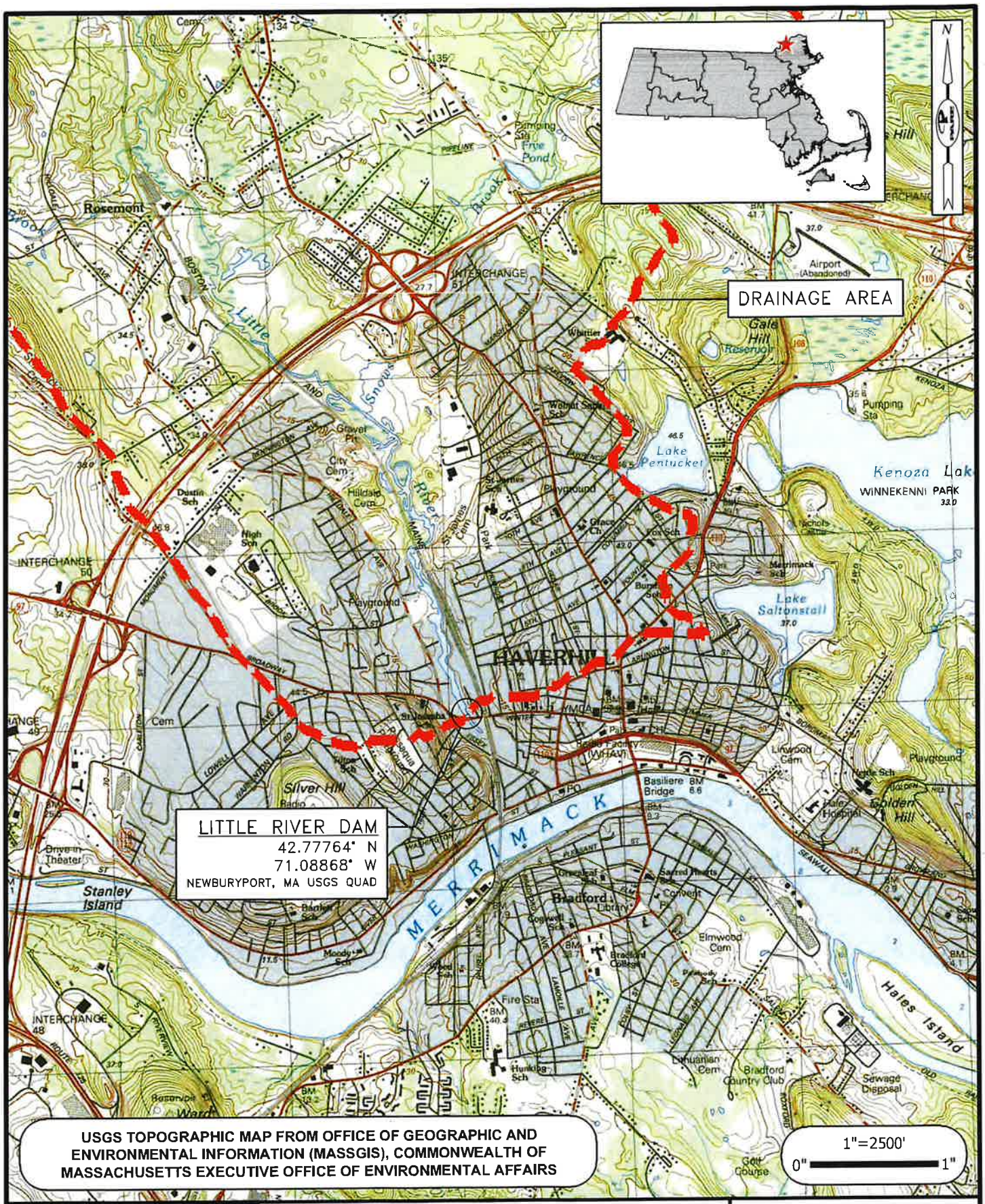
1.	Clear and Grub Right Abutment Establish Grass Cover	$ 10,000 -	$ 30,000
2.	Clear vegetation from spillway approach	$ 10,000 -	$ 30,000
3.	Concrete Repairs	$ 10,000 -	$ 25,000
	Subtotal	**$ 30,000 -**	**$ 85,000**

Engineering & Design	$ 10,000 -	$ 25,000
Permitting	$ 5,000 -	$ 15,000
Contingency	$ 8,000 -	$ 19,000
RECOMMENDATIONS TOTAL	**$ 85,000 -**	**$ 203,000**

When comparing costs, the total cost including design, engineering, permitting, construction and long-term maintenance should be considered.

While some of these activities can be undertaken as maintenance activities under 302 CMR 10 Dam Safety and will only require that the Office of Dam Safety be notified of the activities, the applicability of other environmental permits (i.e., NOI, PGP, Water Quality Certificate, etc.) needs to be determined prior to undertaking maintenance activities that may occur within resource areas under the jurisdiction of MADEP, the local conservation commission, or other regulatory agency.

FIGURES
Little River Dam
Haverhill, MA



USGS TOPOGRAPHIC MAP FROM OFFICE OF GEOGRAPHIC AND ENVIRONMENTAL INFORMATION (MASSGIS), COMMONWEALTH OF MASSACHUSETTS EXECUTIVE OFFICE OF ENVIRONMENTAL AFFAIRS

PARE CORPORATION

LITTLE RIVER DAM

MA00739

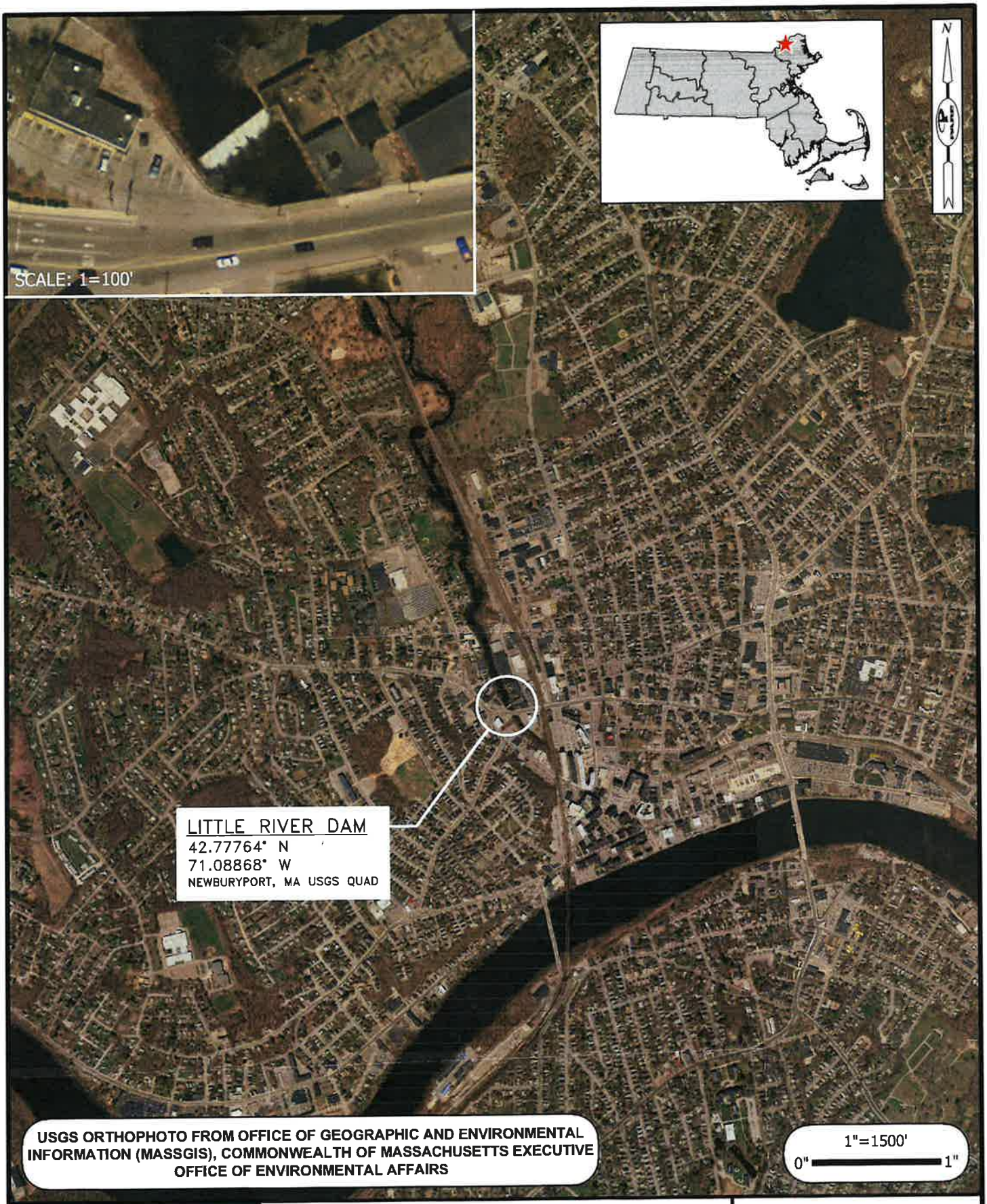
HAVERHILL, MASSACHUSETTS

OWNER UNKNOWN

LOCUS PLAN

JUNE 2019

FIGURE 1



PARE CORPORATION

LITTLE RIVER DAM

MA00739

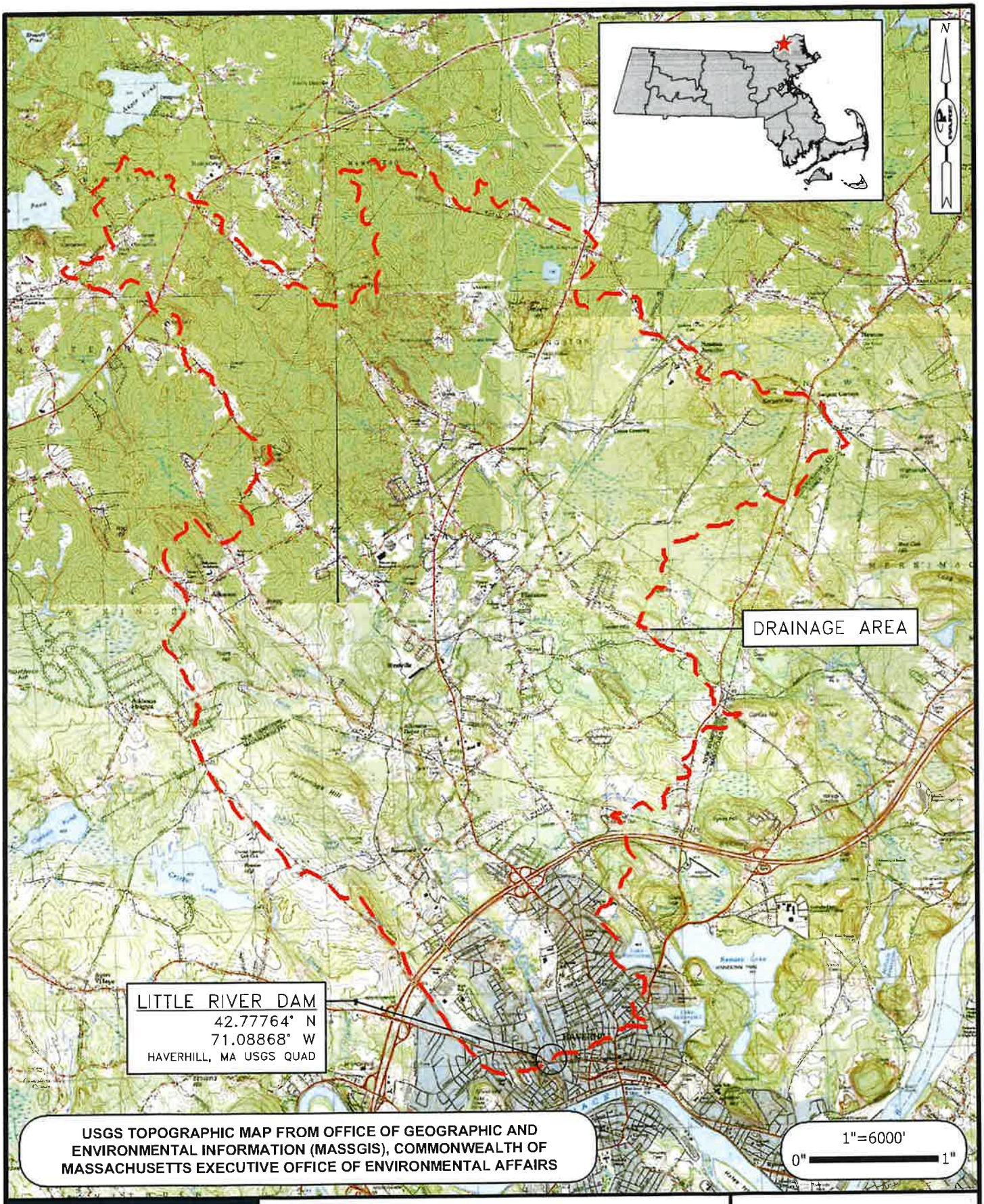
HAVERHILL, MASSACHUSETTS

OWNER UNKNOWN

AERIAL PLAN

JUNE 2019

FIGURE 2



PARE CORPORATION

LITTLE RIVER DAM

MA00739

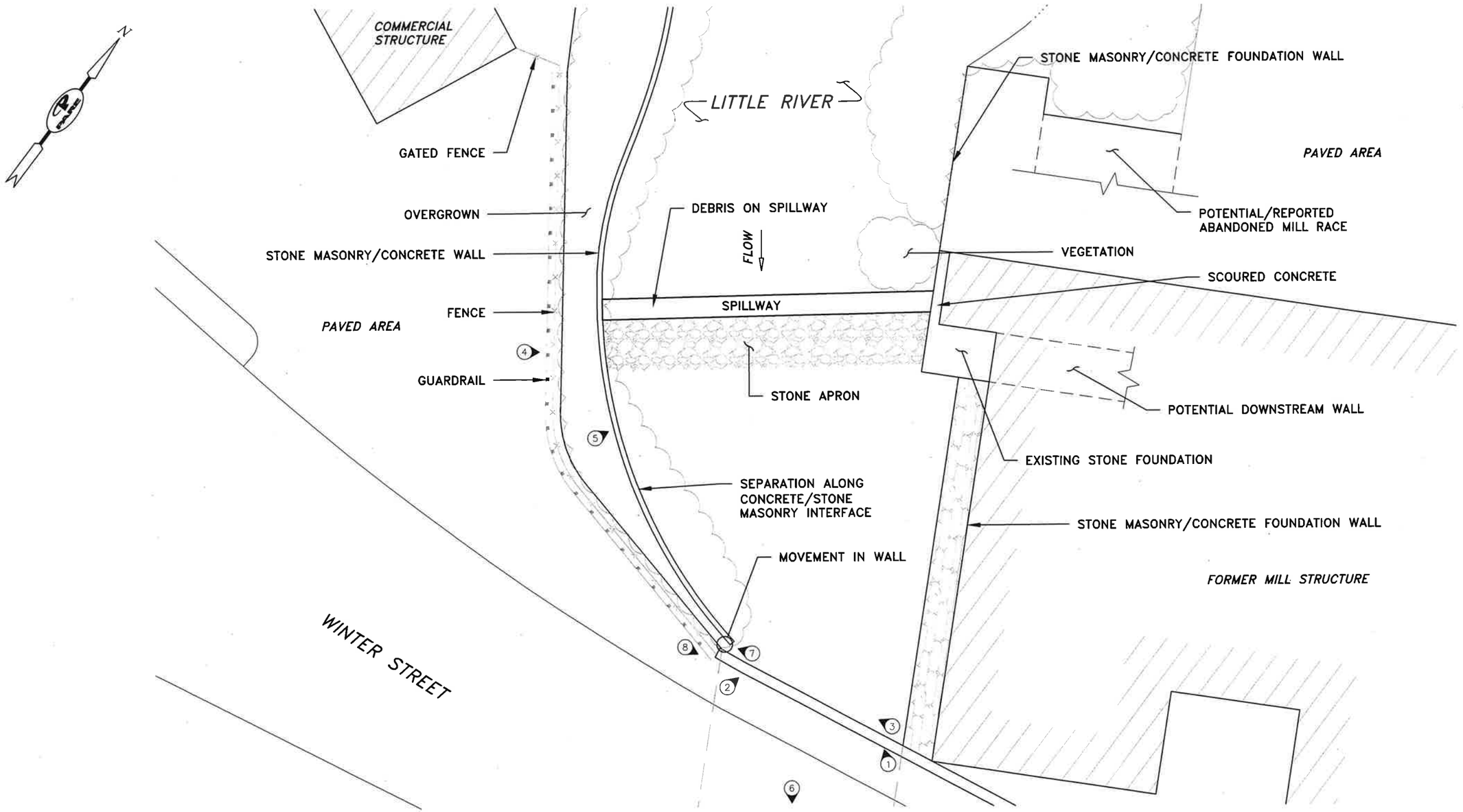
HAVERHILL, MASSACHUSETTS

OWNER UNKNOWN

DRAINAGE AREA MAP

JUNE 2019

FIGURE 3



SITE SKETCH

SCALE: 1"=20'±

NOTES AND LEGEND

1. PLAN DEVELOPED FROM NOTES TAKEN DURING THE INSPECTION AND AVAILABLE AERIAL IMAGERY FROM MASSGIS. INFORMATION IS PROVIDED FOR REFERENCE PURPOSES ONLY.

◀(#) DENOTES APPROXIMATE LOCATION AND DIRECTION OF PHOTOGRAPH.

PARE CORPORATION
ENGINEERS - SCIENTISTS - PLANNERS
10 LINCOLN ROAD, SUITE 210
FOXBORO, MA 02035
508-543-1755

SCALE ADJUSTMENT GUIDE

0" 1"

BAR IS ONE INCH ON ORIGINAL DRAWING.

LITTLE RIVER DAM
MA00739
HAVERHILL, MASSACHUSETTS
OWNER UNKNOWN

REVISIONS:

PROJECT NO.:	18208.02/007
DATE:	JUNE 2019
SCALE:	AS NOTED
DESIGNED BY:	DRC/RAL
CHECKED BY:	ARO
DRAWN BY:	LMC
APPROVED BY:	ARO

SITE SKETCH

FIGURE NO.: 4

Y:\JOBS\18 Jobs\18208.02 QDS-FY19\02-AbandonedDamInspections-MA\0_JUN 2019 PHASE 1s\07_LittleRiverDam_MA00739_PH1_Dec18\DWGS\FIG 4 SITE SKETCH.dwg

APPENDIX A
Photographs
Little River Dam
Haverhill, MA

Photo No. 1: Overview of the dam from Winter Street Bridge looking upstream.

Photo No. 2: Left abutment of the dam. Note the concrete scouring along the left training wall (arrow) approximately 1 foot above the spillway crest, vegetation encroaching on the left spillway approach, and missing mortar/chinking stone from the downstream stone masonry foundation.

Photo No. 3: Right abutment of the dam. Note the overgrowth of vegetation and timber log on the spillway crest.

Photo No. 4: Typical vegetation growth along the right abutment.

Photo No. 5: Spillway crest and downstream face from the right abutment.

Photo No. 6: Overview of the downstream channel from the Winter Street Bridge looking downstream.

Photo No. 7: Downstream channel right concrete wall adjacent to the Winter Street Bridge. Note the outward movement of the wall toward the downstream channel.

Photo No. 8: Granite curb along the downstream channel right concrete wall adjacent to the Winter Street Bridge. Note the displacement.

APPENDIX B
Inspection Checklists
Little River Dam
Haverhill, MA

DAM SAFETY INSPECTION CHECKLIST

NAME OF DAM: Little River Dam

STATE ID #: 5-5-128-6

REGISTERED: ☑ YES ☐ NO

NID ID #: MA00739

STATE SIZE CLASSIFICATION: Small

STATE HAZARD CLASSIFICATION: Significant

CHANGE IN HAZARD CLASSIFICATION REQUESTED?: No

DAM LOCATION INFORMATION

CITY/TOWN: Haverhill

COUNTY: Essex

DAM LOCATION: (street address if known) Near 93 Lafayette Square; Winter Street / Route 97

ALTERNATE DAM NAME: N/A

USGS QUAD.: Haverhill

LAT.: 42.77764°N

LONG.: 71.08868°W

DRAINAGE BASIN: Merrimack

RIVER: Little River

IMPOUNDMENT NAME(S): Little River

GENERAL DAM INFORMATION

TYPE OF DAM: Stone Embankment

OVERALL LENGTH (FT): 70

PURPOSE OF DAM: Recreation (Formerly mill power)

NORMAL POOL STORAGE (ACRE-FT): 11

YEAR BUILT: Early 19th Century

MAXIMUM POOL STORAGE (ACRE-FT): Unknown

STRUCTURAL HEIGHT (FT): 12

EL. NORMAL POOL (FT): 15.0

HYDRAULIC HEIGHT (FT): 12

EL. MAXIMUM POOL (FT): 22 (Assumed; approximate EL. top of RT training wall)

FOR INTERNAL MADCR USE ONLY

FOLLOW-UP INSPECTION REQUIRED: ☐ YES ☐ NO

CONDITIONAL LETTER: ☐ YES ☐ NO

NAME OF DAM: Little River Dam | STATE ID #: 5-5-128-6

INSPECTION DATE: June 19, 2019 | NID ID #: MA00739

INSPECTION SUMMARY

DATE OF INSPECTION: June 19, 2019 | DATE OF PREVIOUS INSPECTION: June 19, 2013

TEMPERATURE/WEATHER: 70° F Overcast | ARMY CORPS PHASE I: ☐ YES ☑ NO | If YES, date

CONSULTANT: Pare Corporation | PREVIOUS DCR PHASE I: ☑ YES ☐ NO | If YES, date June 19, 2013

BENCHMARK/DATUM: Unknown

OVERALL PHYSICAL CONDITION OF DAM: FAIR | DATE OF LAST REHABILITATION: Unknown

SPILLWAY CAPACITY: N/A

EL. POOL DURING INSP.: 15.3 | EL. TAILWATER DURING INSP.: 3.0 +/- (Estimated) / Not Accessible

PERSONS PRESENT AT INSPECTION

NAME	TITLE/POSITION	REPRESENTING
David R. Caouette, P.E.	Project Engineer	Pare Corporation
Ryan A. Lozinski	Engineer I	Pare Corporation

EVALUATION INFORMATION

	Click on box to select E-code
E1) TYPE OF DESIGN	2
E2) LEVEL OF MAINTENANCE	1
E3) EMERGENCY ACTION PLAN	1
E4) EMBANKMENT SEEPAGE	N/A
E5) EMBANKMENT CONDITION	N/A
E6) CONCRETE CONDITION	4
E7) LOW-LEVEL OUTLET CAPACITY	1

	Click on box to select E-code
E8) LOW-LEVEL OUTLET CONDITION	1
E9) SPILLWAY DESIGN FLOOD CAPACITY	5
E10) OVERALL PHYSICAL CONDITION	3
E11) ESTIMATED REPAIR COST	$85k-$203k
ROADWAY OVER CREST	NO
BRIDGE NEAR DAM	NO

NAME OF INSPECTING ENGINEER: David R. Caouette, P.E. | SIGNATURE:

NAME OF DAM: Little River Dam

STATE ID #: 5-5-128-6

INSPECTION DATE: June 19, 2019

NID ID #: MA00739

OWNER:		CARETAKER:	
ORGANIZATION	Unknown	ORGANIZATION	Unknown
NAME/TITLE	Unknown	NAME/TITLE	Unknown
STREET	Unknown	STREET	Unknown
TOWN, STATE, ZIP	Unknown	TOWN, STATE, ZIP	Unknown
PHONE	Unknown	PHONE	Unknown
EMERGENCY PH. #	Unknown	EMERGENCY PH. #	Unknown
FAX	Unknown	FAX	Unknown
EMAIL	Unknown	EMAIL	Unknown
OWNER TYPE	Other State Agencies		

PRIMARY SPILLWAY TYPE: Uncontrolled broad crested weir

SPILLWAY LENGTH (FT): 75.0

SPILLWAY CAPACITY (CFS): 1940 +/-

AUXILIARY SPILLWAY TYPE: N/A

AUX. SPILLWAY CAPACITY (CFS): N/A

NUMBER OF OUTLETS: 0

OUTLET(S) CAPACITY (CFS): N/A

TYPE OF OUTLETS: N/A

TOTAL DISCHARGE CAPACITY (CFS): 1940 +/-

DRAINAGE AREA (SQ MI): 28

SPILLWAY DESIGN FLOOD (PERIOD/CFS): 100-year / 1,930 CFS (Regression)

HAS DAM BEEN BREACHED OR OVERTOPPED ☐ YES ☑ NO

IF YES, PROVIDE DATE(S): None Reported

FISH LADDER (LIST TYPE IF PRESENT): N/A

DOES CREST SUPPORT PUBLIC ROAD? ☐ YES ☑ NO

IF YES, ROAD NAME:

PUBLIC BRIDGE WITHIN 50' OF DAM? ☐ YES ☑ NO

IF YES, ROAD/BRIDGE NAME: Winter Street Bridge ~80' downstream

MHD BRIDGE NO. (IF APPLICABLE

NAME OF DAM: Little River Dam STATE ID #: 5-5-128-6

INSPECTION DATE: June 19, 2019 NID ID #: MA00739

EMBANKMENT (CREST)

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
CREST	1. SURFACE TYPE	Unknown		X	
	2. SURFACE CRACKING	Unknown		X	
	3. SINKHOLES, ANIMAL BURROWS	Unknown		X	
	4. VERTICAL ALIGNMENT (DEPRESSIONS	Unknown		X	
	5. HORIZONTAL ALIGNMENT	Unknown		X	
	6. RUTS AND/OR PUDDLES	Unknown		X	
	7. VEGETATION (PRESENCE/CONDITION)	Unknown		X	
	8. ABUTMENT CONTACT	Unknown		X	

ADDITIONAL COMMENTS: Potential emabnkment left of spillway; No access during the inspection

NAME OF DAM: Little River Dam STATE ID #: 5-5-128-6

INSPECTION DATE: June 19, 2019 NID ID #: MA00739

EMBANKMENT (D/S SLOPE)

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
D/S SLOPE	1. WET AREAS (NO FLOW)	Unknown		X	
	2. SEEPAGE	Unknown		X	
	3. SLIDE, SLOUGH, SCARP	Unknown		X	
	4. EMB.-ABUTMENT CONTACT	Unknown		X	
	5. SINKHOLE/ANIMAL BURROWS	Unknown		X	
	6. EROSION	Unknown		X	
	7. UNUSUAL MOVEMENT	Unknown		X	
	8. VEGETATION (PRESENCE/CONDITION)	Unknown		X	

ADDITIONAL COMMENTS: Potential emabnkment left of spillway; No access during the inspection.

NAME OF DAM: Little River Dam STATE ID #: 5-5-128-6

INSPECTION DATE: June 19, 2019 NID ID #: MA00739

EMBANKMENT (U/S SLOPE)

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
U/S SLOPE	1. SLIDE, SLOUGH, SCARP	Unknown		X	
	2. SLOPE PROTECTION TYPE AND COND.	Unknown		X	
	3. SINKHOLE/ANIMAL BURROWS	Unknown		X	
	4. EMB.-ABUTMENT CONTACT	Unknown		X	
	5. EROSION	Unknown		X	
	6. UNUSUAL MOVEMENT	Unknown		X	
	7. VEGETATION (PRESENCE/CONDITION)	Unknown		X	

ADDITIONAL COMMENTS: Potential emabnkment left of spillway; No access during the inspection.

NAME OF DAM: Little River Dam STATE ID #: 5-5-128-6

INSPECTION DATE: June 19, 2019 NID ID #: MA00739

INSTRUMENTATION

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
INSTR.	1. PIEZOMETERS	None noted	X		
	2. OBSERVATION WELLS	None noted	X		
	3. STAFF GAGE AND RECORDER	None noted	X		
	4. WEIRS	None noted	X		
	5. INCLINOMETERS	None noted	X		
	6. SURVEY MONUMENTS	None noted	X		
	7. DRAINS	None noted	X		
	8. FREQUENCY OF READINGS	Not applicable	X		
	9. LOCATION OF READINGS	Not applicable	X		

ADDITIONAL COMMENTS:

NAME OF DAM: Little River Dam STATE ID #: 5-5-128-6

INSPECTION DATE: June 19, 2019 NID ID #: MA00739

DOWNSTREAM MASONRY WALLS

AREA INSPECTED	CONDITION	OBSERVATIONS			NO ACTION	MONITOR	REPAIR
D/S WALLS	1. WALL TYPE	Unknown				X	
	2. WALL ALIGNMENT	Unknown				X	
	3. WALL CONDITION	Unknown				X	
	4. HEIGHT: TOP OF WALL TO MUDLINE	min: Unknown	max: Unknown	avg: Unknown		X	
	5. SEEPAGE OR LEAKAGE	Unknown				X	
	6. ABUTMENT CONTACT	Unknown				X	
	7. EROSION/SINKHOLES BEHIND WALL	Unknown				X	
	8. ANIMAL BURROWS	Unknown				X	
	9. UNUSUAL MOVEMENT	Unknown				X	
	10. WET AREAS AT TOE OF WALL	Unknown				X	

ADDITIONAL COMMENTS: Potential embankment left of spillway; No access during the inspection.

NAME OF DAM: Little River Dam STATE ID #: 5-5-128-6

INSPECTION DATE: June 19, 2019 NID ID #: MA00739

UPSTREAM MASONRY WALLS

AREA INSPECTED	CONDITION	OBSERVATIONS			NO ACTION	MONITOR	REPAIR
U/S WALLS	1. WALL TYPE	Unknown				X	
	2. WALL ALIGNMENT	Unknown				X	
	3. WALL CONDITION	Unknown				X	
	4. HEIGHT: TOP OF WALL TO MUDLINE	min: Unknown	max: Unknown	avg: Unknown		X	
	5. ABUTMENT CONTACT	Unknown				X	
	6. EROSION/SINKHOLES BEHIND WALL	Unknown				X	
	7. ANIMAL BURROWS	Unknown				X	
	8. UNUSUAL MOVEMENT	Unknown				X	

ADDITIONAL COMMENTS: Potential embankment left of spillway; No access during the inspection.

NAME OF DAM: Little River Dam STATE ID #: 5-5-128-6

INSPECTION DATE: June 19, 2019 NID ID #: MA00739

DOWNSTREAM AREA

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
D/S AREA	1. ABUTMENT LEAKAGE	None observed.		X	
	2. FOUNDATION SEEPAGE	None observed. Area was underwater at time of inspection.		X	
	3. SLIDE, SLOUGH, SCARP	None observed.		X	
	4. WEIRS	Fromer stone masonry wall/weir exists approximately 170 feet downstream of the dam. Weir appears to be deteriorated and no longer obstructing flow.		X	
	5. DRAINAGE SYSTEM	None observed	X		
	6. INSTRUMENTATION	None observed	X		
	7. VEGETATION	Heavy growth of vegetation continues along the right side of the river abutment.		X	
	8. ACCESSIBILITY	No accessability within the downstream area.		X	X
	9. DOWNSTREAM HAZARD DESCRIPTION	Numerous residential, commercial, and industrial building. Haverhill Train Station. Muitiple state and local road.		X	
	10. DATE OF LAST EAP UPDATE	None.		X	X

ADDITIONAL COMMENTS: Along the channel right wall at contact with the Winter Street bridge, concrete section of wall was seperated 12-inches from the right bridge abutment. From the upstream sidewalk, 3-inches of seperation appears from the granite block to the asphalt sidewalk. This is reportedly a historical issue caused from stormwater erosion.

NAME OF DAM: Little River Dam STATE ID #: 5-5-128-6

INSPECTION DATE: June 19, 2019 NID ID #: MA00739

MISCELLANEOUS

AREA INSPECTED	CONDITION	OBSERVATIONS
MISC.	1. RESERVOIR DEPTH (AVG)	Unknown
	2. RESERVOIR SHORELINE	Densely wooded and urban
	3. RESERVOIR SLOPES	Moderate to steep slopes, with sections of earth retaining structures.
	4. ACCESS ROADS	None
	5. SECURITY DEVICES	Chain link fence along the right abutment.
	6. VANDALISM OR TRESPASS	☑ YES ☐ NO WHAT: Graffiti is present on the mill building at the left abutment.
	7. AVAILABILITY OF PLANS	☐ YES ☑ NO DATE:
	8. AVAILABILITY OF DESIGN CALCS	☐ YES ☑ NO DATE:
	9. AVAILABILITY OF EAP/LAST UPDATE	☐ YES ☑ NO DATE:
	10. AVAILABILITY OF O&M MANUAL	☐ YES ☑ NO DATE:
	11. CARETAKER/OWNER AVAILABLE	☐ YES ☑ NO DATE:
	12. CONFINED SPACE ENTRY REQUIRED	☐ YES ☑ NO PURPOSE:

ADDITIONAL COMMENTS:

NAME OF DAM: Little River Dam STATE ID #: 5-5-128-6

INSPECTION DATE: June 19, 2019 NID ID #: MA00739

PRIMARY SPILLWAY

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
SPILLWAY	SPILLWAY TYPE	Broad crested weir / granite stone embankment	X		
	WEIR TYPE	Uncontrolled	X		
	SPILLWAY CONDITION	Appears good. Water is flowing evenly over weir during inspection. Energy from overtopping waters uniformly dissipated on rock apron.		X	
	TRAINING WALLS	Right wall and channel was overgrown with dense vegetation. Left wall scouring, cracked concrete, and exposed aggregate was observed along the apparent high-water line.		X	X
	SPILLWAY CONTROLS AND CONDITION	Uncontrolled		X	
	UNUSUAL MOVEMENT	None observed. Channel right wall appeared normal.		X	
	APPROACH AREA	Appears good		X	
	DISCHARGE AREA	Appears good		X	
	DEBRIS	Minor debris on crest.		X	
	WATER LEVEL AT TIME OF INSPECTION	EL. 15.3 (Approximately 3-inches over crest.)		X	

ADDITIONAL COMMENTS: 1. Vegetative growth and fencing along the right training wall and channel limited inspection and access to the dam and spillway.
2. Due to inaccessibility of the site, the inspection was performed visually from the Winter Street Bridge approximately 80 feet downstream of the dam.

NAME OF DAM: Little River Dam STATE ID #: 5-5-128-6

INSPECTION DATE: June 19, 2019 NID ID #: MA00739

AUXILIARY SPILLWAY

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
SPILLWAY	SPILLWAY TYPE				
	WEIR TYPE				
	SPILLWAY CONDITION				
	TRAINING WALLS				
	SPILLWAY CONTROLS AND CONDITION				
	UNUSUAL MOVEMENT				
	APPROACH AREA				
	DISCHARGE AREA				
	DEBRIS				
	WATER LEVEL AT TIME OF INSPECTION				

NOT APPLICABLE TO THIS STRUCTURE

ADDITIONAL COMMENTS:

NAME OF DAM: Little River Dam STATE ID #: 5-5-128-6

INSPECTION DATE: June 19, 2019 NID ID #: MA00739

OUTLET WORKS

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
OUTLET WORKS	TYPE	Unknown		X	
	INTAKE STRUCTURE	Unknown		X	
	TRASHRACK	Unknown		X	
	PRIMARY CLOSURE	Unknown		X	
	SECONDARY CLOSURE	Unknown		X	
	CONDUIT	Unknown		X	
	OUTLET STRUCTURE/HEADWALL	Unknown		X	
	EROSION ALONG TOE OF DAM	Unknown		X	
	SEEPAGE/LEAKAGE	Unknown		X	
	DEBRIS/BLOCKAGE	Unknown		X	
	UNUSUAL MOVEMENT	Unknown		X	
	DOWNSTREAM AREA	Unknown		X	
	MISCELLANEOUS	Unknown		X	

ADDITIONAL COMMENTS: Potential reported mill race abandoned. Not accessible / not located during the current inspection.

NAME OF DAM: Little River Dam STATE ID #: 5-5-128-6

INSPECTION DATE: June 19, 2019 NID ID #: MA00739

CONCRETE/MASONRY DAMS

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
GENERAL	TYPE				
	AVAILABILITY OF PLANS				
	AVAILABILITY OF DESIGN CALCS				
	PIEZOMETERS				
	OBSERVATION WELLS				
	INCLINOMETERS				
	SEEPAGE GALLERY				
	UNUSUAL MOVEMENT				

NOT APPLICABLE TO THIS STRUCTURE

ADDITIONAL COMMENTS:

NAME OF DAM: Little River Dam STATE ID #: 5-5-128-6

INSPECTION DATE: June 19, 2019 NID ID #: MA00739

CONCRETE/MASONRY DAMS (CREST)

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
CREST	TYPE				
	SURFACE CONDITIONS				
	CONDITIONS OF JOINTS				
	UNUSUAL MOVEMENT				
	HORIZONTAL ALIGNMENT				
	VERTICAL ALIGNMENT				

NOT APPLICABLE TO THIS STRUCTURE

ADDITIONAL COMMENTS:

NAME OF DAM: Little River Dam STATE ID #: 5-5-128-6

INSPECTION DATE: June 19, 2019 NID ID #: MA00739

CONCRETE/MASONRY DAMS (DOWNSTREAM FACE)

NOT APPLICABLE TO THIS STRUCTURE

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
D/S FACE	TYPE				
	SURFACE CONDITIONS				
	CONDITIONS OF JOINTS				
	UNUSUAL MOVEMENT				
	ABUTMENT CONTACT				
	LEAKAGE				

ADDITIONAL COMMENTS:

NAME OF DAM: Little River Dam STATE ID #: 5-5-128-6

INSPECTION DATE: June 19, 2019 NID ID #: MA00739

CONCRETE/MASONRY DAMS (UPSTREAM FACE)

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
U/S FACE	TYPE				
	SURFACE CONDITION				
	CONDITIONS OF JOINTS				
	UNUSUAL MOVEMENT				
	ABUTMENT CONTACTS				

NOT APPLICABLE TO THIS STRUCTURE

ADDITIONAL COMMENTS:

APPENDIX C
Previous Reports and References
Little River Dam
Haverhill, MA

PREVIOUS REPORTS AND REFERENCES

The following is a list of reports that were located during the file review, or were referenced in previous reports.

1. Little River Dam – Phase I Inspection/Evaluation Report, prepared by Fuss & O'Neill, Boston , MA, June 2013
2. Notice of Inspection for Little River Dam, MA00739, R. David Clark, Massachusetts, DEM, January 11, 2000

The following references were utilized during the preparation of this report and the development of the recommendations presented herein:

1. "Design of Small Dams", United States Department of the Interior Bureau of Reclamation, 1987.
2. "ER 110-2-106 - Recommended Guidelines for Safety Inspection of Dams", Department of the Army, September 26, 1979.
3. "Guidelines for Reporting the Performance of Dams" National Performance of Dams Program, August 1994.
4. 302 CMR: Department of Conservation and Recreation Section 10.00 Dam Safety.

APPENDIX D
Common Dam Safety Definitions
Little River Dam
Haverhill, MA

COMMON DAM SAFETY DEFINITIONS

For a comprehensive list of dam engineering terminology and definitions refer to 302 CMR10.00 Dam Safety, or other reference published by FERC, Dept. of the Interior Bureau of Reclamation, or FEMA. Please note should discrepancies between definitions exits, those definitions included within 302 CMR 10.00 govern for dams located within the Commonwealth of Massachusetts.

Orientation

Upstream – Shall mean the side of the dam that borders the impoundment.

Downstream – Shall mean the high side of the dam, the side opposite the upstream side.

Right – Shall mean the area to the right when looking in the downstream direction.

Left – Shall mean the area to the left when looking in the downstream direction.

Dam Components

Dam – Shall mean any artificial barrier, including appurtenant works, which impounds or diverts water.

Embankment – Shall mean the fill material, usually earth or rock, placed with sloping sides, such that it forms a permanent barrier that impounds water.

Crest – Shall mean the top of the dam, usually provides a road or path across the dam.

Abutment – Shall mean that part of a valley side against which a dam is constructed. An artificial abutment is sometimes constructed as a concrete gravity section, to take the thrust of an arch dam where there is no suitable natural abutment.

Appurtenant Works – Shall mean structures, either in dams or separate therefrom, including but not be limited to, spillways; reservoirs and their rims; low level outlet works; and water conduits including tunnels, pipelines, or penstocks, either through the dams or their abutments.

Spillway – Shall mean a structure over or through which water flows are discharged. If the flow is controlled by gates or boards, it is a controlled spillway; if the fixed elevation of the spillway crest controls the level of the impoundment, it is an uncontrolled spillway.

Size Classification

(as listed in Commonwealth of Massachusetts, 302 CMR 10.00 *Dam Safety*)

Large – structure with a height greater than 40 feet or a storage capacity greater than 1,000 acre-feet.

Intermediate – structure with a height between 15 and 40 feet or a storage capacity of 50 to 1,000 acre-feet.

Small – structure with a height between 6 and 15 feet and a storage capacity of 15 to 50 acre-feet.

Non-Jurisdictional – structure less than 6 feet in height or having a storage capacity of less than 15 acre-feet.

Hazard Classification

(as listed in Commonwealth of Massachusetts, 302 CMR 10.00 *Dam Safety*)

High Hazard (Class I) – Shall mean dams located where failure will likely cause loss of life and serious damage to home(s), industrial or commercial facilities, important public utilities, main highway(s) or railroad(s).

Significant Hazard (Class II) – Shall mean dams located where failure may cause loss of life and damage to home(s), industrial or commercial facilities, secondary highway(s) or railroad(s), or cause the interruption of the use or service of relatively important facilities.

Low Hazard (Class III) – Dams located where failure may cause minimal property damage to others. Loss of life is not expected.

General

EAP – Emergency Action Plan - Shall mean a predetermined plan of action to be taken to reduce the potential for property damage and/or loss of life in an area affected by an impending dam break.

O&M Manual – Operations and Maintenance Manual; Document identifying routine maintenance and operational procedures under normal and storm conditions.

Normal Pool – Shall mean the elevation of the impoundment during normal operating conditions.

Acre-foot – Shall mean a unit of volumetric measure that would cover one acre to a depth of one foot. It is equal to 43,560 cubic feet. One million U.S. gallons = 3.068 acre feet

Height of Dam – Shall mean the vertical distance from the lowest portion of the natural ground, including any stream channel, along the downstream toe of the dam to the crest of the dam.

Spillway Design Flood (SDF) – Shall mean the flood used in the design of a dam and its appurtenant works particularly for sizing the spillway and outlet works, and for determining maximum temporary storage and height of dam requirements.

Condition Rating

Unsafe - Major structural, operational, and maintenance deficiencies exist under normal operating conditions.

Poor - Significant structural, operational and maintenance deficiencies are clearly recognized for normal loading conditions.

Fair - Significant operational and maintenance deficiencies, no structural deficiencies. Potential deficiencies exist under unusual loading conditions that may realistically occur. Can be used when uncertainties exist as to critical parameters.

Satisfactory - Minor operational and maintenance deficiencies. Infrequent hydrologic events would probably result in deficiencies.

Good - No existing or potential deficiencies recognized. Safe performance is expected under all loading including SDF.

APPENDIX E
Visual Dam Inspection Limitations
Little River Dam
Haverhill, MA

VISUAL DAM INSPECTION LIMITATIONS

Visual Inspection

1. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigations and analyses involving topographic mapping, subsurface investigations, testing and detailed computational evaluations are beyond the scope of this report.

2. In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection, along with data available to the inspection team.

3. In cases where an impoundment is lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions, which might otherwise be detectable if inspected under the normal operating environment of the structure.

4. It is critical to note that the condition of the dam depends on numerous and constantly changing internal and external conditions and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Use of Report

1. The applicability of other environmental permits (i.e., NOI, PGP, Water Quality Certificate, etc.) needs to be determined prior to undertaking maintenance activities that may occur within resource areas under the jurisdiction of MADEP, the local conservation commission or other regulatory agency.

2. This report has been prepared for the exclusive use of the Massachusetts Department and Recreation Office of Dam Safety for specific application to the Little River Dam in accordance with generally accepted engineering practices. No other warranty, expressed or implied, is made.

3. This report has been prepared for this project by Pare. This report is for preliminary evaluation purposes only and is not necessarily sufficient to support design or repairs or recommendations or to prepare an accurate bid.

LITTLE RIVER DAM

PHASE I

INSPECTION / EVALUATION REPORT

Dam Name:	Little River Dam
State Dam ID#:	5-5-128-6
NID ID#:	MA00739
Owner:	Shain Realty Trust
Town:	Haverhill, MA
Consultant:	Fuss & O'Neill, Inc.
Date of Inspection:	June 19, 2013

FUSS & O'NEILL

EXECUTIVE SUMMARY

The Little River Dam is a Significant Hazard, Small Size dam located on Little River in Haverhill, Massachusetts. The dam was visually inspected by Fuss & O'Neill, Inc. on June 19, 2013 and appeared to be in Fair condition.

The deficiencies or potential items of concern identified are as follows:

1. Spalling and cracking of concrete and masonry in left training wall, up- and downstream of the spillway.
2. Several pieces of debris observed on the spillway, approach area, or discharge area.
3. Thick vegetation and/or trees growing on and obscuring right and left abutment areas, right spillway training wall, and right channel wall between the dam and bridge.
4. Unknown status of unused mill channel.
5. Reported storm water run-off erosion at right downstream bridge abutment (not observed due to vegetative growth).
6. No Operation & Maintenance (O&M) Manual.

The major recommendations offered are:

1. Investigate and repair the spalled and cracked concrete and masonry in left training wall, up- and downstream of the spillway.
2. Remove debris from the spillway, approach, and discharge areas.
3. Remove vegetation and trees from the right and left abutment areas, right spillway training wall, and right channel wall between the dam and bridge.
4. Inspect and monitor unused mill channel for signs of seepage.
5. Monitor reported storm water run-off erosion at right downstream bridge abutment.
6. Develop an O&M Manual.
7. Since the dam is not readily accessible for routine inspection, perform a detailed inspection of the dam structure, mill channel, training walls, and foundation area during a period of low flow using a dive team and after clearing vegetation from the area. This will help identify whether there are additional items of concern.

Dam Evaluation Summary Detail Sheet

1. NID ID:	**MA00739**	**4. Inspection Date:**	**June 19, 2013**
2. Dam Name:	**Little River Dam**	**5. Last Insp. Date:**	**January 11, 2000**
3. Dam Location:	**Haverhill, MA**	**6. Next Inspection:**	**June 19, 2018**
7. Inspector:	**Christopher J. Cullen, P.E.**		
8. Consultant:	**Fuss & O'Neill, Inc.**		
9. Hazard Code:	**Significant**	**9a. Is Hazard Code Change Requested?:**	**No**
10. Insp. Frequency:	**5 Years**	**11. Overall Physical Condition of Dam:**	**FAIR**
12. Spillway Capacity (% SDF)	**90-100% of the SDF**		

E1. Design Methodology:	**1**	**E7. Low-Level Discharge Capacity:**	**1**
E2. Level of Maintenance:	**2**	**E8. Low-Level Outlet Physical Condition:**	**1**
E3. Emergency Action Plan:	**1**	**E9. Spillway Design Flood Capacity:**	**3**
E4. Embankment Seepage:	**N/A**	**E10. Overall Physical Condition of the Dam:**	**3**
E5. Embankment Condition:	**N/A**	**E11. Estimated Repair Cost:**	**$33,000 - $70,000**
E6. Concrete Condition:	**2**		

Evaluation Description

E1: DESIGN METHODOLOGY
1. Unknown Design – no design records available
2. No design or post-design analyses
3. No analyses, but dam features appear suitable
4. Design or post design analysis show dam meets most criteria
5. State of the art design – design records available & dam meets all criteria

E2: LEVEL OF MAINTENANCE
1. Dam in disrepair, no evidence of maintenance, no O&M manual
2. Dam in poor level of upkeep, very little maintenance, no O&M manual
3. Dam in fair level of upkeep, some maintenance and standard procedures
4. Adequate level of maintenance and standard procedures
5. Dam well maintained, detailed maintenance plan that is executed

E3: EMERGENCY ACTION PLAN
1. No plan or idea of what to do in the event of an emergency
2. Some idea but no written plan
3. No formal plan but well thought out
4. Available written plan that needs updating
5. Detailed, updated written plan available and filed with MADCR, annual training

E4: SEEPAGE (Embankments, Foundations, & Abutments)
1. Severe piping and/or seepage with no monitoring
2. Evidence of monitored piping and seepage
3. No piping but uncontrolled seepage
4. Minor seepage or high volumes of seepage with filtered collection
5. No seepage or minor seepage with filtered collection

E5: EMBANKMENT CONDITION (See Note 1)
1. Severe erosion and/or large trees
2. Significant erosion or significant woody vegetation
3. Brush and exposed embankment soils, or moderate erosion
4. Unmaintained grass, rodent activity and maintainable erosion
5. Well maintained healthy uniform grass cover

E6: CONCRETE CONDITION (See Note 2)
1. Major cracks, misalignment, discontinuities causing leaks, seepage or stability concerns
2. Cracks with misalignment inclusive of transverse cracks with no misalignment but with potential for significant structural degradation
3. Significant longitudinal cracking and minor transverse cracking
4. Spalling and minor surface cracking
5. No apparent deficiencies

E7: LOW-LEVEL OUTLET DISCHARGE CAPACITY
1. No low level outlet, no provisions (e.g. pumps, siphons) for emptying pond
2. No operable outlet, plans for emptying pond, but no equipment
3. Outlet with insufficient drawdown capacity, pumping equipment available
4. Operable gate with sufficient drawdown capacity
5. Operable gate with capacity greater than necessary

E8: LOW-LEVEL OUTLET PHYSICAL CONDITION
1. Outlet inoperative needs replacement, non-existent or inaccessible
2. Outlet inoperative needs repair
3. Outlet operable but needs repair
4. Outlet operable but needs maintenance
5. Outlet and operator operable and well maintained

E9: SPILLWAY DESIGN FLOOD CAPACITY
1. 0 - 50% of the SDF or unknown
2. 50-90% of the SDF
3. 90 - 100% of the SDF
4. >100% of the SDF with actions required by caretaker (e.g. open outlet)
5. >100% of the SDF with no actions required by caretaker

E10: OVERALL PHYSICAL CONDITION OF DAM
1. UNSAFE – Major structural, operational, and maintenance deficiencies exist under normal operating conditions
2. POOR - Significant structural, operation and maintenance deficiencies are clearly recognized under normal loading conditions
3. FAIR - Significant operational and maintenance deficiencies, no structural deficiencies. Potential deficiencies exist under unusual loading conditions that may realistically occur. Can be used when uncertainties exist as to critical parameters
4. SATISFACTORY - Minor operational and maintenance deficiencies. Infrequent hydrologic events would probably result In deficiencies.
5. GOOD - No existing or potential deficiencies recognized. Safe performance is expected under all loading including SDF

E11: ESTIMATED REPAIR COST

Estimation of the total cost to address all identified structural, operational, maintenance deficiencies. Cost shall be developed utilizing standard estimating guides and procedures

Changes/Deviations to Database Information since Last Inspection

PREFACE

The assessment of the general condition of the dam reported herein was based upon available data and visual inspections. Detailed investigations and analyses involving topographic mapping, subsurface investigations, testing and detailed computational evaluations were beyond the scope of this report unless reported otherwise.

In reviewing this report, it should be realized that the reported condition of the dam was based on observations of field conditions at the time of inspection, along with data available to the inspection team.

It is critical to note that the condition of the dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the reported condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

*Licensed Professional's Signature**

Christopher J. Cullen, P.E.
Project Manager
Fuss & O'Neill, Inc.
Massachusetts License No.: 47018
License Type: Civil

** 302 CMR 10.00 requires inspecting engineers to be Commonwealth of Massachusetts Registered Professional Engineers with a Civil Engineering license with experience in dam safety inspections and engineering. The Department will also accept inspection by a Commonwealth of Massachusetts Registered Professional Engineer with a Structural or Sanitary Engineering license, provided the Registered Professional Engineer has experience in the field of dam engineering and inspection.*

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SECTION 1

1.0 DESCRIPTION OF PROJECT

1.1 General

1.1.1 Authority

The Massachusetts DCR Office of Dam Safety retained Fuss & O'Neill, Inc. to perform a visual inspection and develop a report of conditions for the Little River Dam on the Little River, a tributary to the Merrimack River, in the City of Haverhill, Essex County, Massachusetts. This inspection and report were performed in accordance with MGL Chapter 253, Sections 44-50 of the Massachusetts General Laws as amended by Chapter 330 of the Acts of 2002.

1.1.2 Purpose of Work

The purpose of this investigation was to inspect and evaluate the present condition of the dam and appurtenant structures in accordance with 302 CMR 10.07 to provide information that will assist in both prioritizing dam repair needs and planning/conducting maintenance and operation.

The investigation was divided into four parts: 1) obtain and review available reports, investigations, and data previously submitted to the owner pertaining to the dam and appurtenant structures; 2) perform a visual inspection of the site; 3) evaluate the status of an emergency action plan for the site and; 4) prepare and submit a final report presenting the evaluation of the structure, including recommendations and remedial actions, and opinion of probable costs.

1.1.3 Definitions

To provide the reader with a better understanding of the report, definitions of commonly used terms associated with dams are provided in Appendix D. Many of these terms may be included in this report. The terms are presented under common categories associated with dams which include: 1) orientation; 2) dam components; 3) size classification; 4) hazard classification; and 5) miscellaneous.

1.2 Description of Project

1.2.1 Location

The dam is located at latitude 42.77766 North and longitude 71.08866 West on the Little River in the Merrimack River Basin in Essex County. The dam sits 70 feet upstream of Winter Street and can be seen from the bridge. To reach the dam from the intersection of Main Street and Water Street in Haverhill, drive north on Main Street for 0.7 miles and turn left onto Winter Street. The dam can be seen on the right after about 0.9 miles, immediately after passing Stevens Street.

If coming from the I-495 freeway, take exit 50 and travel east on Broadway Street (Route 97) toward Haverhill. Follow Route 97 for 1.3 miles until you see the dam on the left side.

1.2.2 Owner/Caretaker

Owner/caretaker information obtained from DCR records is listed in the following table and is also contained in Table 1.1.

	Dam Owner	Dam Caretaker
Name	Shain Realty Trust	Steven Shain
Mailing Address	355 Concord Street	355 Concord Street
Town	Haverhill, MA 01830	Haverhill, MA 01830
Daytime Phone	Unknown	978-837-7401
Emergency Phone	Unknown	Unknown
Email Address	Unknown	Unknown

1.2.3 Purpose of the Dam

The dam was constructed around 1870 to provide water for power generation for the mill complex located along the east side of the river. The dam no longer functions in this capacity, and the mill race has reportedly been closed off with concrete. The dam now serves to maintain the river level in the immediate upstream reach, and as an aesthetic water feature visible from Winter Street.

1.2.4 Description of the Dam and Appurtenances

The Little River Dam is a run-of-the-river dam located adjacent to a historic mill complex about 70 feet upstream of a public bridge. The dam has no embankment, but consists entirely of a cascading, granite block masonry, gravity structure. According to a 2000 inspection report, the structural height of the dam is 12 feet and the granite block crest is 75 feet long and 18 inches wide. A mill channel race way was reportedly sealed off with cement and is no longer used. The dam does not appear to have a low-level outlet.

At its right end, the dam abuts a vertical channel wall, which extends up approximately 6 feet above the dam crest. This wall is stone masonry except for the top 2.5 feet or so, which is concrete. A chain link fence is located behind the top of the wall, and a parking lot associated with a local business sits on the right abutment.

The left end of the dam abuts a brick mill building. A concrete training wall runs along the building upstream of the dam up to a height of about 3 feet above the spillway elevation. The building juts left at the dam, so a short length of stone masonry is exposed at its left end, beyond the end of the spillway.

The downstream face of the dam consists of granite blocks or cobbles, over which the spillway flow cascades to dissipate energy before continuing into the downstream channel.

1.2.5 Operations and Maintenance

According to DCR records, Steven Shain of the Shain Realty Trust is responsible for maintenance of the dam. Since the dam has no appurtenances or controls that require active operation, the only routine maintenance that would likely be performed would be removal of debris from the spillway, removal of trees and vegetation from the abutment areas, and repairs to the dam structure itself. It is not known whether or how frequently Mr. Shain performs these activities. The vegetation on the abutments had not been recently cleared and no visible signs of recent repair could be seen at the time of inspection.

1.2.6 DCR Size Classification

The Little River has a maximum structural height of approximately 12 feet and a maximum storage capacity of 25 acre-feet. Therefore, in accordance with Department of Conservation and Recreation Office of Dam Safety classification, under Commonwealth of Massachusetts dam safety rules and regulations stated in 302 CMR 10.00 as amended by Chapter 330 of the Acts of 2002, Little River Dam is a **Small** size structure.

1.2.7 DCR Hazard Potential Classification

Little River Dam is located approximately 2,300 feet upstream of the confluence of the Little River and the Merrimack River**.** Winter Street is located 70 feet downstream of the dam, where it crosses the Little River on a stone arch bridge. The river is contained between vertical channel walls through this reach and the surrounding area is of urban character. About 700 feet downstream of the dam the river apparently enters a conduit (beginning at the railroad track), through which it is conveyed to the Merrimack River.

The impoundment behind this run-of-river dam does not have a large surface area or flood storage. Nevertheless, due to the structural height of the dam and the considerable amount of infrastructure surrounding the downstream reach, it appears that a failure of the dam at maximum pool "may cause loss of life and damage home(s), industrial or commercial facilities, secondary highway(s) or railroad(s) or cause interruption of use or service of relatively important facilities." Therefore, in accordance with Department of Conservation and Recreation classification procedures, under Commonwealth of Massachusetts dam safety rules and regulations stated in 302 CMR 10.00 as amended by Chapter 330 of the Acts of 2002, Little River Dam is classified as a **Significant** hazard (Class II) dam.

1.3 Pertinent Engineering Data

1.3.1 Drainage Area

The drainage area for Little River Dam is approximately 27.9 square miles and extends through the communities of Haverhill, MA; Plaistow, NH; Atkinson, NH; Newton, NH; Kingston, NH; and Hampstead, NH. The drainage area was delineated using USGS StreamStats online software.

The watershed consists primarily of rolling terrain and is primarily wooded with residential development, roads and highways, and urban areas in the lower portions of the drainage area. There are no large impoundments located upstream of the Little River Dam.

1.3.2 Reservoir

See Table 1.1 for approximate normal, maximum, and spillway design flood (SDF) pool data.

	Length (feet)	Width (feet)	Surface Area (acres)	Storage Volume (acre-feet)
Normal Pool	2,300	75	4	11
Maximum Pool	2,700	80	5	25

1.3.3 Discharges at the Dam Site

There are no operating records for Little River Dam

1.3.4 General Elevations (feet, assumed datum)

A. Top of Dam	15
B. Spillway Design Flood Pool	Not Calculated
C. Normal Pool	15±
D. Spillway Crest	15
E. Upstream Water at Time of Inspection	15.3
F. Downstream water at Time of Inspection	5
G. Low Point along Toe of the Dam	3±

1.3.5 Main Spillway Data

A. Type	Granite block uncontrolled broad-crested
B. Weir Length (ft)	75
C. Weir Crest Elevation	15
D. Upstream Channel	Unknown
E. Downstream Channel	3

1.3.6 Low-level Outlet Structure

The dam has no low-level outlet structure. The abandoned mill race is discussed elsewhere.

1.3.7 Design and Construction Records and History

No design or construction records are available for the dam. According to DCR records, the dam was built ca. 1870. This is consistent with a history of Haverhill found in the local library, which indicates that the area surrounding the dam was built up in the mid-1800s and that shoe manufacturing and other manufacturing activity was a significant enterprise in this era.

1.3.8 Operating Records

There are no operating records available for the dam.

1.4 Summary Data Table

See Table 1.1, Summary Data Table, on the next page.

1.1 Summary Data Table

Required Phase I Report Data	Data Provided by the Inspecting Engineer
National ID #	MA00739
Dam Name	Little River Dam
Dam Name (Alternate)	N/A
River Name	Little River
Impoundment Name	Little River
Hazard Class	Significant
Size Class	Small
Dam Type	Broad-crested, granite block masonry
Dam Purpose	Recreation (formerly mill power)
Structural Height of Dam (feet)	12
Hydraulic Height of Dam (feet)	10
Drainage Area (sq. mi.)	27.9
Reservoir Surface Area (acres)	4
Normal Impoundment Volume (acre-feet)	11
Max Impoundment Volume ((top of dam) acre-feet)	25
SDF Impoundment Volume* (acre-feet)	Unknown
Spillway Type	Uncontrolled broad-crested
Spillway Length (feet)	75
Freeboard at Normal Pool (feet)	3 feet
Principal Spillway Capacity* (cfs)	1170
Auxiliary Spillway Capacity* (cfs)	N/A
Low-Level Outlet Capacity* (cfs)	N/A
Spillway Design Flood* (flow rate - cfs)	100-Year / 1,200 cfs (regress. eqn)
Winter Drawdown (feet below normal pool)	N/A
Drawdown Impoundment Vol. (acre-feet)	N/A
Latitude	42.77766
Longitude	-71.08866
City/Town	Haverhill
County Name	Essex
Public Road on Crest	No
Public Bridge over Spillway	No
EAP Date (if applicable)	N/A
Owner Name	Shain Realty Trust
Owner Address	355 Concord Street
Owner Town	Haverhill, MA 01830
Owner Phone	0
Owner Emergency Phone	0
Owner Type	0
Caretaker Name	Steven Shain
Caretaker Address	355 Concord Street
Caretaker Town	Haverhill, MA 01830
Caretaker Phone	(978) 837-7401
Caretaker Emergency Phone	0
Date of Field Inspection	6/19/2013
Consultant Firm Name	Fuss & O'Neill, Inc.
Inspecting Engineer	Christopher J. Cullen, P.E.
Engineer Phone Number	(800) 286-2469

*In the event a hydraulic and hydrologic analysis has not been completed for the dam, indicate "No H&H" in this table, recommendation section shall include specific recommendation to hire a qualified dam engineering consultant to conduct analysis to determine spillway adequacy in conformance with 302 CMR 10.00.

SECTION 2

2.0 INSPECTION

2.1 Visual Inspection

Little River Dam was inspected on June 19, 2013. At the time of the inspection, the weather was sunny and the temperature was approximately 75° F. The days prior to the inspection were rainy, and as such there was a sizeable flow passing over the dam spillway. This fact, combined with the difficulty of accessing the dam, meant that the inspection was limited to what could be viewed from the downstream bridge and the right abutment. Photographs to document the current conditions of the dam were taken during the inspection and are included in Appendix A. The water surface elevation of the impoundment was approximately 4 inches over the spillway. Underwater areas were not inspected. A copy of the inspection checklist is included in Appendix B.

2.1.1 General Findings

In general, Little River Dam appeared to be in ***Fair*** condition. The specific concerns are identified in more detail in the sections below:

2.1.2 Dam

- **Abutments –** Abutment contact appears to be good, although active spillway flow obscured the point of contact.
- **Upstream Face –** The upstream face of the dam is reported to be granite block masonry. This area was underwater and was not inspected.
- **Crest –** The crest of the dam / spillway is reported to be granite block masonry. Although spillway flow obscured the crest, this flow was uniform and laminar. No major irregularities in the crest affecting flow were observed. A few minor pieces of debris were observed to be caught on the spillway.
- **Downstream Face –** The downstream face of the dam consists of blocks or cobbles, allowing spillway discharge to cascade down and dissipate flow energy. The spillway flow obscured this area, preventing detailed inspection. The portions of the downstream face that were visible did not appear to have any major defects.
- **Drains –** No drains were visible during the dam inspection.
- **Instrumentation –** There is no instrumentation installed at the dam.
- **Access Roads and Gates –** There are no access roads or gates associated with this dam.

2.1.3 Appurtenant Structures

- **Primary Spillway –** The spillway is discussed above, under "crest."

- **Low Level Outlet –** As is often typical for run-of-the-river dams, this dam does not have a low-level outlet.

- **Auxiliary/Emergency Spillway –** Little River Dam does not have an emergency spillway structure.

- **Dikes –** There is no dike associated with this dam.

2.1.4 Downstream Area

The area between the dam and the Winter Street Bridge (approximately 70 feet downstream of the dam) is bordered on the left by the walls and foundation of the mill complex and on the right by a vertical channel wall, which is stone masonry except for the top two to three feet, which is concrete. A significant amount of vegetation obscures much of the right abutment and channel walls. The river channel is lined with stone. The stone arch bridge rises to about 10 feet above the water surface of the river. The entire downstream toe of the dam is submerged in the river.

2.1.5 Reservoir Area

The area surrounding the impoundment is generally urban, although the shoreline is lined with trees and thick vegetation. The right channel wall at the dam is a vertical masonry / concrete wall, extending up approximately 6 feet above the dam crest. The left side of the dam and impoundment immediately upstream of the dam is occupied by a historic mill complex, with the mill walls abutting the impoundment. The reservoir itself is the Little River. The impounded section of the river is approximately 2,300 feet long and 75 feet wide.

2.2 Caretaker Interview

The caretaker was not present during the inspection.

2.3 Operation and Maintenance Procedures

2.3.1 Operational Procedures

There are no formal operational procedures for Little River Dam.

2.3.2 Maintenance of Dam and Operating Facilities

There are no formal written maintenance procedures for this dam.

2.4 Emergency Warning System

No Emergency Action Plan is known to exist for this dam.

2.5 Hydrologic/Hydraulic Data

Little River Dam is a **Small** size, **Class II** (Significant) hazard structure and in accordance with MADCR regulations, the spillway design flood (SDF) for the site is the 100-year storm event.

No detailed hydrologic and hydraulic study is available for this dam. Region-specific USGS Regression Equations were used to estimate frequency flows based solely on the drainage area size. Since this is a run-of-river dam, there is not expected to be any reduction of peak flows in the impoundment.

Spillway capacity was estimated based on the weir equation and assuming a depth of overtopping of 3 feet, which corresponds to the approximate height of the left training wall along the side of the mill building.

Based on the approximate methods described above, it appears the dam may be able to safely pass the 100-year flood. This should be confirmed, however, based on updated spillway capacity information using measurements from a detailed inspection.

The information is summarized as follows:

A. Spillway Design Flood (SDF) Return Period	100-year
B. SDF Outflow (CFS)	1,200
C. Spillway Capacity (CFS)	1,170
D. Depth of Overtopping (FT)	0±

2.6 Structural and Seepage Stability

2.6.1 Embankment Structural Stability

This dam has no soil embankment.

2.6.2 Structural Stability of Non-Embankment Structures

The dam was submerged by spillway flow at the time of inspection and a detailed assessment could not be performed. Based on the even flow of the flow passing over the spillway, the spillway crest appears to have relatively good horizontal and vertical alignment. The historic mill race, mill foundations, and mill walls were not inspected.

2.6.3 Seepage Stability

This run-of-river dam was obscured by flow at the time of inspection, and the toe is submerged by river flow under normal conditions. As such no seepage stability assessment was performed.

SECTION 3

3.0 ASSESSMENTS AND RECOMMENDATIONS

3.1 Assessments

It is difficult to make an assessment of condition since the dam was obscured by high flow during the inspection. In general, however, the condition of Little River Dam appeared to be Fair. The dam was found to have the following deficiencies:

1. Spalling and cracking of concrete and masonry in left training wall, up- and downstream of the spillway.
2. Several pieces of debris observed on the spillway, approach area, or discharge area.
3. Thick vegetation and/or trees growing on and obscuring right and left abutment areas, right spillway training wall, and right channel wall between the dam and bridge.
4. Unknown status of unused mill channel.
5. Reported storm water run-off erosion at right downstream bridge abutment (not observed due to vegetative growth).
6. No Operation & Maintenance (O&M) Manual.

Previously identified deficiencies and major recommendations from prior inspection reports are summarized in the table below. The table also presents the present condition or resolution of the specified deficiencies and recommendations.

Previously Identified Deficiency	*Resolution or Current Condition*
Minor debris build-up in spillway approach area	Ongoing – This is a routine maintenance item
Significant erosion at downstream right bridge abutment from storm water runoff	Undetermined – Vegetation obscured this area and prevented detailed inspection

The following recommendations and remedial measures generally describe the recommended approach to address current deficiencies at the dam. Prior to undertaking recommended maintenance, repairs, or remedial measures, the applicability of environmental permits needs to be determined for activities that may occur within resource areas under the jurisdiction of local conservation commissions, MADEP, or other regulatory agencies.

3.2 Studies and Analyses

The following studies or analyses are recommended to evaluate concerns and comply with current regulations.

- An operation and maintenance (O&M) manual should be developed and implemented for this dam. The O&M manual should contain explicit schedules and instructions for maintenance activities to be performed on the dam and its appurtenances, as well as operational procedures to be followed under both routine and flood conditions.

- Inspect and monitor unused mill channel for signs of seepage.
- Monitor reported storm water run-off erosion at right downstream bridge abutment.
- Since the dam is not readily accessible for routine inspection, perform a detailed inspection of the dam structure, mill channel, training walls, and foundation area during a period of low flow using a dive team and after clearing vegetation from the area. This will help identify whether there are any items of concern.

3.3 Recurrent Maintenance Recommendations

The activities presented below should be undertaken on a regular or yearly basis by the dam owner/caretaker to improve the safety, maintenance, and operation of the dam. Typically these activities do not require engineering design.

- Remove debris from the spillway, approach, and discharge areas.
- Remove vegetation and trees from the right and left abutment areas, right spillway training wall, and right channel wall between the dam and bridge.

3.4 Minor Repair Recommendations

The following recommendations are intended to improve the overall condition of the dam but do not alter the current design of the dam. The recommendations will probably require assistance by a professional engineer and construction by a contractor experienced in dam construction or repair. A Chapter 253 permit may be required.

- Investigate and repair the spalled and cracked concrete and masonry in left training wall, up- and downstream of the spillway.

3.5 Remedial Modifications Recommendations

Remedial modifications **alter** the current dam design and require design by a professional engineer and construction by a contractor experienced in dam construction or repair. No remedial modifications are recommended for the Little River Dam at this time.

3.6 Alternatives

Dam removal is not considered an option for this dam based on its historical value and use for aesthetic purposes.

3.7 Opinion of Probable Construction Costs

The following conceptual order-of-magnitude opinions of cost have been developed for the recommendations and remedial measures noted above. Order-of-Magnitude opinions of cost are normally expected to be accurate within plus 50 percent to minus 30 percent, which is the range indicated. The costs shown herein are based on a limited investigation and are provided

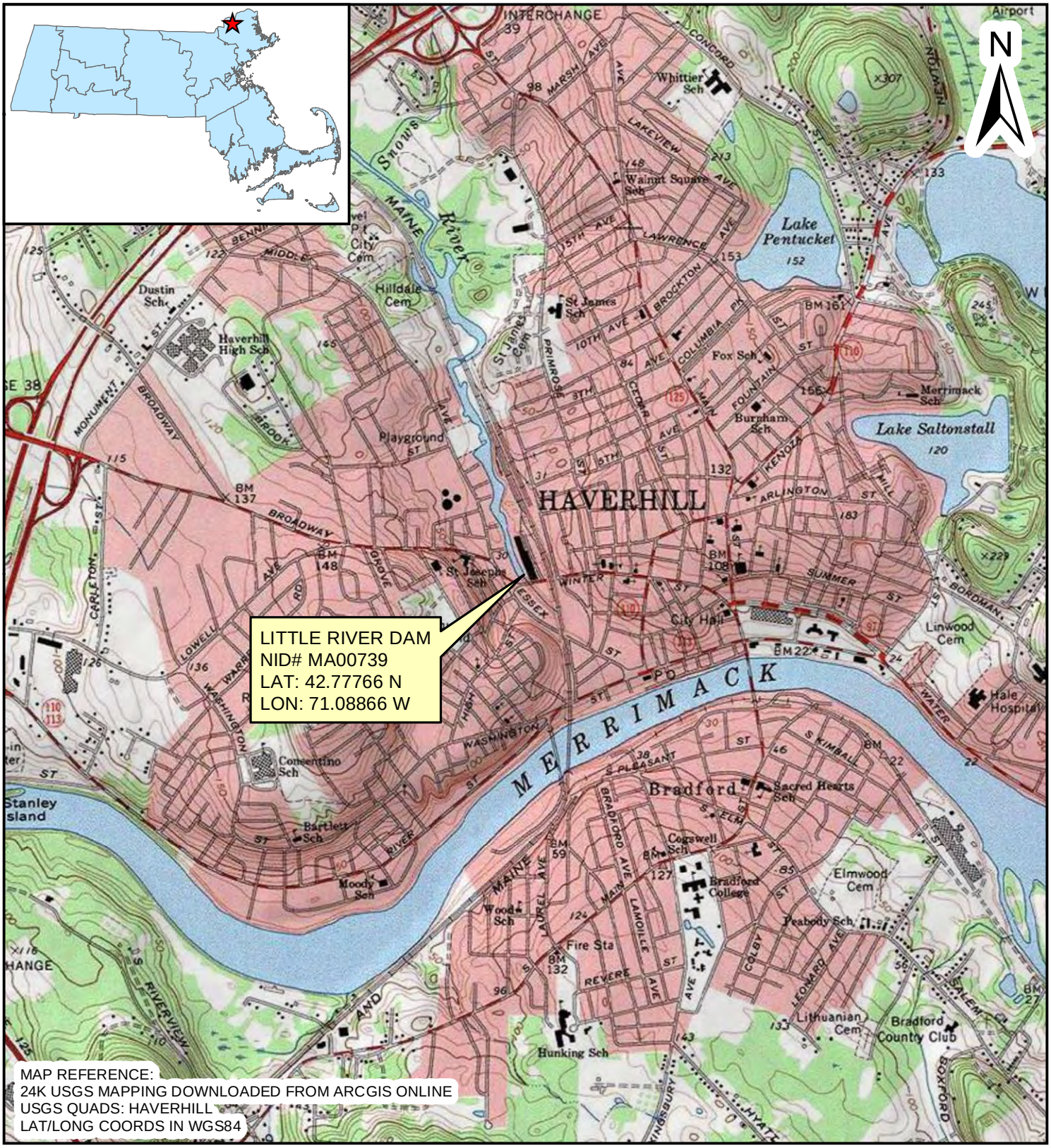
for general information only. They should not be considered an engineer's estimate, as construction costs may be less or considerably more than indicated.

Prior to commencing construction of repairs or maintenance activities, the owner/caretaker should contact the Office of Dam Safety and the local Conservation Commission to determine whether a permit is required. Consultation with a professional engineer familiar with the dam safety regulatory process is recommended to determine which other federal, state, and local permits may apply.

Recommendations	Order-of-Magnitude Range of Cost
Studies / Analyses / Manuals	
Develop O&M manual	$3,000 - $6,000
Inspect & monitor unused mill channel for signs of seepage	$2,000 - $5,000
Monitor reported storm water run-off erosion at bridge abutment	-
Perform detailed inspection of all dam components using diver	$7,000 - $15,000
Subtotal	$12,000 - $26,000
10% Contingency	$1,200 - $2,600
Total	**$13,200 - $28,600**
Minor Repairs	
Repair spalled / cracked concrete & masonry in left training wall	$11,000 - $23,000
Remove debris from spillway, approach, & discharge areas	-
Remove trees and vegetation from abutments & channel walls	$7,000 - $15,000
Subtotal	$18,000 - $38,000
10% Contingency	$1,800 - $3,800
Total	**$19,800 - $41,800**
Remedial Modifications	
None	-
Grand Total	**$33,000 – $70,400**

FIGURES

Figure 1: **Locus Plan**
Figure 2: **Aerial Photograph**
Figure 3: **Drainage Area**
Figure 4: **Dam and Downstream Area**
Figure 5: **Site Sketch**



JUNE 2013

FIGURE 1

2,000 1,000 0 2,000 Feet

MASSACHUSETTS DEPT OF CONSERVATION & RECREATION

LOCUS MAP

LITTLE RIVER DAM (MA00739)

HAVERHILL, MASSACHUSETTS

SCALE
HORZ: 1 INCH = 2,000 FEET
VERT:
DATUM
HORZ:
VERT: NGVD29 (10-FOOT CONTOURS)

FUSS & O'NEILL

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JUNE 2013

FIGURE 2

200 100 0 200 Feet

MASSACHUSETTS DEPT OF CONSERVATION & RECREATION

AERIAL PHOTOGRAPH

LITTLE RIVER DAM (MA00739)

HAVERHILL, MASSACHUSETTS

SCALE
HORZ: 1 INCH = 200 FEET
VERT:
DATUM
HORZ:
VERT:

FUSS & O'NEILL

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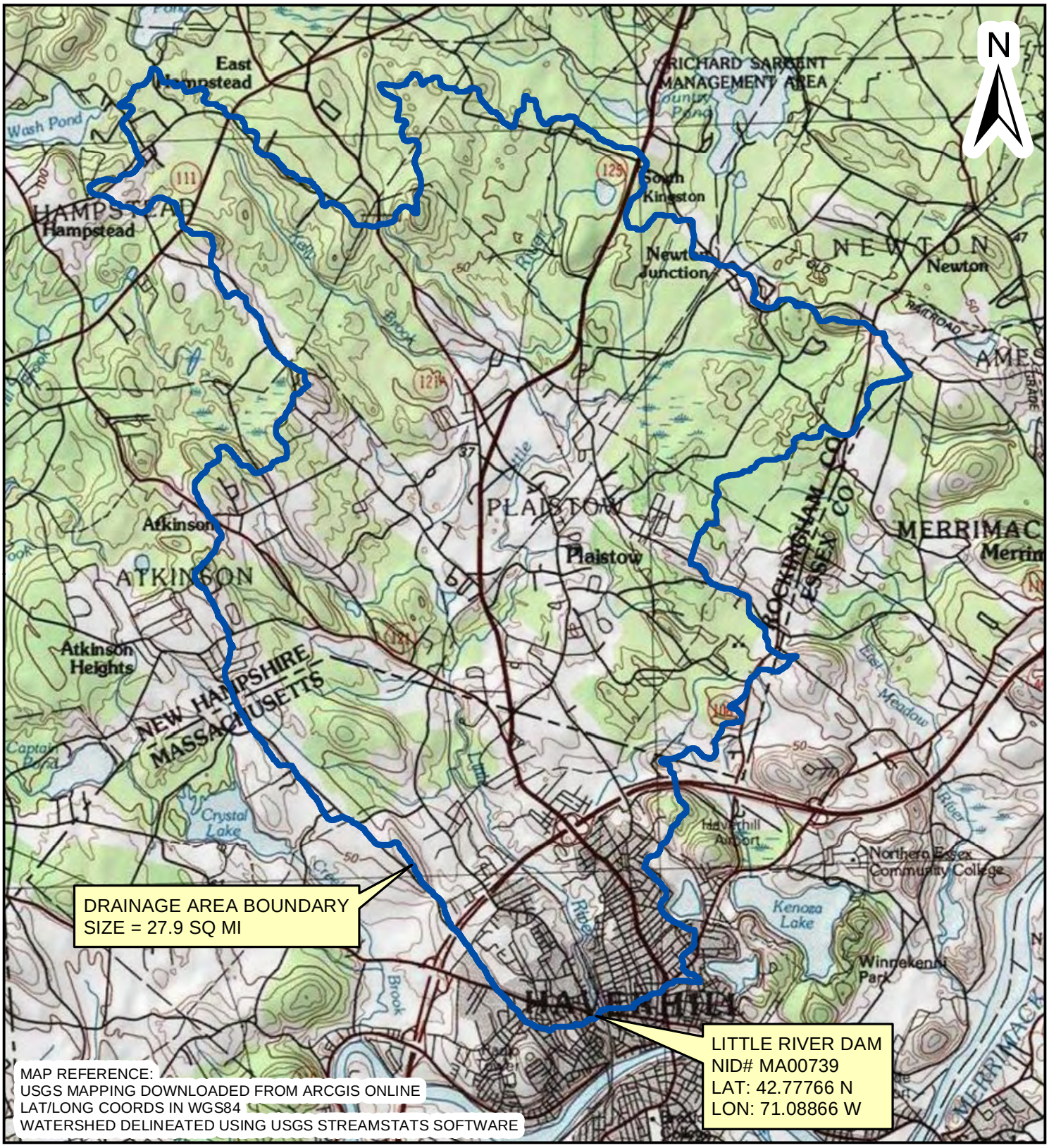

JUNE 2013

FIGURE 3

6,000 3,000 0 6,000 Feet

MASSACHUSETTS DEPT OF CONSERVATION & RECREATION

DRAINAGE AREA

LITTLE RIVER DAM (MA00739)

HAVERHILL, MASSACHUSETTS

SCALE
HORZ: 1 INCH = 6,000 FEET
VERT:
DATUM
HORZ:
VERT: NGVD29 (10-METER CONTOURS)

FUSS & O'NEILL

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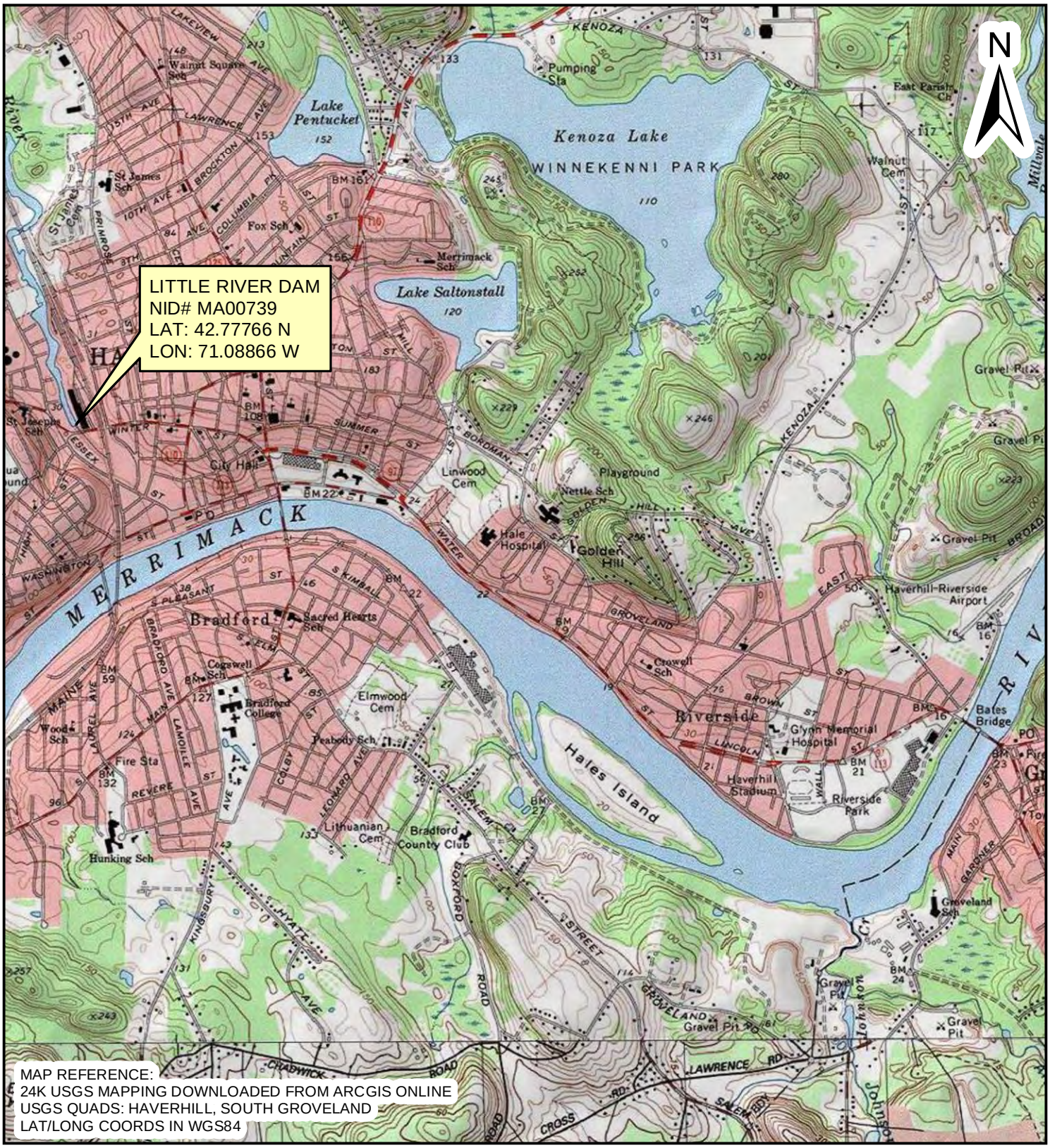

JUNE 2013

FIGURE 4

2,000 1,000 0 2,000 Feet

MASSACHUSETTS DEPT OF CONSERVATION & RECREATION

DOWNSTREAM AREA

LITTLE RIVER DAM (MA00739)

HAVERHILL, MASSACHUSETTS

SCALE
HORZ: 1 INCH = 2,000 FEET
VERT:
DATUM
HORZ:
VERT: NGVD29 (10-FOOT CONTOURS)

FUSS & O'NEILL

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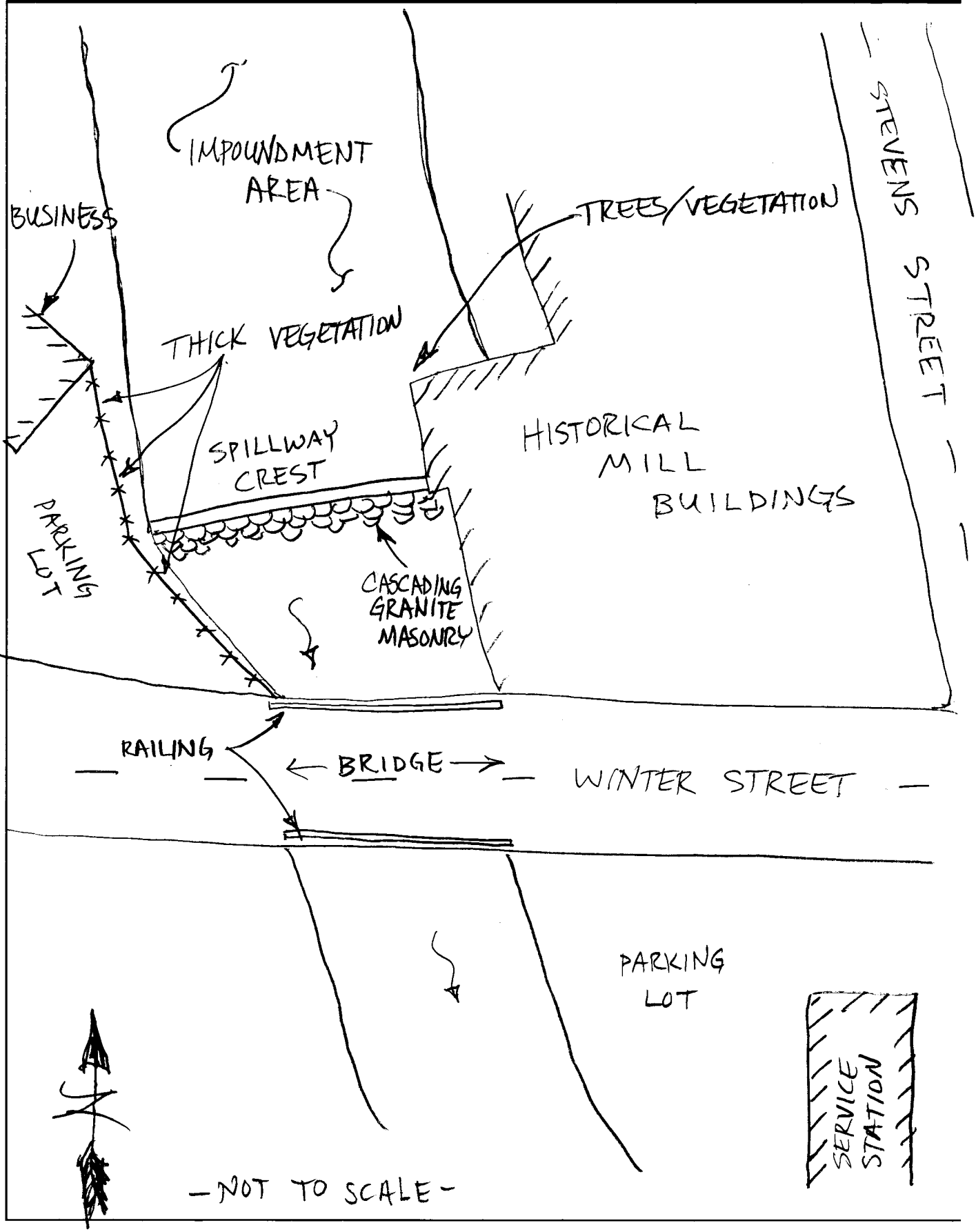
FUSS & O'NEILL	Prepared By	Date	Checked By	Date	Project No
	DWH	6/19/13			20090254.D13

FIELD SKETCH OF LITTLE RIVER DAM, HAVERHILL

Sheet No 1 of 1



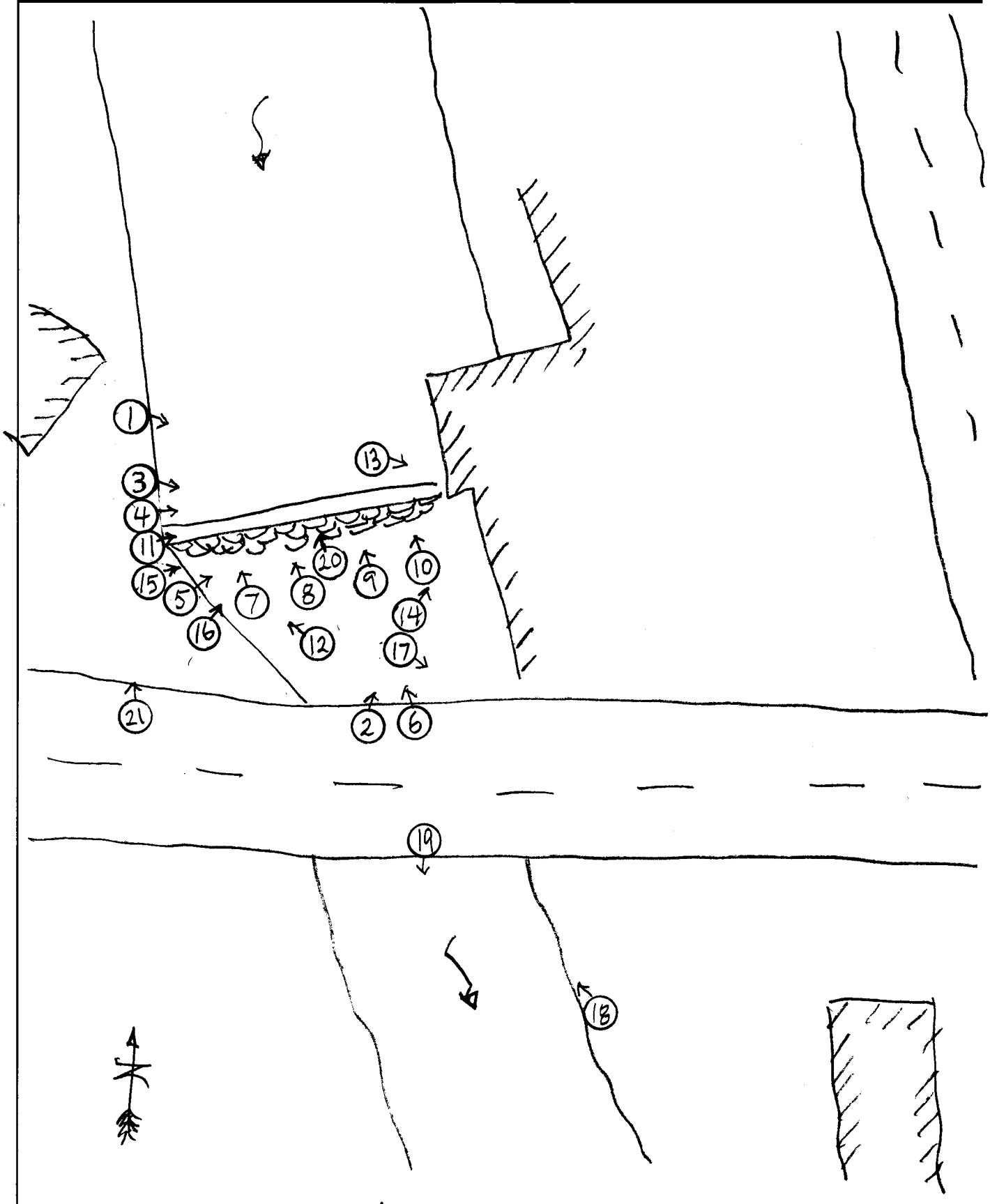
APPENDIX A

Photographs

FUSS & O'NEILL	Prepared By DWA	Date 6/19/13	Checked By	Date	Project No 20090254.D13

PHOTO LOCATION SKETCH FOR LITTLE RIVER DAM

Sheet No of



-NOT TO SCALE-

Photo 1: Overview of dam from upstream

Photo 2: Overview of dam from downstream

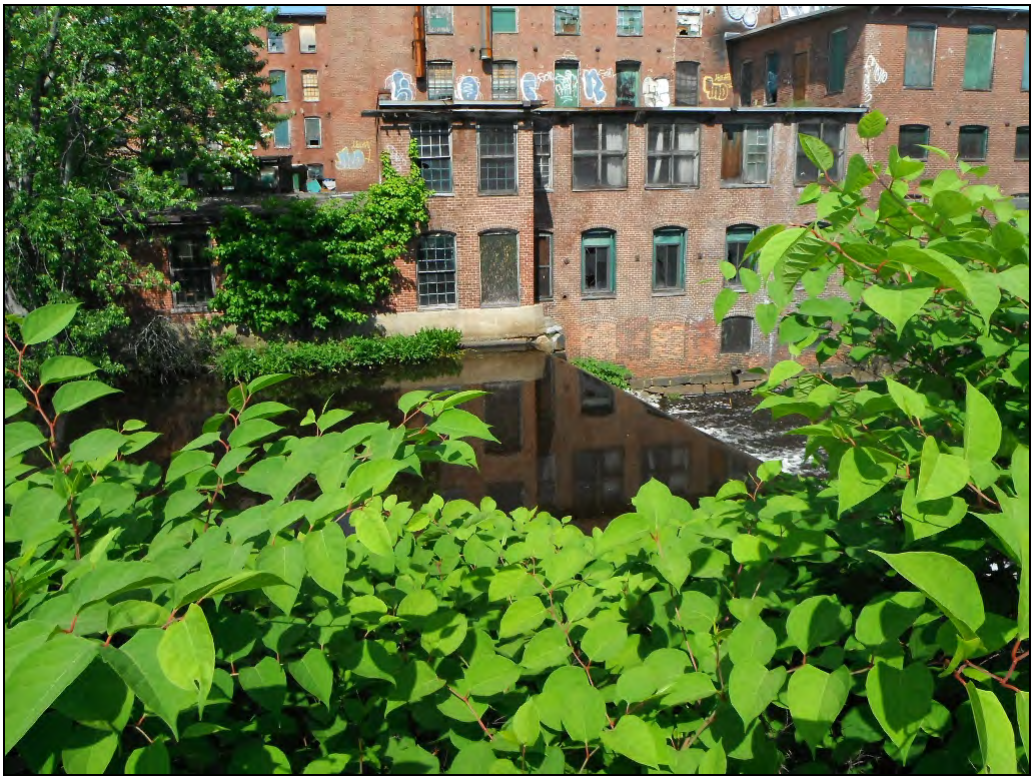


Photo 3: Overview of upstream face from right abutment

Photo 4: Overview of dam crest from right abutment

Photo 5: Overview of downstream face from right abutment.

Photo 6: Overview of downstream face from downstream bridge

Photo 7: Overview of downstream face (1 of 4) – right section

Photo 8: Overview of downstream face (2 of 4) – right center section

Photo 9: Overview of downstream face (3 of 4) – left center section

Photo 10: Overview of downstream face (4 of 4) – left section

Photo 11: Overview of right training wall (1 of 2)

Photo 12: Overview of right training wall (2 of 2)

Photo 13: Overview of left training wall (1 of 2)

Photo 14: Overview of left training wall (2 of 2)

Photo 15: Overview of weir

Photo 16: Overview of stilling basin

Photo 17: Overview of downstream bridge (viewed from upstream side)

Photo 18: Overview of downstream bridge (viewed from downstream side)

Photo 19: Overview of downstream channel (viewed from downstream bridge)

Photo 20: Overview of reservoir

Photo 21: Right abutment, viewed from downstream side

APPENDIX B

Inspection Checklist

DAM SAFETY INSPECTION CHECKLIST

NAME OF DAM: Little River Dam

STATE ID #: 5-5-128-6

REGISTERED: ☑ YES ☐ NO

NID ID #: MA00739

STATE SIZE CLASSIFICATION: Small

STATE HAZARD CLASSIFICATION: Significant

CHANGE IN HAZARD CLASSIFICATION REQUESTED?: No

DAM LOCATION INFORMATION

CITY/TOWN: Haverhill

COUNTY: Essex

DAM LOCATION: Winter St / Rt 97, between Essex St & Stevens St
(street address if known)

ALTERNATE DAM NAME: N/A

USGS QUAD.: Haverhill

LAT.: 42.77766 LONG.: -71.08866

DRAINAGE BASIN: Merrimack

RIVER: Little River

IMPOUNDMENT NAME(S): Little River

GENERAL DAM INFORMATION

TYPE OF DAM: Broad-crested, granite block masonry

OVERALL LENGTH (FT): 75

PURPOSE OF DAM: Recreation (formerly mill power)

NORMAL POOL STORAGE (ACRE-FT): 11

YEAR BUILT: 1870

MAXIMUM POOL STORAGE (ACRE-FT): 25

STRUCTURAL HEIGHT (FT): 12

EL. NORMAL POOL (FT): 15.0

HYDRAULIC HEIGHT (FT): 10

EL. MAXIMUM POOL (FT): 18.0

FOR INTERNAL MADCR USE ONLY

FOLLOW-UP INSPECTION REQUIRED: ☐ YES ☐ NO

CONDITIONAL LETTER: ☐ YES ☐ NO

NAME OF DAM: Little River Dam | STATE ID #: 5-5-128-6

INSPECTION DATE: June 19, 2013 | NID ID #: MA00739

INSPECTION SUMMARY

DATE OF INSPECTION: June 19, 2013 | DATE OF PREVIOUS INSPECTION: January 11, 2000

TEMPERATURE/WEATHER: 75 deg / clear | ARMY CORPS PHASE I: ☐ YES ☑ NO | If YES, date

CONSULTANT: Fuss & O'Neill, Inc. | PREVIOUS DCR PHASE I: ☐ YES ☑ NO | If YES, date

BENCHMARK/DATUM: Assumed datum (normal pool / dam crest = 15 ft)

OVERALL PHYSICAL CONDITION OF DAM: FAIR | DATE OF LAST REHABILITATION: Unknown

SPILLWAY CAPACITY: 90-100% of the SDF

EL. POOL DURING INSP.: 15.3 | EL. TAILWATER DURING INSP.: 5

PERSONS PRESENT AT INSPECTION

NAME	TITLE/POSITION	REPRESENTING
David W. Hammond, P.E.	Project Engineer	Fuss & O'Neill, Inc.

EVALUATION INFORMATION

	Click on box to select E-code
E1) TYPE OF DESIGN	1
E2) LEVEL OF MAINTENANCE	2
E3) EMERGENCY ACTION PLAN	1
E4) EMBANKMENT SEEPAGE	N/A
E5) EMBANKMENT CONDITION	N/A
E6) CONCRETE CONDITION	2
E7) LOW-LEVEL OUTLET CAPACITY	1

	Click on box to select E-code
E8) LOW-LEVEL OUTLET CONDITION	1
E9) SPILLWAY DESIGN FLOOD CAPACITY	3
E10) OVERALL PHYSICAL CONDITION	3
E11) ESTIMATED REPAIR COST	$33,000 - $70,000
ROADWAY OVER CREST	NO
BRIDGE NEAR DAM	YES

NAME OF INSPECTING ENGINEER: Christopher J. Cullen, P.E. | SIGNATURE:

NAME OF DAM: Little River Dam

STATE ID #: 5-5-128-6

INSPECTION DATE: June 19, 2013

NID ID #: MA00739

OWNER:		CARETAKER:	
ORGANIZATION	Shain Realty Trust	ORGANIZATION	Shain Realty Trust
NAME/TITLE	Steven & Carol Shain	NAME/TITLE	Steven Shain
STREET	355 Concord Street	STREET	355 Concord Street
TOWN, STATE, ZIP	Haverhill, MA 01830	TOWN, STATE, ZIP	Haverhill, MA 01830
PHONE		PHONE	(978) 837-7401
EMERGENCY PH. #		EMERGENCY PH. #	
FAX		FAX	
EMAIL		EMAIL	
OWNER TYPE			

PRIMARY SPILLWAY TYPE: Uncontrolled broad-crested

SPILLWAY LENGTH (FT): 75

SPILLWAY CAPACITY (CFS): 1,170

AUXILIARY SPILLWAY TYPE: NA

AUX. SPILLWAY CAPACITY (CFS): N/A

NUMBER OF OUTLETS: 0

OUTLET(S) CAPACITY (CFS): N/A

TYPE OF OUTLETS: N/A

TOTAL DISCHARGE CAPACITY (CFS): 1,170

DRAINAGE AREA (SQ MI): 27.9

SPILLWAY DESIGN FLOOD (PERIOD/CFS): 100-Year / 1,200 cfs (regress. eqn)

HAS DAM BEEN BREACHED OR OVERTOPPED ☐ YES ☑ NO IF YES, PROVIDE DATE(S)

FISH LADDER (LIST TYPE IF PRESENT): N/A

DOES CREST SUPPORT PUBLIC ROAD? ☐ YES ☑ NO IF YES, ROAD NAME:

PUBLIC BRIDGE WITHIN 50' OF DAM? ☑ YES ☐ NO IF YES, ROAD/BRIDGE NAME: Winter Street / Route 97

MHD BRIDGE NO. (IF APPLICABLE)

NAME OF DAM: Little River Dam STATE ID #: 5-5-128-6

INSPECTION DATE: June 19, 2013 NID ID #: MA00739

EMBANKMENT (CREST) - N/A

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
CREST	1. SURFACE TYPE	N/A			
	2. SURFACE CRACKING	N/A			
	3. SINKHOLES, ANIMAL BURROWS	N/A			
	4. VERTICAL ALIGNMENT (DEPRESSIONS)	N/A			
	5. HORIZONTAL ALIGNMENT	N/A			
	6. RUTS AND/OR PUDDLES	N/A			
	7. VEGETATION (PRESENCE/CONDITION)	N/A			
	8. ABUTMENT CONTACT	N/A			

ADDITIONAL COMMENTS:

NAME OF DAM: Little River Dam STATE ID #: 5-5-128-6

INSPECTION DATE: June 19, 2013 NID ID #: MA00739

EMBANKMENT (D/S SLOPE) - N/A

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
D/S SLOPE	1. WET AREAS (NO FLOW)	N/A			
	2. SEEPAGE	N/A			
	3. SLIDE, SLOUGH, SCARP	N/A			
	4. EMB.-ABUTMENT CONTACT	N/A			
	5. SINKHOLE/ANIMAL BURROWS	N/A			
	6. EROSION	N/A			
	7. UNUSUAL MOVEMENT	N/A			
	8. VEGETATION (PRESENCE/CONDITION)	N/A			

ADDITIONAL COMMENTS:

NAME OF DAM: Little River Dam STATE ID #: 5-5-128-6

INSPECTION DATE: June 19, 2013 NID ID #: MA00739

EMBANKMENT (U/S SLOPE) - N/A

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
U/S SLOPE	1. SLIDE, SLOUGH, SCARP	N/A			
	2. SLOPE PROTECTION TYPE AND COND.	N/A			
	3. SINKHOLE/ANIMAL BURROWS	N/A			
	4. EMB.-ABUTMENT CONTACT	N/A			
	5. EROSION	N/A			
	6. UNUSUAL MOVEMENT	N/A			
	7. VEGETATION (PRESENCE/CONDITION)	N/A			

ADDITIONAL COMMENTS:

NAME OF DAM: Little River Dam STATE ID #: 5-5-128-6

INSPECTION DATE: June 19, 2013 NID ID #: MA00739

INSTRUMENTATION - N/A

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
INSTR.	1. PIEZOMETERS	N/A			
	2. OBSERVATION WELLS	N/A			
	3. STAFF GAGE AND RECORDER	N/A			
	4. WEIRS	N/A			
	5. INCLINOMETERS	N/A			
	6. SURVEY MONUMENTS	N/A			
	7. DRAINS	N/A			
	8. FREQUENCY OF READINGS	N/A			
	9. LOCATION OF READINGS	N/A			

ADDITIONAL COMMENTS:

NAME OF DAM: Little River Dam STATE ID #: 5-5-128-6

INSPECTION DATE: June 19, 2013 NID ID #: MA00739

DOWNSTREAM MASONRY WALLS - N/A

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
D/S WALLS	1. WALL TYPE	N/A			
	2. WALL ALIGNMENT	N/A			
	3. WALL CONDITION	N/A			
	4. HEIGHT: TOP OF WALL TO MUDLINE	min: max: avg:			
	5. SEEPAGE OR LEAKAGE	N/A			
	6. ABUTMENT CONTACT	N/A			
	7. EROSION/SINKHOLES BEHIND WALL	N/A			
	8. ANIMAL BURROWS	N/A			
	9. UNUSUAL MOVEMENT	N/A			
	10. WET AREAS AT TOE OF WALL	N/A			

ADDITIONAL COMMENTS:

NAME OF DAM: Little River Dam STATE ID #: 5-5-128-6

INSPECTION DATE: June 19, 2013 NID ID #: MA00739

UPSTREAM MASONRY WALLS - N/A

AREA INSPECTED	CONDITION	OBSERVATIONS			NO ACTION	MONITOR	REPAIR
U/S WALLS	1. WALL TYPE	N/A					
	2. WALL ALIGNMENT	N/A					
	3. WALL CONDITION	N/A					
	4. HEIGHT: TOP OF WALL TO MUDLINE	min:	max:	avg:			
	5. ABUTMENT CONTACT	N/A					
	6. EROSION/SINKHOLES BEHIND WALL	N/A					
	7. ANIMAL BURROWS	N/A					
	8. UNUSUAL MOVEMENT	N/A					

ADDITIONAL COMMENTS:

NAME OF DAM: Little River Dam STATE ID #: 5-5-128-6

INSPECTION DATE: June 19, 2013 NID ID #: MA00739

DOWNSTREAM AREA

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
D/S AREA	1. ABUTMENT LEAKAGE	Unknown		X	
	2. FOUNDATION SEEPAGE	Unknown		X	
	3. SLIDE, SLOUGH, SCARP	N/A			
	4. WEIRS	N/A			
	5. DRAINAGE SYSTEM	N/A			
	6. INSTRUMENTATION	N/A			
	7. VEGETATION	Channel lined with trees and heavy vegetation			X
	8. ACCESSIBILITY	Difficult. Rappel from top of left channel wall or Winter St bridge; may be able to enter channel d/s of bridge and travel u/s using boat and/or waders	X		
	9. DOWNSTREAM HAZARD DESCRIPTION	Winter Street (Rt 97) approx. 70 ft d/s. Area surrounding d/s channel is urban. River appears to enter pressure conduit 700' d/s and then into Merrimack River.			
	10. DATE OF LAST EAP UPDATE	N/A			

ADDITIONAL COMMENTS: The dam consist of a granite block masonry spillway that extends between a vertical channel wall on the left and a mill building on the right. As such the entire structure is inundated during periods of high flow (such as was the case at inspection). The downstream toe was also submerged, preventing evaluation of seepage.

NAME OF DAM: Little River Dam STATE ID #: 5-5-128-6

INSPECTION DATE: June 19, 2013 NID ID #: MA00739

MISCELLANEOUS

AREA INSPECTED	CONDITION	OBSERVATIONS
MISC.	1. RESERVOIR DEPTH (AVG)	Unknown
	2. RESERVOIR SHORELINE	Urban. Right channel wall at dam is vertical masonry / concrete wall; Left wall is mill buildings. Trees line shores of impoundment in upstream reach.
	3. RESERVOIR SLOPES	Mild slopes around reservoir
	4. ACCESS ROADS	Dam can be seen from Winter Street but is difficult to access. Reservoir is between Stevens Street & Hilldale Ave.
	5. SECURITY DEVICES	Chain link fencing along left abutment.
	6. VANDALISM OR TRESPASS	☐ YES ☑ NO WHAT:
	7. AVAILABILITY OF PLANS	☐ YES ☑ NO DATE:
	8. AVAILABILITY OF DESIGN CALCS	☐ YES ☑ NO DATE:
	9. AVAILABILITY OF EAP/LAST UPDATE	☐ YES ☑ NO DATE: N/A
	10. AVAILABILITY OF O&M MANUAL	☐ YES ☑ NO DATE:
	11. CARETAKER/OWNER AVAILABLE	☐ YES ☑ NO DATE:
	12. CONFINED SPACE ENTRY REQUIRED	☐ YES ☑ NO PURPOSE:

ADDITIONAL COMMENTS:

NAME OF DAM: Little River Dam STATE ID #: 5-5-128-6

INSPECTION DATE: June 19, 2013 NID ID #: MA00739

PRIMARY SPILLWAY

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
SPILLWAY	SPILLWAY TYPE	Uncontrolled granite block			
	WEIR TYPE	Broad-crested			
	SPILLWAY CONDITION	Unknown*			
	TRAINING WALLS	Left training wall along mill bldg is concrete u/s of weir, stone masonry on d/s side. Right training wall / channel wall is vertical, of masonry & concrete**			X
	SPILLWAY CONTROLS AND CONDITION	N/A			
	UNUSUAL MOVEMENT	Unknown*			
	APPROACH AREA	No problems noted			
	DISCHARGE AREA	Stony channel			
	DEBRIS	Some limited debris on spillway			X
	WATER LEVEL AT TIME OF INSPECTION	Approx 4" over spillway			

ADDITIONAL COMMENTS: * There was heavy flow over spillway at the time of inspection, obscuring the structure and preventing detailed inspection.

** Left wall had horizontal cracking and spalling. Right side could not be inspected due to vegetation, but appeared to be primarily of masonry, with the top several feet being concrete.

NAME OF DAM: Little River Dam STATE ID #: 5-5-128-6

INSPECTION DATE: June 19, 2013 NID ID #: MA00739

AUXILIARY SPILLWAY

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
SPILLWAY	SPILLWAY TYPE	N/A			
	WEIR TYPE	N/A			
	SPILLWAY CONDITION	N/A			
	TRAINING WALLS	N/A			
	SPILLWAY CONTROLS AND CONDITION	N/A			
	UNUSUAL MOVEMENT	N/A			
	APPROACH AREA	N/A			
	DISCHARGE AREA	N/A			
	DEBRIS	N/A			
	WATER LEVEL AT TIME OF INSPECTION	N/A			

ADDITIONAL COMMENTS:

NAME OF DAM: Little River Dam STATE ID #: 5-5-128-6

INSPECTION DATE: June 19, 2013 NID ID #: MA00739

OUTLET WORKS

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
OUTLET WORKS	TYPE	N/A			
	INTAKE STRUCTURE	N/A			
	TRASHRACK	N/A			
	PRIMARY CLOSURE	N/A			
	SECONDARY CLOSURE	N/A			
	CONDUIT	N/A			
	OUTLET STRUCTURE/HEADWALL	N/A			
	EROSION ALONG TOE OF DAM	N/A			
	SEEPAGE/LEAKAGE	N/A			
	DEBRIS/BLOCKAGE	N/A			
	UNUSUAL MOVEMENT	N/A			
	DOWNSTREAM AREA	N/A			
	MISCELLANEOUS	N/A			

ADDITIONAL COMMENTS:

NAME OF DAM: Little River Dam STATE ID #: 5-5-128-6

INSPECTION DATE: June 19, 2013 NID ID #: MA00739

CONCRETE/MASONRY DAMS

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
GENERAL	TYPE	Granite masonry block (reported)			
	AVAILABILITY OF PLANS	Not available			
	AVAILABILITY OF DESIGN CALCS	Not available			
	PIEZOMETERS	None observed			
	OBSERVATION WELLS	None observed			
	INCLINOMETERS	None observed			
	SEEPAGE GALLERY	None observed			
	UNUSUAL MOVEMENT	Unknown - dam / spillway obscured by heavy flow			

ADDITIONAL COMMENTS:

NAME OF DAM: Little River Dam STATE ID #: 5-5-128-6

INSPECTION DATE: June 19, 2013 NID ID #: MA00739

CONCRETE/MASONRY DAMS (CREST)

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
CREST	TYPE	Granite block (reported)			
	SURFACE CONDITIONS	Unknown		X	
	CONDITIONS OF JOINTS	Unknown		X	
	UNUSUAL MOVEMENT	Unknown		X	
	HORIZONTAL ALIGNMENT	Appeared good based on flow profile	X		
	VERTICAL ALIGNMENT	Appeared good based on flow profile	X		

ADDITIONAL COMMENTS:

NAME OF DAM: Little River Dam STATE ID #: 5-5-128-6

INSPECTION DATE: June 19, 2013 NID ID #: MA00739

CONCRETE/MASONRY DAMS (DOWNSTREAM FACE)

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
D/S FACE	TYPE	Cascading granite masonry			
	SURFACE CONDITIONS	Unknown			
	CONDITIONS OF JOINTS	Unknown			
	UNUSUAL MOVEMENT	Unknown			
	ABUTMENT CONTACT	Unknown			
	LEAKAGE	Unknown			

ADDITIONAL COMMENTS:

NAME OF DAM: Little River Dam STATE ID #: 5-5-128-6

INSPECTION DATE: June 19, 2013 NID ID #: MA00739

CONCRETE/MASONRY DAMS (UPSTREAM FACE)

AREA INSPECTED	CONDITION	OBSERVATIONS	NO ACTION	MONITOR	REPAIR
U/S FACE	TYPE	Granite masonry			
	SURFACE CONDITIONS	Unknown			
	CONDITIONS OF JOINTS	Unknown			
	UNUSUAL MOVEMENT	Unknown			
	ABUTMENT CONTACTS	Unknown			

ADDITIONAL COMMENTS: Condition of the upstream masonry could not be determined since underwater areas were not inspected. Spillway is reported to be made of granite masonry block.

APPENDIX C

Previous Reports and References

PREVIOUS REPORTS AND REFERENCES

The following is a list of reports that were located during the file review, or were referenced in previous reports.

1. Notice of Inspection for Little River Dam, MA00739, R. David Clark, Massachusetts DEM, January 11, 2000
2. Estimating Peak Discharges of Small Rural Streams in Massachusetts (Open File Report 80-76), S. William Wandle, U.S. Geological Survey, Department of the Interior, Boston, 1980.
3. The History of Haverhill, Massachusetts, George W. Chase, 1983, Somersworth, New Hampshire.

APPENDIX D

Definitions

COMMON DAM SAFETY DEFINITIONS

For a comprehensive list of dam engineering terminology and definitions refer to 302 CMR10.00 Dam Safety, or other reference published by FERC, Dept. of the Interior Bureau of Reclamation, or FEMA. Please note should discrepancies between definitions exist, those definitions included within 302 CMR 10.00 govern for dams located within the Commonwealth of Massachusetts.

Orientation

Upstream – Shall mean the side of the dam that borders the impoundment.

Downstream – Shall mean the high side of the dam, the side opposite the upstream side.

Right – Shall mean the area to the right when looking in the downstream direction.

Left – Shall mean the area to the left when looking in the downstream direction.

Dam Components

Dam – Shall mean any artificial barrier, including appurtenant works, which impounds or diverts water.

Embankment – Shall mean the fill material, usually earth or rock, placed with sloping sides, such that it forms a permanent barrier that impounds water.

Crest – Shall mean the top of the dam, usually provides a road or path across the dam.

Abutment – Shall mean that part of a valley side against which a dam is constructed. An artificial abutment is sometimes constructed as a concrete gravity section, to take the thrust of an arch dam where there is no suitable natural abutment.

Appurtenant Works – Shall mean structures, either in dams or separate therefrom, including but not be limited to, spillways; reservoirs and their rims; low-level outlet works; and water conduits including tunnels, pipelines, or penstocks, either through the dams or their abutments.

Spillway – Shall mean a structure over or through which water flows are discharged. If the flow is controlled by gates or boards, it is a controlled spillway; if the fixed elevation of the spillway crest controls the level of the impoundment, it is an uncontrolled spillway.

Size Classification

(as listed in Commonwealth of Massachusetts, 302 CMR 10.00 Dam Safety)

Large – structure with a height greater than 40 feet or a storage capacity greater than 1,000 acre-feet.

Intermediate – structure with a height between 15 and 40 feet or a storage capacity of 50 to 1,000 acre-feet.

Small – structure with a height between 6 and 15 feet and a storage capacity of 15 to 50 acre-feet.

Non-Jurisdictional – structure less than 6 feet in height or having a storage capacity of less than 15 acre-feet.

Hazard Classification
(as listed in Commonwealth of Massachusetts, 302 CMR 10.00 Dam Safety)

High Hazard (Class I) – Shall mean dams located where failure will likely cause loss of life and serious damage to home(s), industrial or commercial facilities, important public utilities, main highway(s) or railroad(s).

Significant Hazard (Class II) – Shall mean dams located where failure may cause loss of life and damage to home(s), industrial or commercial facilities, secondary highway(s) or railroad(s), or cause the interruption of the use or service of relatively important facilities.

Low Hazard (Class III) – Dams located where failure may cause minimal property damage to others. Loss of life is not expected.

General

EAP – Emergency Action Plan – Shall mean a predetermined (and properly documented) plan of action to be taken to reduce the potential for property damage and/or loss of life in an area affected by an impending dam failure.

O&M Manual – Operations and Maintenance Manual; Document identifying routine maintenance and operational procedures under normal and storm conditions.

Normal Pool – Shall mean the elevation of the impoundment during normal operating conditions.

Acre-foot – Shall mean a unit of volumetric measure that would cover one acre to a depth of one foot. It is equal to 43,560 cubic feet. One million U.S. gallons = 3.068 acre feet.

Height of Dam (Structural Height) – Shall mean the vertical distance from the lowest portion of the natural ground, including any stream channel, along the downstream toe of the dam to the lowest point on the crest of the dam.

Hydraulic Height – means the height to which water rises behind a dam and the difference between the lowest point in the original streambed at the axis of the dam and the maximum controllable water surface.
Maximum Water Storage Elevation – means the maximum elevation of water surface which can be contained by the dam without overtopping the embankment section.

Spillway Design Flood (SDF) – Shall mean the flood used in the design of a dam and its appurtenant works particularly for sizing the spillway and outlet works, and for determining maximum temporary storage and height of dam requirements.

Maximum Storage Capacity – The volume of water contained in the impoundment at maximum water storage elevation.

Normal Storage Capacity – The volume of water contained in the impoundment at normal water storage elevation.

Condition Rating

Unsafe – Major structural*, operational, and maintenance deficiencies exist under normal operating conditions.

Poor – Significant structural*, operation and maintenance deficiencies are clearly recognized for normal loading conditions.

Fair – Significant operational and maintenance deficiencies, no structural deficiencies. Potential deficiencies exist under unusual loading conditions that may realistically occur. Can be used when uncertainties exist as to critical parameters.

Satisfactory – Minor operational and maintenance deficiencies. Infrequent hydrologic events would probably result in deficiencies.

Good – No existing or potential deficiencies recognized. Safe performance is expected under all loading including SDF.

* Structural deficiencies include but are not limited to the following:

- Excessive uncontrolled seepage (e.g., upwelling of water, evidence of fines movement, flowing water, erosion, etc.)
- Missing riprap with resulting erosion of slope
- Sinkholes, particularly behind retaining walls and above outlet pipes, possibly indicating loss of soil due to piping, rather than animal burrows
- Excessive vegetation and tree growth, particularly if it obscures features of the dam and the dam cannot be fully inspected
- Deterioration of concrete structures (e.g., exposed rebar, tilted walls, large cracks with or without seepage, excessive spalling, etc.)
- Inoperable outlets (gates and valves that have not been operated for many years or are broken)

O'Reilly, Talbot & Okun
ENGINEERING ASSOCIATES

J2950-13-01
May 31, 2022

Ms. Julianne Busa, PhD, SE
Fuss & O'Neill, Inc.
1550 Main Street, Suite 400
Springfield, Massachusetts 01103

Re: Preliminary Geotechnical Engineering Recommendations Report
Little River Restoration Project
Fishing Platform and Pedestrian Overlook
Haverhill, Massachusetts

Dear Ms. Busa:

O'Reilly, Talbot & Okun Associates, Inc. (OTO) is pleased to provide this letter report summarizing our preliminary geotechnical engineering recommendations for the proposed fishing platform and pedestrian overlook, which are part of the larger Little River restoration project in Haverhill, Massachusetts. A Site Locus is provided as Figure 1. Site Plans are provided as Figures 2 and 3. Preliminary recommendations for the proposed pedestrian bridge were provided under separate cover.

Our geotechnical recommendations are based upon subsurface conditions observed in three soil borings. Our services consisted of the full-time observation of the borings, review of the logs and soil samples, engineering analyses, and preparation of this report. This report is subject to the attached limitations.

1.0 PROJECT DESCRIPTION

The project consists of the construction of a fishing platform and a pedestrian overlook on the west bank of the Little River in Haverhill, Massachusetts. The project also includes the removal of the existing dam and the construction of a pedestrian bridge and retaining wall, which are not addressed in this report. The fishing platform will be located at Cashmans Park and the pedestrian overlook will be located near the northwest corner of the existing Winter Street bridge over the Little River. Both locations are shown on Figure 1, and in more detail on Figures 2 and 3.

Details for each proposed structure were not known at the time of this report. However, we anticipate that both will be a relatively light, timber structure that will be founded on either helical piles, driven piles (specifically ductile iron pipe piles or DIPPs), or drilled micropiles (DMPs). The structures will be subject to live loads (transient pedestrian use), as well as lateral and uplift loads (water, ice, wind, seismic). In addition, the fishing platform may be subject during its design life to upward buoyant forces during flooding events.

1.1 Fishing Platform at Cashmans Park

The proposed fishing platform will be located along the west bank of the Little River at Cashmans Park. The approximate location of the proposed fishing platform is shown on Figure 2. Topography near the proposed construction is generally flat, near elevation 20 feet. The ground surface slopes upward to the west, then is generally flat within Cashmans Park, between elevations 28 and 29 feet.

Ice was present in the Little River near elevation 20 feet during our subsurface explorations in January 2022. The proposed fishing platform will be located within the National Flood Insurance Program (NFIP) Zone AE, or Base Flood boundary[1]. The Base Flood (100-year flood), known as the 1% annual chance flood, has a one percent chance of occurring or being exceeded in any calendar year. The Flood Insurance Rate Map (FIRM) for the project area shows the Base Flood between elevation 24 and 25 feet.

1.2 Pedestrian Overlook at Winter Street

The proposed pedestrian overlook will be located near the northwest corner of the Winter Street bridge over the Little River. The approximate location of the proposed overlook is shown on Figure 3. Topography at Winter Street is generally flat, near elevation 24 feet. An approximately six- to eight-foot-high retaining wall provides topographic relief between Winter Street and the Little River. We understand that the pedestrian overlook will extend beyond the existing retaining wall and project over a portion of the Little River and its bank.

2.0 SUBSURFACE EXPLORATIONS AND TESTING

Subsurface investigations consisted of three soil borings (LR-1 through LR-3) performed by Seaboard Drilling of Chicopee, Massachusetts. The borings were performed using a Diedrich D-50 track mounted drill rig or a Mobile B-53 truck mounted drill rig, using hollow stem or drive and wash drilling techniques. They were performed at the following locations between January 24 and February 11, 2022:

- LR-1: near the west abutment of the proposed pedestrian bridge approximately 70 feet north of the fishing platform (Cashmans Park)
- LR-2: near the proposed fishing platform (Cashmans Park)
- LR-3: near the proposed pedestrian overlook (Winter Street)

Boring locations are shown on Figures 2 and 3. These locations were limited to accessible areas with the track and/or truck mounted drill rig. Boring logs are attached.

Soil samples were generally collected continuously or semi-continuously from the ground surface to a depth of 12 feet below ground surface, at a depth of 15 feet, and every five feet thereafter. Soil samples were collected using a two-inch diameter split spoon sampler,

[1] Federal Emergency Management Agency (2012). "Flood Insurance Rate Map: Essex County, Massachusetts (All Jurisdictions)", *National Flood Insurance Program*, Community: City of Haverhill, Number: 250085, Panel: 0087F.

driven 24 inches with a 140-pound automatic hammer falling 30 inches (American Society for Testing and Materials Test Method D1586 “Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils”). The number of blows required to drive the sampler each six inches was recorded. The standard penetration resistance, or N-value, is the number of blows required to drive the sampler the middle 12 inches. Soil properties, such as strength and density, are related to the N-value. The field N-values are corrected to a standard 60% hammer efficiency, known as N_{60}, to account for differing hammer efficiencies for each hammer type and drill rig. The N-values presented on the boring logs are field values, which are not adjusted for hammer efficiency. However, the adjusted N_{60} values were used in our engineering calculations and analysis.

An O’Reilly, Talbot & Okun Associates, Inc. (OTO) engineer observed and logged the borings. Samples were classified according to a modified version of the Burmister Soil Classification System. After drilling, bore holes were backfilled with soil cuttings and patched with asphalt, where applicable.

2.1 Photo-Ionization Detector (PID) Screening

The headspace of each soil sample collected from the borings was screened using a MiniRAE Lite Photo-Ionization Detector (PID). PID screening provides an assessment of volatile organic content of the samples. PID readings are provided on the attached boring logs.

2.2 Field Strength Testing

Field strength testing was performed on selected samples of the silt and clay using pocket torvane (E-285 Pocket Vane Shear Tester) and pocket penetrometer devices. These field measurements are intended to provide a rough measure of the strength of fine-grained soils. The pocket penetrometer provides a measure of the unconfined compressive strength of soil by failing the clay by “punching”. The torvane device provides an estimate of the undrained shear strength of fine-grained soils by failing the silt and/or clay in a rotational shearing mode. Theoretically, the unconfined compressive strength is twice the undrained shear strength. A total of six pocket penetrometer and torvane tests (each) were completed in the field. Pocket torvane and pocket penetrometer results are presented on the attached boring logs.

2.3 Rock Cores

Two bedrock cores, totaling nine feet in length, were obtained from boring LR-1. The rock cores were obtained using a 2-inch diameter, diamond bit core barrel. The weight of the tooling and equipment and rotation of the cutting shoe were used to advance the core barrel. No additional down pressure was applied. Rock drilling times (minutes per foot) were recorded, and the Rock Quality Designation (RQD) and Rock Mass Quality (RMQ) were determined based upon the samples collected from each rock core. An OTO geologist classified each core. Rock core information is presented on the boring logs. Photographs of the rock cores are attached.

3.0 SUBSURFACE CONDITIONS

Subsurface conditions were interpreted based upon the soil borings. In general, soils encountered consisted of the following, in order of increasing depth: a surface layer of topsoil or asphalt with granular base; non-engineered fill; native fine-grained soils; and native granular soils.

3.1 Soil Conditions

Topsoil: Approximately five inches of topsoil were present at the ground surface of boring LR-2. The topsoil consisted of dark brown, fine sand containing some medium sand, little silt and trace amounts of organics (roots).

Asphalt Pavement: Approximately four inches of asphalt underlain by six inches of granular base course were present at the ground surface at boring location LR-3. The granular base generally consisted of brown, fine to medium sand with trace amounts of gravel, coarse sand, silt, and debris (brick).

Fill: Non-engineered fill was encountered in the upper five feet of boring LR-1 and to a depth of 20 feet (elevation 4 feet) in boring LR-3. The fill at boring location LR-1 generally consists of medium dense, fine to medium sand with little silt and trace amounts of debris (coal, ash). These soils were likely placed to form the fields at Cashmans Park. The fill at boring location LR-3 generally consists of loose to very loose, fine sand and silt with trace amounts of debris (brick). Furthermore, a one-inch thick piece of pressure treated wood was observed at a depth of 15 feet. In addition, occasional auger griding was observed below a depth of 16 feet, possibly indicating the presence of large cobbles and boulders within this layer. These soils were likely placed or disturbed during construction of the dam. The fill is an unsuitable bearing layer due to the low relative density, variable composition, and presence of debris.

Glacial Lake Deposits: The fill at Cashmans Park (LR-1) is underlain by soft deposits of varved silt, sand, and clay to a depth of approximately 40 feet. The varved layer was also observed at boring location LR-2, immediately below a surficial six-inch sand layer. The upper 10 to 15 feet of this stratum is desiccated, resulting in a medium to very stiff consistency and/or increased silt content. The varved silt and clay was soft to very soft between a depth of 20 and 40 feet, corresponding to approximate elevations 6 to -14 feet. Given the soft nature of these soils, they are compressible and have a low strength and susceptible to erosion (scour). As a result, Site conditions are not favorable to support the proposed structures on shallow foundations (spread footings).

Deep Granular Soils: Coarse-grained, granular soils were encountered in boring LR-1 at a depth of 40 feet (elevation -14 feet) and in boring LR-3 at a depth of 20 feet (elevation 4 feet). This deposit is a very dense, medium sand or fine to medium sand with trace amounts of silt and varying amounts of gravel. Significant auger griding was observed within the granular layer at boring LR-3, likely indicating the presence of coarse gravel, cobbles, and/or boulders within this layer.

3.2 Bedrock Conditions

Bedrock was not encountered in either the boring near the fishing pier (LR-2) or near the overlook (LR-3). However, boring LR-1 encountered bedrock starting at a depth of approximately 55 feet below ground surface (approximately elevation -29 feet). Given the relatively light loads for the fishing pier and overlook, and the likely depth to bedrock, it is unlikely that bedrock will influence the design or construction of either structure. Boring LR-1 penetrated approximately 20 feet into bedrock with the rock being highly fractured throughout. At boring location LR-3, auger refusal was encountered upon likely bedrock at a depth of 30.4 feet (elevation -6.4 feet). Rock core samples were collected from boring LR-1, but not from boring LR-3. Therefore, it is unclear whether auger refusal in boring LR-3 was upon bedrock or a large boulder.

Based upon drilling conditions in boring LR-1, we were unable to obtain a core above a depth of 66 feet. Two 2-inch diameter rock cores, totaling nine feet in length, were collected between a depth of 66 and 75 feet. The elevation, run times, recovery, RQD, and rock classification are presented on the attached boring logs. Rock core photographs are attached.

The rock recovered from boring LR-1 consisted of dark gray, thin-bedded siltstone. The siltstone is consistent with the Berwick Formation described on bedrock geology maps for the area[2]. The Berwick Formation siltstone is described as “Thin- to thick-bedded metamorphosed calcareous sandstone, siltstone, and minor muscovite schist.” The bedrock samples collected met that description.

The recovered rock was very intensely to intensely fractured, with minimal weathering (discoloration) present at the edges of natural fractures. The fractures were typically straight and dipped approximately 20 degrees from horizontal. Voids and/or large fractures in the rock were filled with silty clay, sand, and gravel.

Core recovery is the ratio of the length of core recovered to the length drilled. Recovery can range from 0 percent for no core recovery to 100 percent for total recovery. Core recovery at this Site ranged from 43 to 60 percent. Cores were difficult to advance due to fractured nature of the rock, with the core barrel jamming numerous times. As a result, drilling times ranged from approximately 6 to 15 minutes per foot. Normally, these data would indicate a very hard rock. However, in our opinion these times reflect the fractured nature of the rock and not its hardness.

Rock mass properties can be described using the rock quality designation (RQD)[3], which is based on core recovery. The RQD is a modification of core recovery, in that the sum of the intact pieces of core that are greater than four inches long is divided by total core length recovered (i.e., pieces less than four inches in length are disregarded). The

[2] Zen, E. et al. (1983). “Bedrock Geologic Map of Massachusetts” *US Geological Survey*.
[3] Deere, D.H. (1968), “Technical Description of Rock Cores for Engineering Purposes” Rock Mechanics and Engineering Geology, Vol. 1, pp 16-22.

resultant is multiplied by 100 to get RQD in percent. The RQDs for both cores were 0% (since no fragments greater than four inches were recovered). Based upon the measured core recoveries and RQDs, the core samples have a Rock Mass Quality (RMQ) of very poor. It should be noted that since bedrock typically becomes less fractured and is of higher quality with depth, we would expect RQD and RMD values to increase with depth.

3.3 Groundwater Conditions

Groundwater was encountered in borings LR-1 and LR-2 at a depth of five feet below ground surface, corresponding to approximate elevations of 21 and 15 feet, respectively. At boring location LR-3, water was encountered at a depth of eight feet, or approximate elevation 16 feet.

3.3.1 Results of Environmental Field Screening

The headspace of each soil sample was screened using a photoionization detector (PID). PID screening provides an assessment of volatile organic compounds (VOCs) of the samples. The majority of PID readings were below the instrument detection limits. VOC concentrations, where detected, were generally 0.4 parts per million (ppm) or less. These readings are relatively low and are not of significant concern. A PID reading of 1.7 ppm was detected in boring LR-3 sample S-7 (15-17'), which contained significant amounts of debris (pressure treated wood). PID readings are presented on the boring logs.

3.3.2 Results of Field Strength Testing

The unconfined compressive strength of the clay stratum was estimated in the field using a pocket penetrometer and the undrained shear strength was estimated using an E-285 Pocket Vane Shear Tester. These field measurements are intended to provide a rough measure of the engineering properties of the fine-grained soils. Vane Shear measurements of shear strength ranged from approximately 300 to 1,900 pounds per square foot (psf) in the soft varved silt and clay portion. Pocket penetrometer measurements of unconfined compression strength ranged from approximately 500 to 3,000 psf. Both tests showed a general decrease in soil strength in the upper, desiccated portion of the fine-grained soil profile, and an increase in the lower portion of the fine-grained profile. Pocket vane shear and penetrometer test results are presented on the attached boring logs.

4.0 SIGNIFICANT GEOTECHNICAL ISSUES

The significant geotechnical issues for the proposed construction addressed in this report include the following: the presence of non-engineered fill within the footprint of the proposed pedestrian overlook; type and depth of foundations; post-construction settlement; seismic design considerations; exterior slab and pavement considerations; and the suitability of on-Site materials for use as engineered fill.

5.0 DESIGN RECOMMENDATIONS

The following recommendations are provided for the construction assumed in this report and refer to the 9th Edition of the Massachusetts State Building Code (MSBC). We note that the MSBC includes amendments to the 2015 International Building Code (IBC).

5.1 Preliminary Foundation Recommendations

The following recommendations are provided for foundation design. Foundations will be designed to resist lateral and vertical loads. Vertical loads consist of downward pressures due to the dead weight of the structure and live loads. Uplift pressures and lateral loads will be generated due to overturning loads (such as wind loads, seismic forces, and flood conditions). After details of the structure and foundation system are known, settlement estimates can be provided.

Driven piles, helical piles, and drilled micropiles (DMPs) are potentially suitable foundation alternatives for the proposed construction. If driven piles are considered, we recommend that the design team consider ductile iron pipe piles (DIPPs), which are a relatively low-cost alternative. Other types of driven piles are likely not a suitable alternative given the relatively small size of this project and the relatively high mobilization cost.

The non-engineered fill encountered at Winter Street is an unsuitable bearing layer. Therefore, we anticipate that the selected foundation system at this structure will derive its capacity from the very dense sand layer or underlying bedrock. At this time, DIPPs appear to be the most cost-effective foundation system. However, drivability concerns through potential debris at this this location (namely the pressure treated wood observed at 15 feet) is a concern. Therefore, we recommend additional investigations be considered to observe the composition of the fill, particularly as part of dam removal. The debris observed at Winter Street also likely precludes the use of helical piles at this location.

At this time, helical piles appear to be a cost-efficient foundation alternative for the proposed fishing platform, potentially deriving capacity within the desiccated clay encountered in the upper 15 feet. This is highly dependent upon vertical and lateral design loads, and estimated available capacity of these elements should be reviewed once additional information in known.

Recommended soil parameters are provided in Table 1. Additional details regarding possible foundation systems are provided below.

Table 1
Soil Properties & Design Parameters

Soil Property/ Design Parameter	Fill	Native Fine-Grained Soils (Upper 15 feet)	Very Dense Fine to Medium Sand	Fractured Bedrock
Elevation Encountered at Cashmans Park	Not Encountered	Ground Surface to -14 feet	-14 to -29 feet	Below -29 feet
Elevation Encountered at Winter Street	Ground Surface to 4 feet	Not Encountered	4 to -6.3 feet	Below -6.3 feet
Angle of Internal Friction, ϕ	--	22 degrees	38 degrees	40 degrees
Cohesion, c	--	0 psf	0 psf	0 psf
Unit Weight (dry), γ	115 pcf	105 pcf	125 pcf	140 pcf
Grout to Ground Bond Strength	--	Not Applicable	25 psi	75 psi
Note: Fill should be neglected in the determination of axial geotechnical pile capacity.				

5.1.1 Helical Piles

Helical piles consist of a central steel shaft with horizontal bearing plates welded to the shaft at spacings on the order of 12 inches. The bearing diameter of the plates is between 8 and 14 inches. Helical piles derive their capacity from the underlying soils. Generally, the helical pile system will be designed by the manufacturer or installer in general accordance with the manufacturer's guidelines and specifications. Helical piles are designed by two methods. One method uses static design principles. This method assumes that pile resistance (in both compression and tension) will be derived from the cone of soil mobilized by the pile bearing plates, either pulling upwards or pushing downward. The design method accounts for the size of the bearing plates, the friction angle of the soil, and the unit weight of the soil. The second design method is based on the torque required to install the piles in the field. Using the first design method, a depth of penetration is specified. Using the second design method, a minimum installation torque experienced during installation is specified.

For applications where significant tensile forces will occur, we recommend that static design methods be used. The parameters given in Table 1 may be used for design of the helical pile system

Other applicable requirements of the Massachusetts State Building Code (MSBC) should be followed. We recommend that the pile installation contractor be required to provide a design submittal prepared by a professional engineer. The design should include pile size, material type and length, design assumptions and connection details with the deck support system.

Helical pile foundations are typically designed by the manufacturer or supplier in general accordance with the manufacturer's guidelines and specifications. Helical pile installation contractors in the area include Atlas Systems of NE (800-688-9774) and Helical Drilling, Inc (781-848-2110).

5.1.2 Ductile Iron Pipe Piles

Ductile Iron Pipe Piles (DIPPs) are the recommended deep foundation system based upon the size of the project, anticipated loads and subsurface conditions. DIPs are a small-diameter, low-vibration pile system that are well-suited for constrained Sites, Sites with vibration concerns and Sites with varying rock profiles. The system uses prefabricated, high-strength ductile iron piles to provide capacities ranging from 25 to more than 100 tons. DIPPs are installed using an excavator-mounted hydraulic (percussion) hammer fitted with a special drive adapter to advance the pile into the ground. DIPPs employ a Plug & Drive connection system that ensures rapid driven pile connections in the field and allows for variable pile lengths without additional equipment or field splicing. The use of the high frequency hydraulic hammer for installation results in rapid driving with minimal vibrations. Additionally, the mobile equipment combined with segmental DIPP sections provides easy access and installation at constrained Sites with vibration sensitivity and/or overhead clearance issues.

DIPP systems are designed to resist loads through either end-bearing on competent soils or frictional resistance within a grouted bond zone. Design capacities in compression typically range from 25 to 100 tons. For this project, DIPs would be installed to penetrate the fill and varved sand and silt to terminate in the dense sand layer or the underlying rock. DIPPs are installed by first inserting a flat or pointed driving shoe over the end of the hollow pile. The pile is then driven into the ground using high-frequency impact energy (hydraulic hammer) until the Plug & Drive socket end is nearly at the working grade. The driving resistance is observed during driving. The spigot end of the second DIP is then inserted into the socket end of the existing pile and the driving process is repeated. This process continues until the pile terminates on refusal or achieves a required driving criteria (typically 1 inch in 50 seconds). The interior of the pile is then grouted for corrosion protection and strength.

Once loads are known, the appropriate DIPP working capacity and pile size can be estimated. In addition, the need for a static pile load test should be evaluated. In our experience a load test is often not required by the building official if the pile design load is 40 tons or less.

The design and installation of Ductile Iron Pipe Pile systems are performed by specialty design/build contractors. Helical Drilling (781-848-2110) is a local design/build installer of Ductile Iron Pipe Piles in New England. OTO shall be retained to review the project design submittal and monitor pile installations on the project.

5.1.3 Drilled Micropiles

Drilled micropiles (DMPs) are a viable foundation alternative. Generally, the DMPs are designed by the specialty contractor in general accordance with a performance-based project specification. We recommend that an experienced pile installation contractor be required to provide a design submittal prepared by a professional engineer. The design should include pile size and length of bond zone, material type and length, installation means and methods, steel reinforcement, and methods for overcoming obstruction (if

encountered) and other design assumptions. All other applicable requirements of the Massachusetts State Building Code (MSBC) should be followed. Our preliminary design recommendations for the design of DMPs are provided below.

Micropile spacing should be greater than 30 inches or three times the pile diameter, whichever is greater, to avoid group effects. If permanent steel outer casing is used for the micropiles, threaded joints shall not be used within three feet of the pile cap (if included). The designer should review moment diagrams and determine if the prohibited depth for threaded joints should be increased.

DMP casing should be drilled through the soft varved silt and clay and/or non-engineered fill into the dense sand and fractured bedrock bonding zone. The top of the DMPs should extend a minimum of 12 inches into the pile cap (if included) and have a minimum cover of 9 inches (distance from the edge of the cap). To prevent uplift loads due to frost, pile caps should bear a minimum of 48 inches below the lowest adjacent ground surface.

DMPs will likely derive compacity from side friction and end bearing in the very dense sand layer. For DMPs relying on side friction only, the tension (uplift) capacity of friction bonded DMPs is theoretically equal to the compression capacity. However, we recommend that for tension the grout to ground bond strength be reduced by 50 percent of the adhesion in compression. Typical values for grout to ground bond strength are presented in the 2005 *FHWA Micropile Design and Construction Reference Manual* (FHWA). Based upon the recommendations contained in the FHWA manual we recommend the grout to ground bond strength values presented in Table 1. The appropriate grout to ground bond strength used for the design of micropiles should be selected by the specialty contractor. We note that the tensile capacity is often limited by the strength of the reinforcing steel. If required, the designer may increase the size of the reinforcing bar or grade of steel to increase the tensile capacity.

5.1.4 Lateral Capacity of Deep Foundation Elements

Helical Piles, DIPPs, and DMPs have limited lateral capacity due to their slender cross-section. Battered piles can be used to obtain a greater lateral capacity. To accommodate higher lateral loads (if needed), we recommend the use of a steel outer casing and/or larger diameter micropiles. Lateral forces (seismic and wind) will be dissipated through earth pressures along the sides of pile caps (if included) and DMP and DIPPs, as well as through friction forces along the bottom of pile caps.

Lateral load resistance should be neglected for the upper four feet of pile immediately below the ground surface. We recommend that the lateral pile capacity be assessed by the specialty contractor using LPILE or a similar analytical software program.

5.2 Seismic Considerations

Earthquake loadings must be considered under requirements in Section 1613 and 1806 of the 9th Edition (October 2017) of the Massachusetts State Building Code (MSBC), which is based upon the International Building Code 2015 (IBC) with Massachusetts

amendments. Note that the IBC refers to ASCE-7 (2010), *Minimum Design Loads for Buildings and Other Structures*.

5.2.1 Site Class and Earthquake Design Factors

Section 1613 of the IBC covers lateral forces imposed on structures from earthquake shaking and requires that every structure be designed and constructed to resist the effects of earthquake motions in accordance with ASCE-7. Lateral forces are dependent on the type and properties of soils present beneath the Site, along with the geographic location. Per Table 1604.11, the maximum considered earthquake spectral response acceleration at short periods (S_s) and at 1-sec (S_1) was determined to be 0.260 and 0.077, respectively, for Haverhill, Massachusetts.

Soil properties are represented through Site Classification. Procedures for the Site-specific determination of Site Classification are provided in Chapter 20 of ASCE-7. At this Site, we evaluated Site Classification using one of the parameters allowed, Standard Penetration Resistance (N-value) based upon soil data collected. Furthermore, the Site coefficients F_a and F_v were determined according to Tables 1613.3.3(1) and 1613.3.3(2) of the IBC (2015), using both the S_s and S_1 values and the Site Class. The seismic Site Class and coefficients for each project area are presented in Table 2.

Table 2
Seismic Site Classification and Design Coefficients

	Fishing Platform at Cashmans Park	**Pedestrian Overlook at Winter Street Bridge**
Site Class	E	D
F_a	1.7	1.4
F_v	3.5	2.4

5.2.2 Liquefaction

Section 1806.4 relates to the liquefaction potential of the underlying soils. The liquefaction potential was evaluated for saturated Site soils, in part by using Figure 1806.4c of the MSBC. However, based upon the observed density and fines content, it is unlikely that significant amounts of liquefaction-induced settlement would occur under the design earthquake. In addition, loose soil layers below the maximum depth explored are not anticipated.

5.3 Exterior Slabs and Pavements

Exterior pavements, such as walkways and sidewalks, should be designed to mitigate differential frost movement between adjacent slabs and pavements. To address this concern, we recommend that exterior slabs and pavements be underlain by a minimum of 12 inches of non-frost susceptible Sand and Gravel fill to provide uniform support and a capillary moisture break.

Fill should be placed in accordance with the recommendations for compaction provided below. Subgrades should also be free of large boulders. We recommend that the entire subgrade of exterior slabs and pavements be proof compacted with a heavy vibrating roller to treat any loose areas. In addition, we recommend that the design team incorporate drainage into the sidewalk areas to remove water from the subgrade, to limit frost and the resulting vertical movement of sidewalks. The Sand and Gravel fill beneath the concrete slabs and sidewalks should meet the grain size distribution characteristics described in Table 3.

5.4 Earthwork Considerations

We anticipate that earthwork for this project will include the following: placement of compacted engineered fill for working pads and beneath exterior slabs and pavements; and the treatment of the existing soils to address any localized loose areas that may be present.

5.4.1 Engineered Fill Recommendations

Three types of engineered fill are recommended:

- Sand and Gravel for use immediately below slabs and sidewalks
- Crushed Stone in place of Sand and Gravel fill
- Granular Fill for use as miscellaneous fill

Grain size distribution requirements are presented in Table 3. It does not appear that significant quantities of on-Site soil meet requirements for reuse as engineered fill. Please note that the Sand and Gravel specification is that for Mass Highway M1.03.0, Type B Gravel Borrow.

Table 3
Grain Size Distribution Requirements

Size	Sand and Gravel	Granular Fill	Crushed Stone
	Percent Finer by Weight		
3 inch	100	100	---
1 inch	---	---	100
¾ inch	---	---	90-100
½ inch	50-85	---	10-50
⅜ inch	---	---	0-20
No. 4	40-75	---	0-5
No. 10	---	30-90	---
No. 40	10-35	10-70	---
No. 200	0-10	0-15	---

5.4.2 Compaction Recommendations

Fill, debris, topsoil, and organic soils should be removed from beneath exterior slabs and pavements and should not be re-used as fill beneath structures. To avoid point loads, any cobbles or boulders larger than four inches in diameter, encountered at the subgrade should also be removed. The resulting excavations should be backfilled with compacted Sand and Gravel or Crushed Stone fill.

Prior to the placement of any engineered fill, we recommend that slab and pavement subgrades be thoroughly proof compacted. Proof compaction should be accomplished by a minimum of six passes with a 6,000-pound vibratory roller. To facilitate compaction, the moisture content of the on-Site material should be maintained at or near the optimum moisture content as determined by ASTM D1557. The contractor should carefully watch for pumping of the fine-grained subgrade. If pumping begins to occur, the contractor should immediately switch to static (non-vibratory) rolling. In the event that the required number of passes cannot be achieved without pumping, OTO should be contacted to provide modified compaction recommendations.

Compacted fill should be placed in loose lifts ranging in thickness between 6 and 12 inches, depending on the size and type of equipment, and compacted to at least 95% of the Modified Proctor dry density as defined in ASTM D1557, Method C.

5.4.3 Weather Considerations

The contractor should note that the near surface fine-grained soils present at Cashmans Park are susceptible to moisture, due to the high percentage of fines within the soil mass. These soils may become soft and easily disturbed under construction traffic and cannot be easily dried or stabilized. It may be necessary to construct a working pad using geogrid reinforcement and Crushed Stone to construct the proposed fishing platform. The working pad should be designed as early as possible. However, the weight and/or surface pressure of construction equipment must be known prior to this design.

6.0 FINAL DESIGN AND CONSTRUCTION PHASE SERVICES

The recommendations in this report should be reviewed during final design, as only conceptual information was available at the time of our investigations. Information regarding structural loads, final structure locations and constructability should be considered when choosing foundation system type for final design. Settlement estimates can be provided at that time.

In addition, we recommend that additional investigations, such as test pits be considered early on during construction (removal of dam) to observe the nature of the fill and to identify any obstructions that may be encountered.

It is recommended that O'Reilly, Talbot & Okun Associates, Inc. (OTO) be retained during final design to prepare and/or review appropriate specification sections and drawings, if necessary. During construction phases, we recommend that OTO be retained to provide engineering support and to document the installation of foundation systems.

We appreciated the opportunity to be of service on this project. If you have any questions, please do not hesitate to contact the undersigned.

Sincerely yours,
O'Reilly, Talbot & Okun Associates, Inc.

Dustin A. Humphrey, P.E.
Project Manager

Ashley L. Sullivan, P.E.
Principal

Attachments: Limitations, Figures 1-3, Boring Logs, Photographs

LIMITATIONS

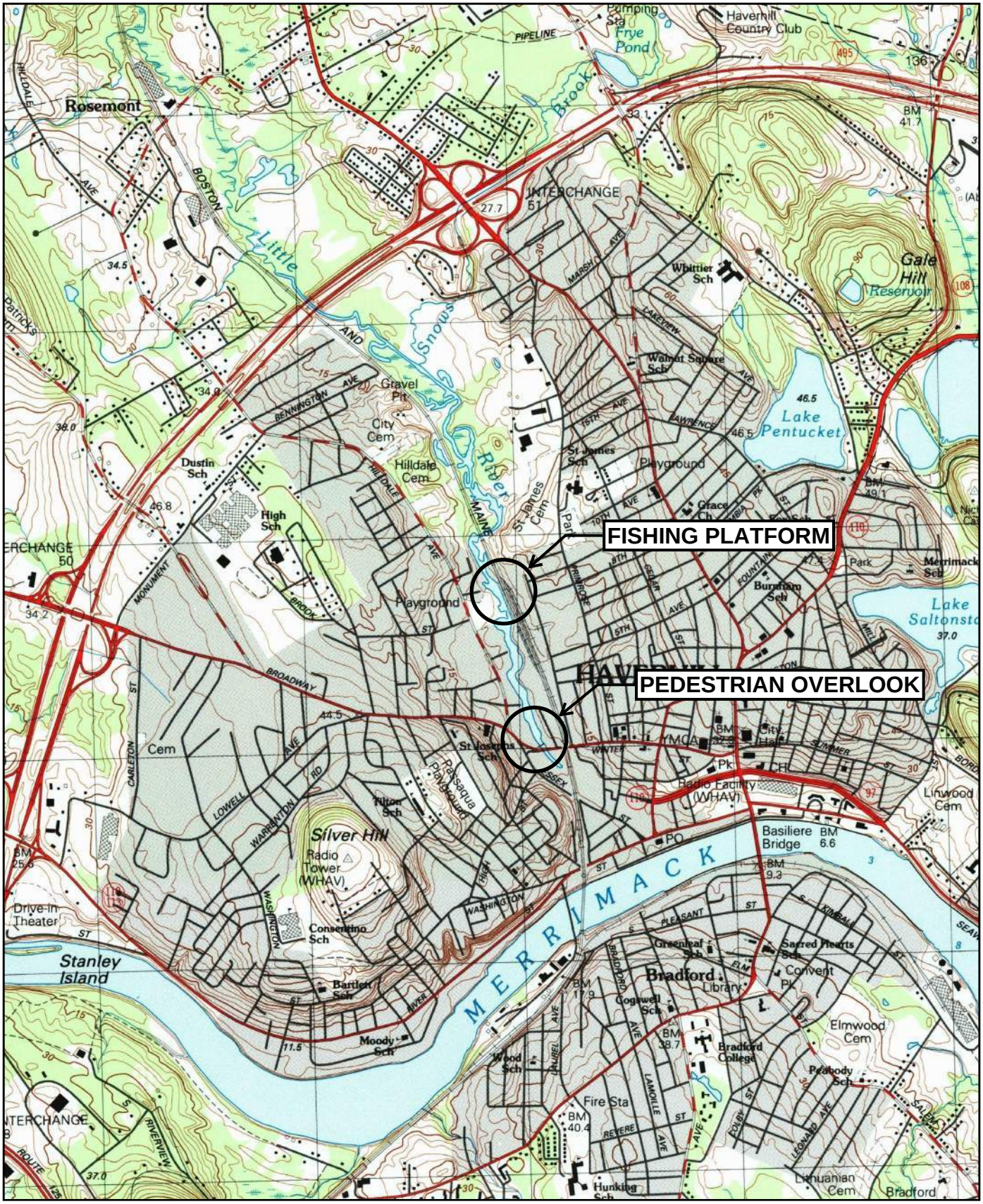
1. The observations presented in this report were made under the conditions described herein. The conclusions presented in this report were based solely upon the services described in the report and not on scientific tasks or procedures beyond the scope of the project or the time and budgetary constraints imposed by the client. The work described in this report was carried out in accordance with the Statement of Terms and Conditions attached to our proposal.

2. The analysis and recommendations submitted in this report are based in part upon the data obtained from widely spaced subsurface explorations. The nature and extent of variations between these explorations may not become evident until construction. If variations then appear evident, it may be necessary to reevaluate the recommendations of this report.

3. The generalized soil profile described in the text is intended to convey trends in subsurface conditions. The boundaries between strata are approximate and idealized and have been developed by interpretations of widely spaced explorations and samples; actual soil transitions are probably more erratic. For specific information, refer to the boring logs.

4. In the event that any changes in the nature, design or location of the proposed structures are planned, the conclusions and recommendations contained in this report shall not be considered valid unless the changes are reviewed and conclusions of this report modified or verified in writing by O'Reilly, Talbot & Okun Associates Inc. It is recommended that we be retained to provide a general review of final plans and specifications.

5. Our report was prepared for the exclusive benefit of our client. Reliance upon the report and its conclusions is not made to third parties or future property owners.



0 1000 FEET

0 0.5 1.0 MILES

0 0.5 1 KILOMETERS

1:25,000 SCALE NATIONAL GEODETIC VERTICAL DATUM 1929 3 METER CONTOUR INTERVAL

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O'Reilly, Talbot & Okun
ENGINEERING ASSOCIATES
293 Bridge Street, Suite 500 Springfield, MA 01103 413.788.6222
www.OTO-ENV.com

LITTLE RIVER RESTORATION
HAVERHILL, MASSACHUSETTS

SITE LOCUS

Topographic Map Quadrant: HAVERHILL, MA

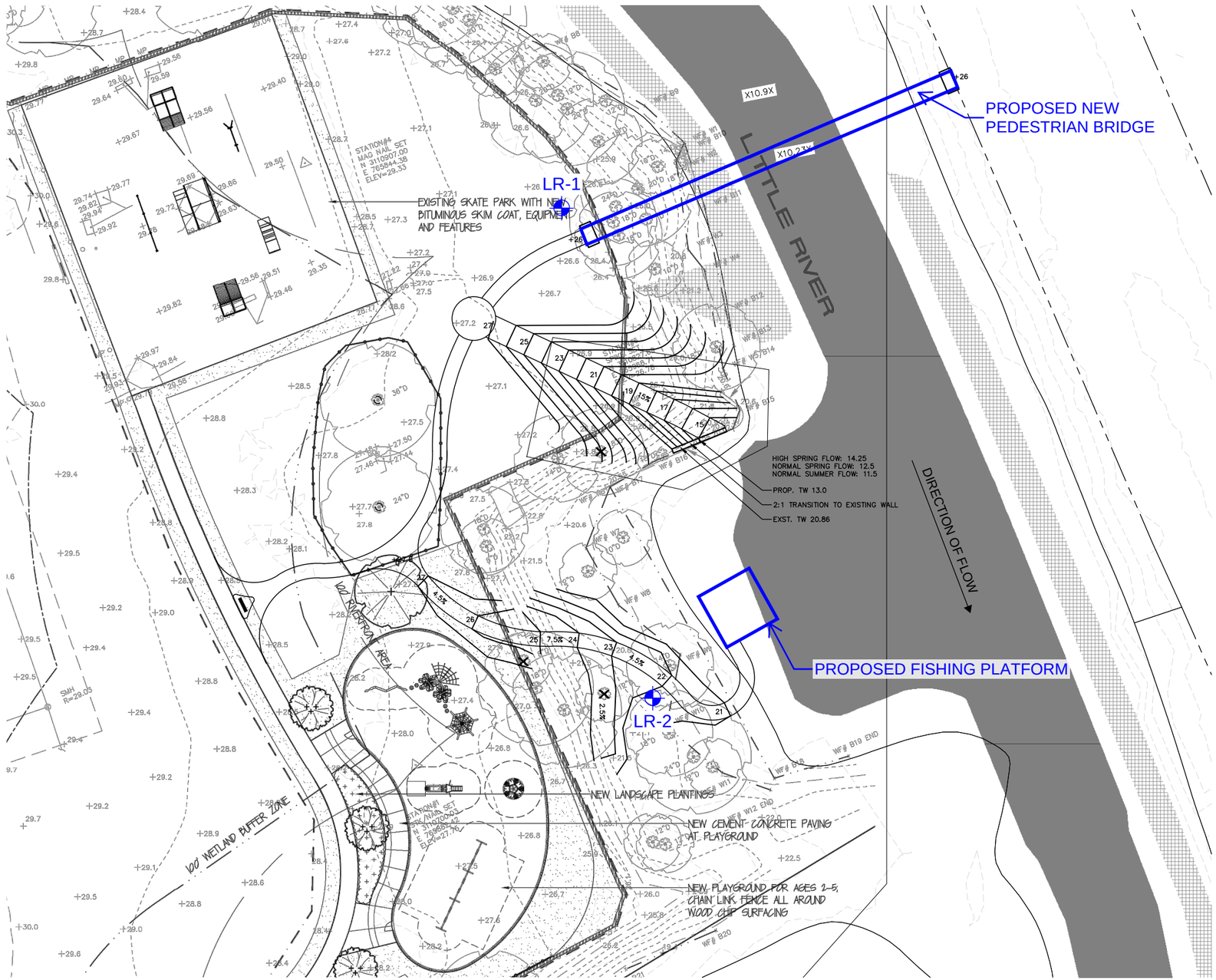
Map Version: 1987

Current As Of: 1987

Date: MAY 2022

PROJECT No. J2950-13-01

FIGURE No. 1



SCALE IN FEET
1" = 40'

0' 20' 40' 80'

LEGEND:

APPROXIMATE SOIL BORING LOCATION PERFORMED BY SEABOARD DRILLING ON 1/24 AND 1/25/2022, OBSERVED BY OTO

NOTES:

1. BASE MAP PROVIDED TO OTO IN ELECTRONIC FORMAT. ORIGINAL DRAWING TITLED "CONCEPT PLAN CASHMAN`S PARK" SHEET CON-01 BY FUSS & O`NEILL, DATED NOVEMBER 2021
2. SAMPLE LOCATIONS ARE SHOWN ACCORDING TO TAPED MEASUREMENTS TAKEN FROM EXISTING SITE FEATURES
3. ALL DATA IS TO BE CONSIDERED ACCURATE ONLY TO THE DEGREE IMPLIED BY THE METHODS USED IN THE DEVELOPMENT OF THIS PLAN

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DESIGNED BY: JE
DRAWN BY: JE
CHECKED BY: DAH
DATE: 02/17/2022
REV. DATE:

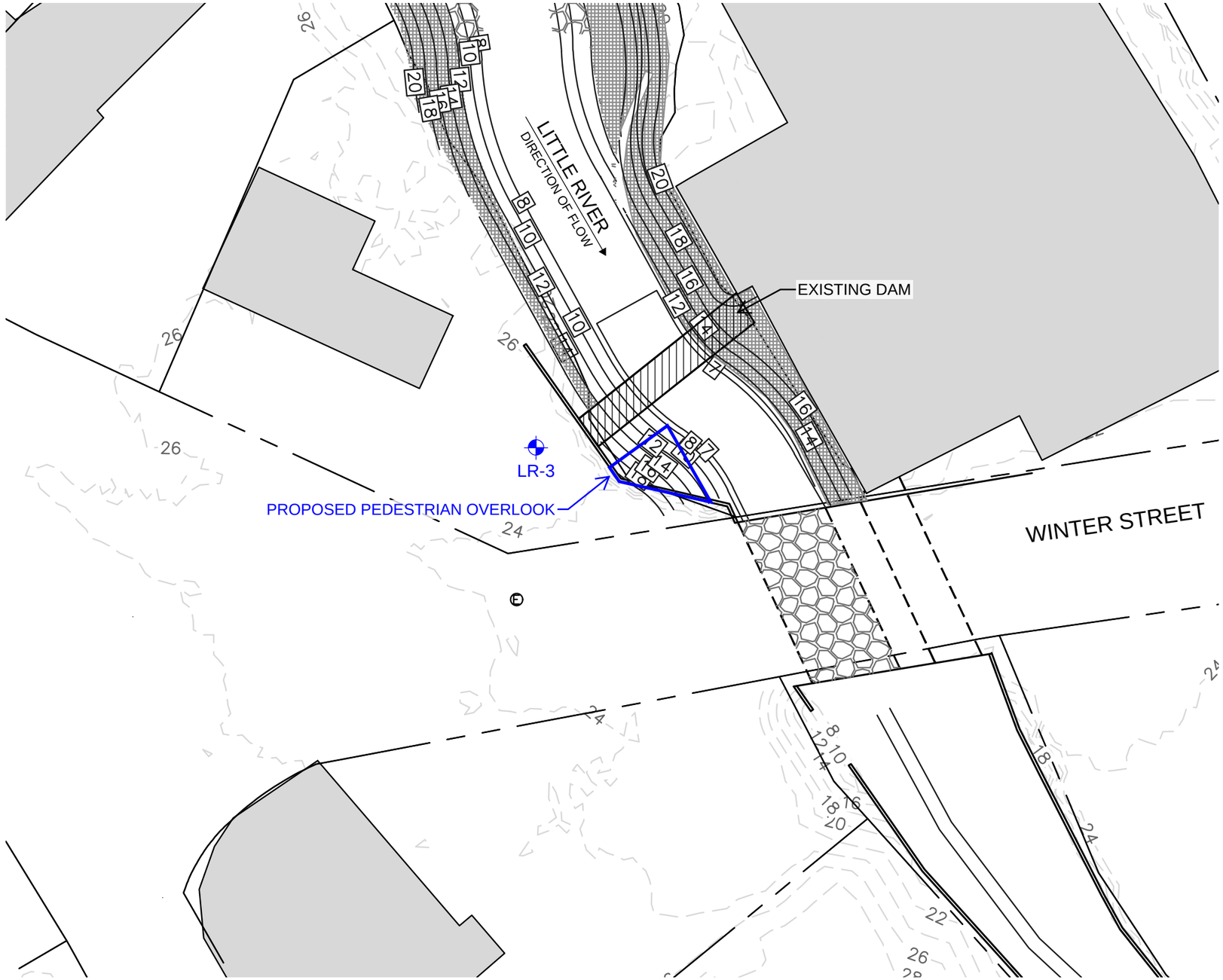
LITTLE RIVER RESTORATION
HAVERHILL, MASSACHUSETTS

SITE PLAN - FISHING PLATFORM

PROJECT NO.
J2950-13-01

FIGURE NO.
2

O:\J29002950 Fuss & ONeill\13-01 Haverhill Little River Dam Removal - Geotech\Figures\Boring Location Plan 2950-13-01 for Overlook & Platform.pdf



LEGEND:

APPROXIMATE SOIL BORING LOCATION PERFORMED BY SEABOARD DRILLING ON 2/11/2022, OBSERVED BY OTO

NOTES:

1. BASE MAP PROVIDED TO OTO IN ELECTRONIC FORMAT. ORIGINAL DRAWING TITLED "IN-RIVER IMPROVEMENT CONCEPT PLAN" SHEET CON-02 BY FUSS & O`NEILL, DATED MAY 2021
2. SAMPLE LOCATIONS ARE SHOWN ACCORDING TO TAPED MEASUREMENTS TAKEN FROM EXISTING SITE FEATURES
3. ALL DATA IS TO BE CONSIDERED ACCURATE ONLY TO THE DEGREE IMPLIED BY THE METHODS USED IN THE DEVELOPMENT OF THIS PLAN

SCALE IN FEET
1" = 40'

0' 20' 40' 80'

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DESIGNED BY: JE
DRAWN BY: JE
CHECKED BY: DAH
DATE: 02/17/2022
REV. DATE:

LITTLE RIVER RESTORATION
HAVERHILL, MASSACHUSETTS

SITE PLAN - OVERLOOK

PROJECT NO.
J2950-13-01

FIGURE NO.
3

O:\J2900\2950 Fuss & O'Neill\13-01 Haverhill Little River Dam Removal - Geotech\Figures\Boring Location Plan 2950-13-01 for Overlook & Platform.pdf

O'Reilly, Talbot & Okun
ENGINEERING ASSOCIATES

BORING LOGS

SUMMARY OF THE BURMISTER SOIL CLASSIFICATION SYSTEM (MODIFIED)

RELATIVE DENSITY (of nonplastic soils) OR CONSISTENCY (of plastic soils)

STANDARD PENETRATION TEST (SPT)
Method: Samples were collected in accordance with ASTM D1586-99, using a 2" diameter split spoon sampler driven 24 inches. If samples were collected using direct push methodology (geoprobe), SPTs were not performed and relative density/consistency were not reported. **N-Value**: The number of blows with a 140 lb. hammer required to drive the sampler the middle 12 inches. **WOR**: Weight Of Rod (depth dependent) **WOH**: Weight Of Hammer (140 lbs.)

COHESIONLESS SOILS		COHESIVE SOILS	
BLOWS/FOOT (SPT N-Value)	RELATIVE DENSITY	BLOWS/FOOT (SPT N-Value)	CONSISTENCY
0-4	Very loose	<2	Very soft
4-10	Loose	2-4	Soft
10-30	Medium dense	4-8	Medium
30-50	Dense	8-15	Stiff
>50	Very dense	15-30	Very stiff
*Based upon uncorrected field N-values		>30	Hard

MATERIAL: (major constituent identified in CAPITAL letters)

COHESIONLESS SOILS		
MATERIAL	FRACTION	GRAIN SIZE RANGE
GRAVEL	Coarse	3/4" to 3"
	Fine	1/4" to 3/4"
SAND	Coarse	1/16" to 1/4"
	Medium	1/64" to 1/16"
	Fine	Finest visible & distinguishable particles
SILT/CLAY	see adjacent table	Cannot distinguish individual particles
COBBLES	3" to 6" in diameter	
BOULDERS	> 6" in diameter	
Note: Boulders and cobbles are observed in test pits and/or auger cuttings.		

COHESIVE SOILS		
SMALLEST DIAMETER	PLASTICITY	IDENTITY
None	Nonplastic	**SILT**
1/4" (pencil)	Slight	**Clayey SILT**
1/8"	Low	**SILT & CLAY**
1/16"	Medium	**CLAY & SILT**
1/32"	High	**Silty CLAY**
1/64"	Very High	**CLAY**
Wetted sample is rolled in hands to smallest possible diameter before breaking.		

ORGANIC SILT: Typically gray to dark gray, often has strong H2S odor. May contain shells or shell fragments. Light weight.

Fibrous PEAT: Light weight, spongy, mostly visible organic matter, water squeezed readily from sample. Typically near top of layer.

Fine grained PEAT: Light weight, spongy, little visible organic matter, water squeezed from sample. Typically below fibrous peat.

DEBRIS: Detailed contents described in parentheses (wood, glass, ash, crushed brick, metal, etc.)

BEDROCK: Underlying rock beneath loose soil, can be weathered (easily crushed) or competent (difficult to crush).

ADDITIONAL CONSTITUENTS

TERM	% OF TOTAL
and	35-50%
some	20-35%
little	10-20%
trace	1-10%

COMMON TERMS

Glacial till: Very dense/hard, heterogeneous mixture of sand, silt, clay, sub-angular gravel. Deposited at base of glaciers, which covered all of New England.

Varved clay: Fine-grained, post-glacial lake sediments characterized by alternating layers (or varves) of silt, sand and clay.

Fill: Material used to raise ground, can be engineered or non-engineered.

COMMON FIELD MEASUREMENTS

Torvane: Undrained shear strength is estimated using an E285 Pocket Torvane (TV). Values in tons/ft^2.

Penetrometer: Unconfined compressive strength is estimated using a Pocket Penetrometer (PP). Values in tons/ft^2.

RQD: Rock Quality Designation is determined by measuring total length of pieces of core 4" or greater and dividing by the total length of the run, expressed as %. 100-90% excellent; 90-75% good; 75-50% fair; 50-25% poor; 25-0% very poor.

PID: Soil screened for volatile organic compounds (VOCs) using a photoionization detector (PID) referenced to benzene in air. Readings in parts per million by volume.

O'Reilly, Talbot & Okun
ENGINEERING ASSOCIATES

LOG OF BORING LR-1

PROJECT	Little River - Dam Removal and River Restoration			CONTRACTOR	Seaboard Environmental Drilling		
JOB NUMBER	2950-13-01	FINAL DEPTH (ft)	75.0	DRILLING EQUIPMENT	B-53 Truck Mounted Rig		
LOCATION	Haverhill, MA	SURFACE ELEV (ft)	26.0	FOREMAN	Dale G.	CASING	
START DATE	1/24/2022	DISTURBED SAMPLES	17	HELPER	Mike K.	CASE DIAMETER	4"
FINISH DATE	1/25/2022	UNDISTURBED SAMPLES	0	BIT TYPE	Roller Bit with Wash	HAMMER WGT	300 lb
ENGINEER/SCIENTIST	Jhonatan Escobar	WATER LEVEL		ROD TYPE	A (1 5/8" O.D.) & N (2 3/8" O.D.)	HAMMER DROP	30"
BORING LOCATION	Near proposed western bridge abutment	FIRST (ft)	5.0	SAMPLER	2" O.D. Split Spoon	ROCK CORING INFORMATION	
		LAST (ft)	--	HAMMER TYPE	Automatic	TYPE	Diamond Bit
		TIME (hr)	--	HAMMER WGT/DROP	140 lb / 30"	SIZE	2"

DEPTH (ft)/ SAMPLES	SAMPLES: PENETR. RESIST. (bl / 6 in)	SAMPLES: REC. (in)	SAMPLES: TYPE/ NO.	SAMPLES: FIELD TEST DATA	SAMPLE DESCRIPTION (MODIFIED BURMISTER)	PROFILE DEPTH (ft) ELEV.	REMARKS/ WELL CONSTRUCTION
	19/11/5/6	6/24	S-1 (0-2')	PID = 0.1	Medium dense, dark brown, fine SAND, some silt, trace organics (roots), trace medium sand, trace debris (coal), damp (FILL)	FILL	1
	6/11/16/20	12/24	S-2 (2-4')	PID = 0.0	Top 3": Medium dense, light brown, fine to medium SAND, little silt, trace gravel, damp (FILL) Bottom 9": Medium dense, light brown, fine to medium SAND, little coarse sand, trace gravel, trace silt, dry (FILL)		
5'	23/16/9/10	16/24	S-3 (4-6')	PID = 0.0	Top 5": Medium dense, dark brown, fine to medium SAND, little coarse sand, trace silt, trace debris (coal ash), trace gravel, damp (FILL)	▽ 21.0	
					Middle 8": Medium dense, light brown, fine to medium SAND, little coarse sand, little gravel, trace silt, wet	FINE TO MEDIUM SAND	
					Bottom 3": Very stiff, light brown, clayey SILT, little fine sand, damp	VARVED SILT AND CLAY	
	7/10/12/14	20/24	S-4 (6-8')	PID = 0.0 PP=2.75 TV=0.75	Very stiff, light brown with significant rust staining, SILT and CLAY, trace fine sand, wet (Varved)		2 3
	14/14/14/14	18/24	S-5 (8-10')	PID = 0.0 PP=3.00 TV=0.95	Very stiff, gray, SILT and CLAY, trace fine sand, damp (Varved)		
10'							
	3/3/3/3	20/24	S-6 (10-12')	PID = 0.0 PP=1.50 TV=0.65	Medium, gray, CLAY and SILT, trace (-) fine sand (Varved)		4
15'						15.0 11.0	
	2/1/1/1	16/24	S-7 (15-17')	PID = 0.0	Very loose, gray, SILT and fine SAND (Varved)	SILT AND FINE SAND	
20'						20.0 6.0	
	3/1/ WOH for 12"	16/24	S-8 (20-22')	PID = 0.0	Very soft, gray, clayey SILT, some fine sand (Varved)	VARVED SILT AND CLAY	5
25'							
	WOH for 24"	18/24	S-9 (25-27')	PID = 0.0 PP=0.25 TV=0.15	Very soft, gray, SILT and CLAY, trace fine sand (varved)		

Remarks:
1. Soil screened in field using MiniRAE Lite photoionization detector (PID) referenced to benzene in air. Readings in parts per million (ppm) by volume.
2. Unconfined compressive strength estimated in field using Pocket Penetrometer (PP). Values in tons/ft2.
3. Undrained shear strength estimated in field using E285 Pocket Torvane (TV). Values in tons/ft2.
4. Began open hole drilling at 12', drove casing at 40' due to caving in of boring.
5. WOH = Weight of rods with automatic hammer and housing.
6. Drove roller bit from 55-66' through weathered bedrock.
7. Began coring at 66', with 0 psi of down pressure throughout.
8. Rock Quality Designation (RQD) is determined by summing the length of all rock core pieces longer than 4", then dividing by the length of the coring run.
9. Rock Mass Quality (RMQ) is determined based upon the RQD %.

PROJECT NO.
2950-13-01

LOG OF BORING
LR-1

O'Reilly, Talbot & Okun
ENGINEERING ASSOCIATES

Job No. 2950-13-01

LOG OF BORING LR-1

DEPTH (ft)/ SAMPLES	SAMPLES: PENETR. RESIST. (bl / 6 in)	SAMPLES: REC. (in)	SAMPLES: TYPE/ NO.	SAMPLES: FIELD TEST DATA	SAMPLE DESCRIPTION (MODIFIED BURMISTER)	PROFILE DEPTH (ft) ELEV.	REMARKS/ WELL CONSTRUCTION
						VARVED SILT AND CLAY (Continued)	
30'	WOH for 18"/2	20/24	S-10 (30-32')	PID = 0.0 PP=0.50 TV=0.25	Very soft, gray, SILT and CLAY, trace fine sand (Varved)		
35'	WOH for 12"/ 2/3	24/24	S-11 (35-37')	PID = 0.0 PP=0.75 TV=0.40	Top 16": Very soft, gray, SILT and CLAY, trace fine sand (Varved) Bottom 8": Very soft, gray to light brown, SILT and CLAY, little fine sand (Varved)		
40'	19/47/50 for 2"	11/14	S-12 (40-41.2')	PID = 0.0	Very dense, light brown, fine to medium SAND, some gravel, little silt,	40.0 -14.0 FINE TO MEDIUM SAND	
45'	35/47/40/47	19/24	S-13 (45-47')	PID = 0.0	Very dense, gray to light brown, fine to medium SAND, trace (+) silt, trace gravel		
50'	33/47/45/44	18/24	S-14 (50-52')	PID = 0.0	Very dense, gray to light brown, fine to medium SAND, trace silt (1/4" silt seam at center)		
55'	50 for 1"	1/1	S-15 (55-55.1')	PID = 0.0	Gray, fractured BEDROCK	55.0 -29.0 BEDROCK	6
60'							

O'Reilly, Talbot & Okun
ENGINEERING ASSOCIATES

Job No. 2950-13-01

LOG OF BORING LR-1

DEPTH (ft)/ SAMPLES	SAMPLES: PENETR. RESIST. (bl / 6 in)	SAMPLES: REC. (in)	SAMPLES: TYPE/ NO.	SAMPLES: FIELD TEST DATA	SAMPLE DESCRIPTION (MODIFIED BURMISTER)	PROFILE DEPTH (ft) ELEV.	REMARKS/ WELL CONSTRUCTION
						BEDROCK (Continued)	
65'							
	Drill Rate (min/ft)						
	8.33	34/57	C-1 (66-70.75')	PID = 0.0	Fresh to slightly weathered, very intensely to intensely fractured, dark gray, thin-bedded siltstone (15" void at center infilled with silty clay, sand, and gravel) Recovery = 60% RQD = 0% RMQ = Very Poor Total run time = 35.34 minutes		7, 8 9
	10.25						
	6.43						
	7.23						
70'	3.10 for 9"						
	8.25	22/51	C-2 (70.75-75')	PID = 0.3	Fresh to slightly weathered, very intensely to intensely fractured, dark gray, thin-bedded siltstone (voids in bottom 10" infilled with silty clay, sand, and gravel) Recovery = 43% RQD = 0% RMQ = Very Poor Total run time = 63.63 minutes		
	10.00						
	14.40						
	15.25					75.0 -49.0	
75'	15.73 for 3"				End of exploration at 75'		
80'							
85'							
90'							
95'							

O'Reilly, Talbot & Okun
ENGINEERING ASSOCIATES

LOG OF BORING LR-2

PROJECT	Little River - Dam Removal and River Restoration			CONTRACTOR	Seaboard Environmental Drilling		
JOB NUMBER	2950-13-01	FINAL DEPTH (ft)	22.0	DRILLING EQUIPMENT	Diedrich D-50 ATV		
LOCATION	Haverhill, MA	SURFACE ELEV (ft)	20.0	FOREMAN	Dale G.	CASING	
START DATE	1/25/2022	DISTURBED SAMPLES	4	HELPER	Mike K.	CASE DIAMETER	N/A
FINISH DATE	1/25/2022	UNDISTURBED SAMPLES	--	BIT TYPE	Hollow Stem Auger	HAMMER WGT	N/A
ENGINEER/SCIENTIST	Jhonatan Escobar	WATER LEVEL		ROD TYPE	A (1 5/8" O.D.)	HAMMER DROP	N/A
BORING LOCATION	Near proposed fishing platform, south of proposed bridge	FIRST (ft)	5.0	SAMPLER	2" O.D. Split Spoon	ROCK CORING INFORMATION	
		LAST (ft)	--	HAMMER TYPE	Automatic	TYPE	N/A
		TIME (hr)	--	HAMMER WGT/DROP	140 lb / 30"	SIZE	N/A

DEPTH (ft)/ SAMPLES	SAMPLES: PENETR. RESIST. (bl / 6 in)	SAMPLES: REC. (in)	SAMPLES: TYPE/ NO.	SAMPLES: FIELD TEST DATA	SAMPLE DESCRIPTION (MODIFIED BURMISTER)	PROFILE DEPTH (ft) ELEV.	REMARKS/ WELL CONSTRUCTION
	7/2/2/4	14/24	S-1 (0-2')	0.0 PPM	Top 5": Very loose, dark brown, fine SAND, some medium sand, little silt, trace organics (roots), damp (TOPSOIL) Middle 6": Very loose, light brown with significant rust staining at 1.75', fine to medium SAND, trace silt, damp	TOPSOIL; FINE TO MEDIUM SAND	
	5/4/2/2	0/24	S-2 (2-4')	--	Bottom 3": Soft, gray to light brown, clayey SILT, little fine sand, trace organics (roots), damp NO RECOVERY Logged from cuttings: Light brown, fine SAND, some silt, wet at 5 feet	CLAYEY SILT 2.5 17.5; SILTY SAND	
5'						▽ 15.0	
	2/3/4/2	13/24	S-3 (5-7')	0.0 PPM	Loose, gray, fine SAND, some silt, wet (1/4" clay seams at top)		
10'							
	3/4/3/5	11/24	S-4 (10-12')	0.0 PPM	Loose, gray, fine SAND, some to little silt, wet (1/2" clay layers at bottom and 1/4" clay seam at bottom)		
15'							
20'						20.0 0.0	
	2/2/1/1	6/24	S-5 (20-22')	0.0 PPM	Soft, gray, SILT and CLAY, trace fine sand, wet (Varved)	VARVED SILT AND CLAY	
						22.0 -2.0	
					End of exploration at 22'		
25'							

Remarks:
1. Soil screened in field using MiniRAE Lite photoionization detector (PID) referenced to benzene in air. Readings in parts per million by volume.
2. ATV was stuck at bottom of slope due to frost at ground surface for approximately 1.5 hours. Was retrieved on 1/26/2022 by Seaboard.

PROJECT NO.
2950-13-01

LOG OF BORING
LR-2

O'Reilly, Talbot & Okun
ENGINEERING ASSOCIATES

LOG OF BORING LR-3

PROJECT	Little River - Dam Removal and River Restoration			CONTRACTOR	Seaboard Environmental Drilling		
JOB NUMBER	2950-13-01	FINAL DEPTH (ft)	30.4	DRILLING EQUIPMENT	B-53 Truck Mounted Rig		
LOCATION	Haverhill, MA	SURFACE ELEV (ft)	24.0	FOREMAN	Dale G.	CASING	
START DATE	02/11/2022	DISTURBED SAMPLES	10	HELPER	Mike K.	CASE DIAMETER	4"
FINISH DATE	02/11/2022	UNDISTURBED SAMPLES	--	BIT TYPE	Roller Bit with Wash	HAMMER WGT	300 lb
ENGINEER/SCIENTIST	Shannon Raymond	WATER LEVEL		ROD TYPE	A (1 5/8" O.D.) & N (2 3/8" O.D.)	HAMMER DROP	30"
BORING LOCATION	Northwest of Little River Bridge	FIRST (ft)	8.0	SAMPLER	2" O.D. Split Spoon	ROCK CORING INFORMATION	
		LAST (ft)	--	HAMMER TYPE	Automatic	TYPE	N/A
		TIME (hr)	--	HAMMER WGT/DROP	140 lb / 30"	SIZE	N/A

DEPTH (ft)/ SAMPLES	SAMPLES: PENETR. RESIST. (bl / 6 in)	SAMPLES: REC. (in)	SAMPLES: TYPE/ NO.	SAMPLES: FIELD TEST DATA	SAMPLE DESCRIPTION (MODIFIED BURMISTER)	PROFILE DEPTH (ft) ELEV.	REMARKS/ WELL CONSTRUCTION
	24/12/4/3	13/24	S-1 (0'-2')	0.1 PPM	Top 4" : Asphalt Middle 6" : Medium dense, brown, fine to medium SAND, trace (+) coarse sand, trace (+) gravel, trace silt, trace debris (brick), dry (BASE COARSE) Bottom 3" : Medium dense, light brown, fine to medium SAND, little coarse sand, trace fine gravel, trace (-) silt, dry	ASPHALT BASE COARSE FILL	
	4/4/3/3	7/24	S-2 (2'-4')	0.1 PPM	Top 4" : Loose, light brown, fine to medium SAND, little coarse sand, trace (+) fine gravel, trace (-) silt, dry Bottom 3" : Loose, orange brown, fine to medium SAND, little silt, little to trace coarse sand, trace fine gravel, dry		
5'	3/3/3/4	20/24	S-3 (4'-6')	0.1 PPM	Top 1" : Loose, orange brown, fine to medium SAND, little silt, little to trace coarse sand, trace fine gravel, dry Bottom 19" : Loose, orange grey, SILT and fine SAND, trace (-) medium sand, dry		
	4/4/3/3	12/24	S-4 (6'-8')	0.1 PPM	Top 11" : Loose, orange grey, SILT and fine SAND, trace coarse sand, trace fine gravel, trace (-) medium sand, damp (moist in bottom 6") Bottom 1" : Loose, grey, SILT and fine SAND, wet	▽ 16.0	
	2/2/2/2	13/24	S-5 (8'-10')	0.1 PPM	Loose, brown grey, SILT and fine SAND, trace (+) gravel, trace coarse sand, trace (-) medium sand, trace debris (brick), trace organics (roots in bottom 8"), wet		
10'	1/2/1/2	16/24	S-6 (10'-12')	0.1 PPM	Top 3" : Very loose, brown grey, SILT and fine SAND, trace coarse sand, trace fine gravel, trace (-) medium sand, wet Middle 8" : Very loose, grey, SILT and fine SAND, wet Bottom 5" : Very loose, brown grey, SILT and fine SAND, trace coarse sand, trace fine gravel, trace (-) medium sand, trace debris (brick), wet		
15'	4/2/4/5	1/24	S-7 (15'-17')	1.7 PPM	Loose, grey brown, DEBRIS (pressure treated wood), trace gravel (rock in tip)		
20'	34/30/24/35	16/24	S-8 (20'-22')	0.4 PPM	Very dense, brown grey, medium SAND, some fine sand, some to little coarse sand, trace (+) gravel, trace silt	20.0 4.0 MEDIUM SAND	
25'	38/31/38/49	8/24	S-9 (25'-27')	0.1 PPM	Very dense, grey brown, medium SAND, some fine sand, some to little coarse sand, trace (+) gravel, trace silt		

Remarks:
1. Soil screened in field using MiniRAE Lite photoionization detector (PID) referenced to benzene in air. Readings in parts per million by volume.
2. Began casing and drilling with wash after sample S-6.
3. Drill slightly grinding between 16 and 18.5 feet below ground surface, upon likely debris (wood, brick), gravel, and cobbles.
4. Drill significantly grinding between 18.5 and 30.4 feet, upon likely dense soils.
5. Drill refusal at 30.4 feet, upon likely bedrock.

PROJECT NO.
2950-13-01

LOG OF BORING
LR-3

O'Reilly, Talbot & Okun
ENGINEERING ASSOCIATES

Job No. 2950-13-01

LOG OF BORING LR-3

DEPTH (ft)/ SAMPLES	SAMPLES: PENETR. RESIST. (bl / 6 in)	SAMPLES: REC. (in)	SAMPLES: TYPE/ NO.	SAMPLES: FIELD TEST DATA	SAMPLE DESCRIPTION (MODIFIED BURMISTER)	PROFILE DEPTH (ft) ELEV.	REMARKS/ WELL CONSTRUCTION
30'						MEDIUM SAND (continued)	
	50 for 4"	3/4	S-10 (30'-32')	0.1 PPM	Very dense, white to grey, fractured ROCK	30.3 -6.3 ROCK	
					Refusal at 30.4'		
35'							
40'							
45'							
50'							
55'							
60'							

Photograph 1 – Boring LR-1, core C-1

Photograph 2 – Boring LR-1, core C-1 top

Photograph 3 – Boring LR-1, core C-1 bottom

Photograph 4 – Boring LR-1, core C-2 overview

O'Reilly, Talbot & Okun
ENGINEERING ASSOCIATES

J2950-13-01
May 25, 2022

Ms. Julianne Busa, PhD, SE
Fuss & O'Neill, Inc.
1550 Main Street, Suite 400
Springfield, Massachusetts 01103

Re: Preliminary Geotechnical Engineering Recommendations Report
New Pedestrian Bridge over Little River
Bridge Number: (Not yet designated)
Haverhill, Massachusetts

Dear Ms. Busa:

O'Reilly, Talbot & Okun Associates, Inc. (OTO) is pleased to provide these geotechnical recommendations for the proposed pedestrian bridge that will span the Little River adjacent to Cashmans Park in Haverhill, Massachusetts. A Project Locus Map and a Boring Location Plan are attached.

Our geotechnical recommendations are based upon subsurface conditions observed in one soil boring performed near the proposed location of the western abutment. The eastern bank of the river was not accessible at the time of or study.

Our services consisted of the full-time observation of the boring, review of the log and soil samples, engineering analyses, and preparation of this report. We note that access could not be coordinated to perform a boring at the eastern abutment prior to this report. The boring at the eastern abutment will be required prior to final design. This report is subject to the limitations attached in Appendix A.

The preliminary geotechnical recommendations provided in this report include bridge foundations and construction related issues. The significant issue for the proposed construction involves the presence of soft, compressible soils in the upper 40 feet that preclude the use of a shallow (spread footing) foundation. Bedrock is present starting at a depth of approximately 55 feet. However, the bedrock is highly fractured and of poor quality. The boring performed for this study penetrated to a depth of 75 feet without encountering competent bedrock.

Several foundation alternatives were considered, including shallow foundations (spread footings), driven piles, and drilled micropiles (DMPs). DMPs appear to be the most cost effective foundation alternative, due to the unknown depth to competent bedrock. The DMPs would obtain capacity through friction in the lower bonded (uncased) zone, end bearing upon competent rock, or a combination of friction and end bearing.

If you have any questions, please do not hesitate to contact the undersigned.

Sincerely yours,
O'Reilly, Talbot & Okun Associates, Inc.

Dustin A. Humphrey, P.E.
Project Manager

Michael J. Talbot, P.E.
Principal

Ashley L. Sullivan, P.E. (Reviewer)
Principal

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6.0 APPENDICES

Appendix A: Limitations

Appendix B: Project Locus Map
Boring Location Plan

Appendix C: Table 1: Requirements for Use as Engineered Fill
Table 2: Soil Properties and Design Parameters

Appendix D: Boring Logs

Appendix E: Photographs

1.0 EXECUTIVE SUMMARY

Introduction

This report provides geotechnical recommendations for the preliminary design of foundation elements for the proposed pedestrian bridge over the Little River in Haverhill, Massachusetts.

Several alternatives were considered to support the bridge, including shallow foundations (spread footings), driven piles, and drilled micropiles, or potentially a combination of the three alternatives. The most cost effective, practical foundation system for the proposed bridge will likely be drilled micropiles.

Subsurface Conditions

One soil boring (LR-1) was performed near the proposed location of the western abutment to collect information on subsurface conditions. The boring was completed to a depth of 75 feet. Bedrock was first encountered starting at a depth of about 55 feet. However, the top 11 feet of bedrock was highly fractured, and it was not feasible to core bedrock until a depth of 66 feet. At that time, a nine-foot-long bedrock core was performed. One additional soil boring with a rock core will be required near the eastern abutment during final design. It also may be appropriate to drill a deeper boring to competent bedrock on the west side of the river.

The conditions observed in the soil boring generally consisted of a surficial layer of non-engineered fill underlain by native, interbedded silty sand and clay. Soft, fractured bedrock was encountered from a depth of 55 to 75 feet below ground surface (elevation -29 to -49 feet). Competent bedrock was not encountered in this boring.

The seismic Site Class was determined according to the AASHTO LRFD Bridge Design Specifications, Article 3.10.3.1. Using the SPT N-value, the Site was determined to be Site Class E. Based upon the conditions encountered in the soil boring, we do not anticipate that soil liquefaction will be a concern under the design earthquake.

Recommended Foundation System

The selection of the suitable foundation alternative is dependent on soil and rock conditions, access considerations, cost, and design restrictions such as scour depth. Based upon these factors, we anticipate that the most suitable foundation alternative will be drilled micropiles deriving their capacity primarily from side friction in the dense granular soils present between a depth of 40 and 55 feet and/or bedrock. We note that the upper 20 feet (minimum) of bedrock appears to be highly fractured and of poor quality.

2.0 INTRODUCTION

2.1 Scope of Report

This report provides preliminary geotechnical engineering recommendations for foundation design and construction of the proposed pedestrian bridge in Haverhill, Massachusetts. The new bridge will span the Little River and be approximately in line with 8th Avenue. The location of the proposed bridge is shown on the attached Project Locus Map.

Please note that elevations shown on the Project Locus Map are in reference to the National Geodetic Vertical Datum (NGVD) 1929, while the attached Boring Location Plan and all elevations described in this report are in reference to the North American Vertical Datum (NAVD) 1988.

2.2 Proposed Construction

Details of the proposed construction are not yet complete. However, the approximate position of the bridge is known and is shown on the attached Boring Location Plan. The bridge will likely be supported on concrete abutments founded upon drilled micropiles. The drilled micropiles will derive capacity primarily from side friction in dense granular soils and bedrock present starting at a depth of 40 feet below existing ground surface (or approximate elevation -14 feet).

2.3 Site Reconnaissance and Overall Description

The Site consists of Cashmans Park, Little River, and MBTA railroad tracks between Hilldale Avenue and Hale Street in Haverhill, Massachusetts. Cashmans Park is generally flat, near elevation 29 feet. The ground surface in the eastern portion of the park slopes downward toward the Little River, with maximum slopes on the order of 2H:1V. The MBTA railroad on the east side of the river is at approximate elevation 28 feet and slopes downward to the west (towards the Little River).

The water level in the Little River was at approximate elevation 20 feet in January 2022. The subject bridge is located outside of the National Flood Insurance Program (NFIP) Zone AE, or Base Flood boundary[1]. The Base Flood (100-year flood), known as the 1% annual chance flood, has a one percent chance of occurring or being exceeded in any calendar year. The Flood Insurance Rate Map (FIRM) for the project area shows the Base Flood between elevation 24 and 25 feet. However, the proposed bridge will be located within Zone X, which is described as “areas of 0.2% annual chance flood” or “areas of 1% annual chance flood with average depths less than one foot”.

[1] Federal Emergency Management Agency (2012). “Flood Insurance Rate Map: Essex County, Massachusetts (All Jurisdictions)”, *National Flood Insurance Program*, Community: City of Haverhill, Number: 250085, Panel: 0087F.

3.0 SUBSURFACE CONDITIONS

3.1 Local Geology

Bedrock at the Site consists of a dark gray, thin-bedded siltstone. The unconsolidated materials consist of fill at the ground surface, underlain by a glacial lake deposit of soft varved silt and clay and a sandy outwash deposit. The recent fill is likely associated with grading and landscaping to construct the fields at Cashmans Park. The glacio-lacustrine (varved silt and clay) and outwash deposits are likely associated with glacial Lake Merrimack since the Merrimack River was a drainage path for the historic lake.

3.2 Subsurface Exploration Program

Subsurface investigations consisted of one soil boring (LR-1) at the proposed location of the west bridge abutment. This boring extended to a depth of 75 feet or approximately 20 feet into bedrock. A bedrock core was collected between a depth of 66 and 75 feet, or approximately the bottom nine feet of the boring. We note that bedrock was present starting at a depth of approximately 55 feet. However, the first 11 feet was soft and highly fractured, and coring was not feasible (based on drilling conditions). The boring location is shown on the attached Boring Location Plan. Boring LR-1 was performed on January 24 and 25, 2022 by Seaboard Drilling of Chicopee, Massachusetts. The boring was completed using a Mobile B-53 truck mounted drill rig and advanced using drive and wash drilling techniques. The boring log is presented in Appendix D.

Soil samples were collected continuously from the ground surface to a depth of 12 feet, at 15 feet, and at five-foot intervals thereafter. Soil samples were collected using a two-inch diameter split spoon sampler, driven 24 inches with a 140-pound automatic hammer falling 30 inches (American Society for Testing and Materials Test Method D1586 “Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils”). The number of blows required to drive the sampler each six inches was recorded. The standard penetration resistance, or N-value, is the number of blows required to drive the sampler the middle 12 inches. Soil properties, such as strength and density, are related to the N-value. We note that the N-value collected in the field was corrected to account for differing hammer efficiencies for each hammer type and drill rig. The field N-values are corrected to a standard 60% hammer efficiency, known as N_{60}, which is used in our engineering calculations and analysis. The N-values presented on the boring logs are field values, which are not adjusted for hammer efficiency.

An O’Reilly, Talbot & Okun Associates, Inc. (OTO) engineer observed and logged the boring. Samples were classified consistent with a modified version of the Burmister Soil Classification System. The boring was backfilled with soil cuttings upon completion.

Rock Cores

The soil boring was advanced through 11 feet of soft, fractured rock, which was not suitable for coring. Two bedrock cores, totaling 9-feet in length, were performed in boring LR-1. The cores were collected using a two-inch diameter, double core barrel with diamond bit. The rock cores were performed without applying additional down pressure to

the core barrel. Rock drilling times (minutes per foot) were recorded on the boring logs. In addition, the Rock Quality Designation (RQD) and Rock Mass Quality (RMQ) were determined based upon the samples collected from each rock core. Rock core information is presented on the boring logs provided in Appendix D. Photographs of the rock cores are attached in Appendix E.

3.3 Verification of Sample Descriptions on Boring Logs

I, Dustin A. Humphrey, a Massachusetts registered professional engineer, attest that I visually and manually examined all soil and rock samples as part of the preparation of this geotechnical report. Samples collected from the subsurface investigations were reviewed at the O'Reilly, Talbot, & Okun Associates, Inc. office, located in Springfield, Massachusetts on April 21, 2022. I concur that the soil and rock descriptions presented on the boring logs concur with the soil samples and rock cores collected during our Site explorations.

3.4 Subsurface Profile

Subsurface conditions were interpreted based upon information and samples collected in the soil boring. In general, subsurface conditions consisted of a surface layer of granular fill, underlain by fine-grained lake bed deposits, alluvial sands, and fractured bedrock. Soil conditions below a depth of 40 feet are generally favorable for the proposed construction. Boring logs are provided in Appendix D.

Soil Conditions

Fill: Non-engineered fill was encountered in the upper five feet of boring LR-1. The fill generally consists of medium dense, fine to medium sand with little silt and trace amounts of debris (coal, ash). These soils were likely placed to form the fields at Cashmans Park.

Glacial Lake Deposits: The fill is underlain by soft deposits of varved silt, sand, and clay to a depth of approximately 40 feet. The upper ten feet of this stratum is desiccated, resulting in a medium to very stiff consistency. The fine-grained soils were found to be very soft between a depth of 20 and 40 feet, corresponding to approximate elevations 6 to -14 feet. Given the soft nature of these soils, they are compressible and have a low strength. As a result, Site conditions are not favorable to support the new bridge on shallow foundations (spread footings).

Deep Granular Soils: Coarse-grained, granular soils were encountered starting at a depth of 40 feet (elevation -14 feet) and extending to a depth of approximately 55 feet (elevation -29 feet). This deposit is a very dense, fine to medium sand with some gravel (near the top of the soil layer) and trace amounts of silt. The granular soils are immediately underlain by soft, fractured bedrock.

Bedrock Conditions

Bedrock is present starting at a depth of approximately 55 feet below ground surface (approximately elevation -29 feet). The soil boring penetrated approximately 20 feet into bedrock with the rock being highly fractured throughout.

Based upon drilling conditions, we were unable to obtain a core above a depth of 66 feet. Two 2-inch diameter rock cores, totaling nine feet in length, were collected between a depth of 66 and 75 feet. The elevation, run times, recovery, RQD, and rock classification are presented on the boring logs, attached as Appendix D. Rock core photographs are provided in Appendix E.

The rock recovered from boring LR-1 consisted of dark gray, thin-bedded siltstone. The siltstone is consistent with the Berwick Formation described on bedrock geology maps for the area[2]. The Berwick Formation siltstone is described as "Thin- to thick-bedded metamorphosed calcareous sandstone, siltstone, and minor muscovite schist." The bedrock samples collected met that description.

The recovered rock was very intensely to intensely fractured, with minimal weathering (discoloration) present at the edges of natural fractures. The fractures were typically straight and dipped approximately 20 degrees from horizontal. Voids and/or large fractures in the rock were filled with silty clay, sand, and gravel.

Core recovery is the ratio of the length of core recovered to the length drilled. Recovery can range from 0 percent for no core recovery to 100 percent for total recovery. Core recovery at this Site ranged from 43 to 60 percent. Cores were difficult to advance due to fractured nature of the rock, with the core barrel jamming numerous times. As a result, drilling times ranged from approximately 6 to 15 minutes per foot. Normally, these data would indicate a very hard rock. However, in our opinion these times reflect the fractured nature of the rock and not its hardness.

Rock mass properties can be described using the rock quality designation (RQD)[3], which is based on core recovery. The RQD is a modification of core recovery, in that the sum of the intact pieces of core that are greater than four inches long is divided by total core length recovered (i.e., pieces less than four inches in length are disregarded). The resultant is multiplied by 100 to get RQD in percent. The RQDs for both cores were 0% (since no fragments greater than four inches were recovered). Based upon the measured core recoveries and RQDs, the core samples have a Rock Mass Quality (RMQ) of very poor. It should be noted that since bedrock typically becomes less fractured and is of higher quality with depth, we would expect RQD and RMD values to increase with depth.

[2] Zen, E. et al. (1983). "Bedrock Geologic Map of Massachusetts" *US Geological Survey*.
[3] Deere, D.H. (1968), "Technical Description of Rock Cores for Engineering Purposes" Rock Mechanics and Engineering Geology, Vol. 1, pp 16-22.

Groundwater Conditions

Groundwater was encountered in boring LR-1 at a depth of five feet below ground surface, corresponding to an approximate elevation of 21 feet, which is similar to the water level in the Little River (approximate elevation 20 feet at the time of our explorations).

3.5 Seismic Design Category Evaluation

The seismic design and analysis of the proposed bridge was performed in accordance with the specifications provided in the 2013 MassDOT *LRFD Bridge Manual*, Revised January 2020 (MassDOT) and the 2017 AASHTO *LRFD Bridge Design Specifications* (AASHTO). Earthquake loadings must be considered under requirements of MassDOT and AASHTO.

Section 3.4 of MassDOT covers seismic analysis and design. Lateral forces generated during a seismic event are dependent on the type and properties of soils present beneath the Site as well as geographic location. The *USGS Seismic Design Maps*[4] web service was used to determine seismic parameters for the Site. The peak ground acceleration (PGA), as well as the maximum considered earthquake spectral response accelerations for short periods (S_s) and for one-second (S_1) were determined to be 0.093, 0.18, and 0.043, respectively, for Haverhill, Massachusetts. These values are for a non-critical/non-essential bridge and based upon a seven percent probability of exceedance in 75 years for a 1,000-year event.

Soil properties are represented through Site Classification. Procedures for the Site-specific determination of Site Classification are provided in Article 3.10.3.1 of AASHTO. At this Site, we evaluated Site Classification using Standard Penetration Resistance (SPT N-value). The Site Class was determined to be Class E based upon soil data collected. Furthermore, the Site coefficients F_{pga}, F_a, and F_v were determined using the PGA, S_s, and S_1 values and the Site Class. For this Site, F_{pga}, F_a, and F_v were determined to be 2.5, 2.5, and 3.5, respectively.

3.6 Liquefaction Potential

The potential for liquefaction was evaluated for the Site soils beneath the groundwater table. Based upon conditions encountered in the soil borings, liquefaction is unlikely to occur under the design earthquake.

[4] https://earthquake.usgs.gov/ws/designmaps/ accessed on April 21, 2022.

4.0 RECOMMENDED FOUNDATION SYSTEM

The following recommendations are provided for foundation design. Foundations will be designed to resist lateral and vertical loads. Vertical loads consist of downward pressures due to the dead weight of the bridge and live traffic loads. Uplift pressures and lateral loads will be generated due to overturning loads (such as wind loads, seismic forces, and flood conditions). All foundations should be designed according to requirements provided in the 2013 MassDOT *LRFD Bridge Manual*, Revised January 2020 (MassDOT) and the 2017 AASHTO *LRFD Bridge Design Specifications* (AASHTO).

4.1 Retain or Modify Existing Foundation

The proposed bridge will be a new construction. Therefore, no existing foundation system exists for reuse.

4.2 Embankment Considerations

The new bridge will not include any significant new embankments to form either approach. The only fill anticipated as part of this project will include backfill for abutments/pile caps and Gravel Base Course layers beneath final pavements. Therefore, no geotechnical concerns have been identified associated with the settlement or stability of embankment soils. The earthwork recommendations provided in Section 5.0 should be followed.

4.3 Shallow Foundation Design

Spread footing foundations were considered. However, spread footings do not appear to be a viable alternative for the following reasons.

- It is unlikely that sufficient bearing capacity could be achieved without constructing extremely large spread footings, due to the near surface loose silty sand and very soft clay soils, especially if the bridge will be a single-span structure.
- The soft varved silt and clay present between a depth of five and 40 feet below ground surface is potentially compressible.
- Installation of coffer dams and dewatering would be required to construct footings in the dry if the proposed bridge will be supported by mid-span piers within the Little River.

4.4 Deep Foundation Design

Driven piles and drilled micropiles bearing in bedrock are potentially suitable foundation alternatives for the proposed construction. However, given the relatively small size of this project, the relatively high mobilization cost associated with driven piles, and drivability concerns through the very dense sand layer and through fractured rock present below a depth of 40 feet, it appears that drilled micropiles (DMPs) are the most cost-efficient foundation alternative. If driven piles are considered further, we recommend that the design team consider ductile iron pipe piles (DIPs), which are a relatively low-cost alternative. We recommend that the DIP option be considered further during final design.

Design of Drilled Micropiles

Drilled micropiles (DMPs) are a viable foundation alternative and appear to be the most feasible and cost-effective foundation alternative for this project. Generally, the DMPs are designed by the specialty contractor in general accordance with a performance-based project specification. We recommend that an experienced pile installation contractor be required to provide a design submittal prepared by a professional engineer. The design should include pile size and length of bond zone, material type and length, installation means and methods, steel reinforcement, and methods for overcoming obstruction (if encountered) and other design assumptions. All other applicable requirements of MassDOT and AASHTO should be followed. Our preliminary design recommendations for the design of DMPs are provided below. Recommended soil parameters are provided in Table 1.

Micropile spacing should be greater than 30 inches or three times the pile diameter, whichever is greater, to avoid group effects. If permanent steel outer casing is used for the micropiles, threaded joints shall not be used within three feet of the pile cap (abutment). The designer should review moment diagrams and determine if the prohibited depth for threaded joints should be increased.

DMP casing should be drilled through the soft varved silt and clay into the dense sand and fractured bedrock bonding zone. The top of the DMPs should extend a minimum of 12 inches into the pile cap (abutment) and have a minimum cover of 9 inches (distance from the edge of the abutment). To prevent uplift loads due to frost, pile caps (abutments) should bear a minimum of 48 inches below the lowest adjacent ground surface.

Vertical Capacity of Drilled Micropiles

Given the Site conditions, it is likely DMPs should be designed as friction piles deriving their compacity from side friction in the very dense sand and fractured rock layers present below a depth of 40 feet. Unless competent bedrock is encountered, tip resistance should be neglected. We note that the single boring completed to date did not encounter competent bedrock at a depth of 75 feet. For DMPs relying on side friction only, the tension (uplift) capacity of friction bonded DMPs is theoretically equal to the compression capacity. However, we recommend that for tension the grout to ground bond strength be reduced by 50 percent of the adhesion in compression. Typical values for grout to ground bond strength are presented in the 2005 *FHWA Micropile Design and Construction Reference Manual* (FHWA). Based upon the recommendations contained in the FHWA manual we recommend the grout to ground bond strength values presented in Table 1. The appropriate grout to ground bond strength used for the design of micropiles should be selected by the specialty contractor. We note that the tensile capacity is often limited by the strength of the reinforcing steel. If required, the designer may increase the size of the reinforcing bar or grade of steel to increase the tensile capacity.

Lateral Capacity of Drilled Micropiles

DMPs have a limited lateral capacity due to their slender cross-section. To accommodate higher lateral loads (if needed), we recommend the use of a steel outer casing and/or larger diameter micropiles. Battered piles can be used to obtain a greater lateral capacity. Lateral forces (seismic and wind) will be dissipated through earth pressures along the sides of abutments and DMPs, as well as through friction forces along the bottom of abutments.

Lateral load resistance should be neglected for the upper four feet of pile immediately below the bottom of the abutment. We recommend that the lateral pile capacity be assessed by the specialty contractor using LPILE or a similar analytical software program. Design parameters for use in the determination of lateral resistance are presented in Table 1. We note that the Table 1 presents the vertical modulus of subgrade reaction, *k*. The horizontal modulus of subgrade reaction, k_h, is a function of depth, and can be estimated using Equation 1, which was developed by Terzaghi.

$$k_h = k_B^Z \quad (1)$$

Where *Z* is the depth of analysis, and *B* is the pile diameter.

Installation of Drilled Micropiles

DMPs will derive their axial capacity from side friction within the very dense sand and fractured bedrock. They should fully penetrate the soft varved silt and clay layer and any friction in that layer should be ignored. We note that a significant penetration of grout into the fractured bedrock may occur during DMP installation. When performing the additional soil boring at the east abutment, the depth to competent rock should be determined, if encountered. The DMP designer can then make a determination on the most appropriate design based upon the additional subsurface information.

The DMPs should be installed using full-length temporary casing and grouted using tremie methods. Centralizers should be placed every 10 feet along the length of the pile to center the steel reinforcement bar.

The DMPs should be installed using duplex drilling methods. The pile installation should be sequenced so that no adjacent piles are installed the same day, and post grouting of DMPs does not occur during installation of adjacent piles.

Verification and Proof Testing of Drilled Micropiles

Verification testing should be performed on two sacrificial piles – one installed near each proposed abutment. MassDOT requires that the verification test piles be installed within ten feet of the proposed abutment, but greater than five feet from any production pile.

Proof load testing should be performed on one production pile at each abutment. All other applicable testing requirements of the 2013 MassDOT *LRFD Bridge Manual* (2020 Revision) and the 2017 AASHTO *LRFD Bridge Design Specifications* should be followed.

5.0 CONSTRUCTION CONSIDERATIONS

5.1 Water Table

As was discussed above, groundwater was encountered in boring LR-1 at a depth of five feet below ground surface, corresponding to an approximate elevation of 21 feet. In addition, the bridge is in a flood zone with a Base Flood (100-year flood) elevation between 24 and 25 feet. We recommend that the contract assume that groundwater will be at the design flood elevation at some time during construction.

5.2 Recommended Method for Water Control

Based upon the observed groundwater levels and potential for flooding, it is possible that groundwater will be present in excavations for abutments, wingwalls, and utilities. It should be possible to dewater shallow excavations using sump pits and submersible pumps or well points. If shallow, saturated soils are encountered in deeper excavations, the contractor will either need to stop work or install sheet pile walls around excavations to cutoff groundwater flow.

5.3 Excavations

The need for temporary earth support should be evaluated by the contractor. Sloping and earth support may be needed during demolition, the removal of debris soils, the installation of utilities, and if foundations are extended to depths greater than four feet below existing grade.

The upper unconsolidated native soils encountered at the Site are estimated to be Type C soils for slope stability purposes. The maximum allowable slope for excavations of Class C soils is 1.5H:1V (34°).

In areas where sloping is not feasible, the excavations may require temporary earth support systems during construction. The design and engineering of these systems should be the responsibility of the contractor. Prior to construction, we recommend that the contractor evaluate the need for a temporary earth support system to protect the existing roadway, canal, and personnel during construction.

We note that protective systems for any excavation exceeding 20 feet in depth must be designed by a registered professional engineer. All excavations should conform to current OSHA requirements.

Engineered Fill Recommendations

Four types of engineered fill are recommended:

- M1.03.0 Type B Gravel Borrow for use immediately behind abutments and retaining walls and below footings;
- Crushed Stone for use immediately below abutments and footings and in place of Gravel Borrow (as needed);

- Gravel Base Course for use immediately below pavements; and
- Granular Fill for use as miscellaneous fill.

Grain size distribution requirements are presented in Table 2. On-Site soils may be suitable for re-use as engineered fill, if free from deleterious (brick and ash debris) and/or oversized material. If the contractor elects to use the on-Site material as fill, we recommend that a representative sample be collected, and a grain size distribution analysis be performed to obtain approval by the engineer.

Compaction Recommendations

Prior to the placement of any engineered fill below abutments, we recommend that the subgrade be thoroughly proof compacted by a minimum of six passes using a 6,000-pound vibratory roller. To facilitate compaction, the moisture content of the on-Site material should be maintained at or near the optimum moisture content as determined by ASTM D1557.

Compacted fill should be placed in loose lifts ranging in thickness between 6 and 12 inches, depending on the size and type of equipment, and compacted to at least 95% of the Modified Proctor dry density as defined in ASTM D1557, Method C.

5.4 Obstructions

It is possible that abandoned utilities and other obstructions a may also be encountered in the granular fill layer present in the upper five feet. We recommend that the contractor be informed of these potential obstructions prior to bidding, and that the owner carry a contingency in the event that unanticipated obstructions are encountered.

5.5 Protection of Adjacent Structures and Utilities

We recommend pre-construction and post-construction surveys be conducted to document the condition of the existing MBTA railroad, as well as any associated structures and buried utilities. Protection of nearby subsurface utilities should be designed by the contractor and approved by the engineer and/or design team.

5.6 Sequence of Construction Activities

We recommend that the contractor and/or design team develop the sequence of construction activities.

5.7 Special Geotechnical Monitoring and Instrumentation

We recommend OTO be retained during final design to prepare and/or review appropriate specification sections and drawings, if necessary. During construction phases, we recommend that OTO be retained on an as-needed basis to provide engineering support, to observe and document DMP installation, and to document earthwork activities and subgrade conditions/preparation for the construction of abutments. We recommend that OTO be retained on a full-time basis during the installation of DMPs.

6.0 APPENDICES

APPENDIX A

Limitations

LIMITATIONS

1. The observations presented in this report were made under the conditions described herein. The conclusions presented in this report were based solely upon the services described in the report and not on scientific tasks or procedures beyond the scope of the project or the time and budgetary constraints imposed by the client. The work described in this report was carried out in accordance with the Statement of Terms and Conditions attached to our proposal.

2. The analysis and recommendations submitted in this report are based in part upon the data obtained from widely spaced subsurface explorations. The nature and extent of variations between these explorations may not become evident until construction. If variations then appear evident, it may be necessary to reevaluate the recommendations of this report.

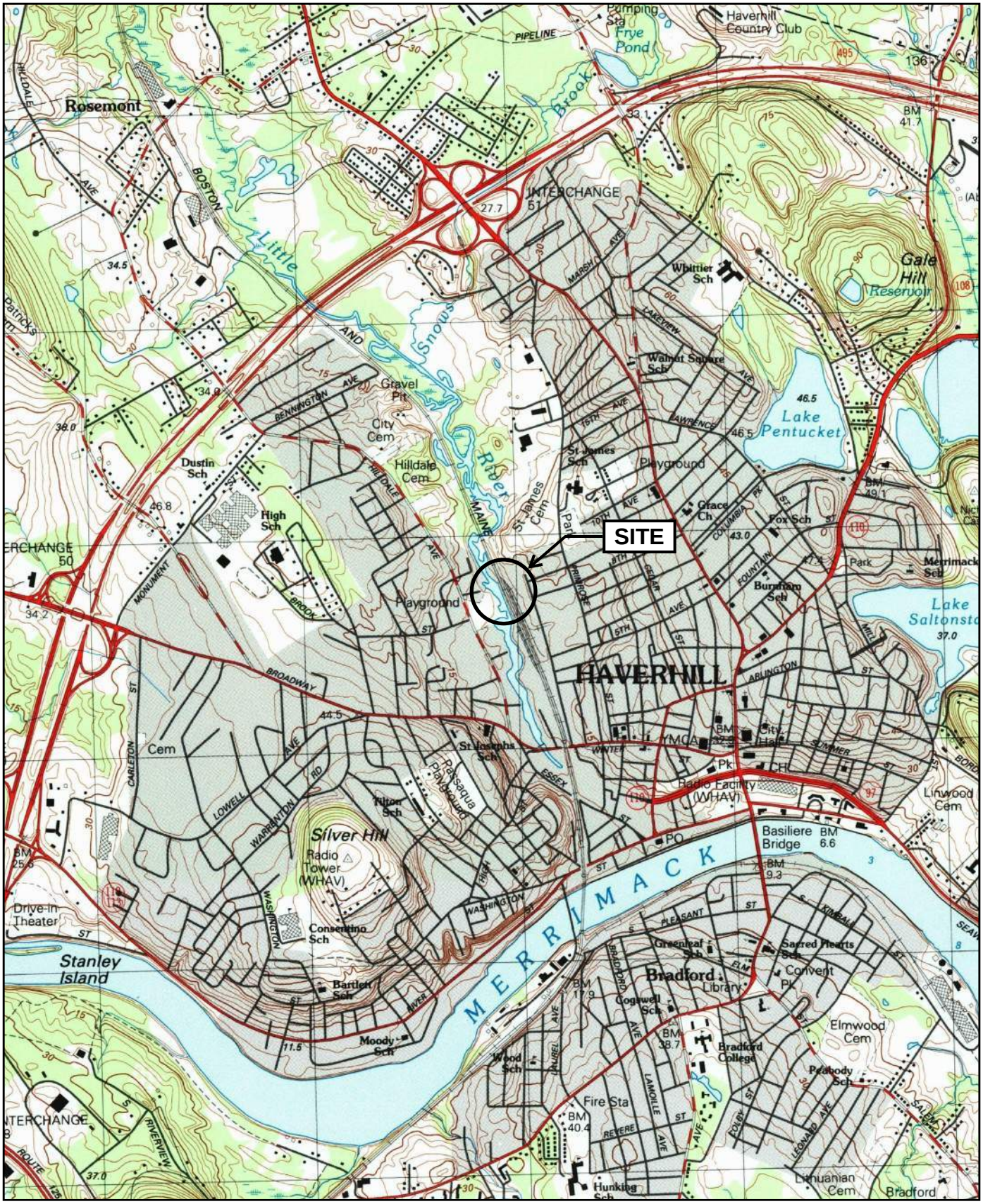
3. The generalized soil profile described in the text is intended to convey trends in subsurface conditions. The boundaries between strata are approximate and idealized and have been developed by interpretations of widely spaced explorations and samples; actual soil transitions are probably more erratic. For specific information, refer to the boring logs.

4. In the event that any changes in the nature, design or location of the proposed structures are planned, the conclusions and recommendations contained in this report shall not be considered valid unless the changes are reviewed and conclusions of this report modified or verified in writing by O'Reilly, Talbot & Okun Associates Inc. It is recommended that we be retained to provide a general review of final plans and specifications.

5. Our report was prepared for the exclusive benefit of our client. Reliance upon the report and its conclusions is not made to third parties or future property owners.

APPENDIX B

Figures



1:25,000 SCALE NATIONAL GEODETIC VERTICAL DATUM 1929 3 METER CONTOUR INTERVAL

O:\J2900\2950 Fuss & O'Neill\13-01 Haverhill Little River Dam Removal - Geotech\Figures\Site Locus 2950-13-01 Bridge.pdf

O'Reilly, Talbot & Okun
ENGINEERING ASSOCIATES
293 Bridge Street, Suite 500 Springfield, MA 01103 413.788.6222
www.OTO-ENV.com

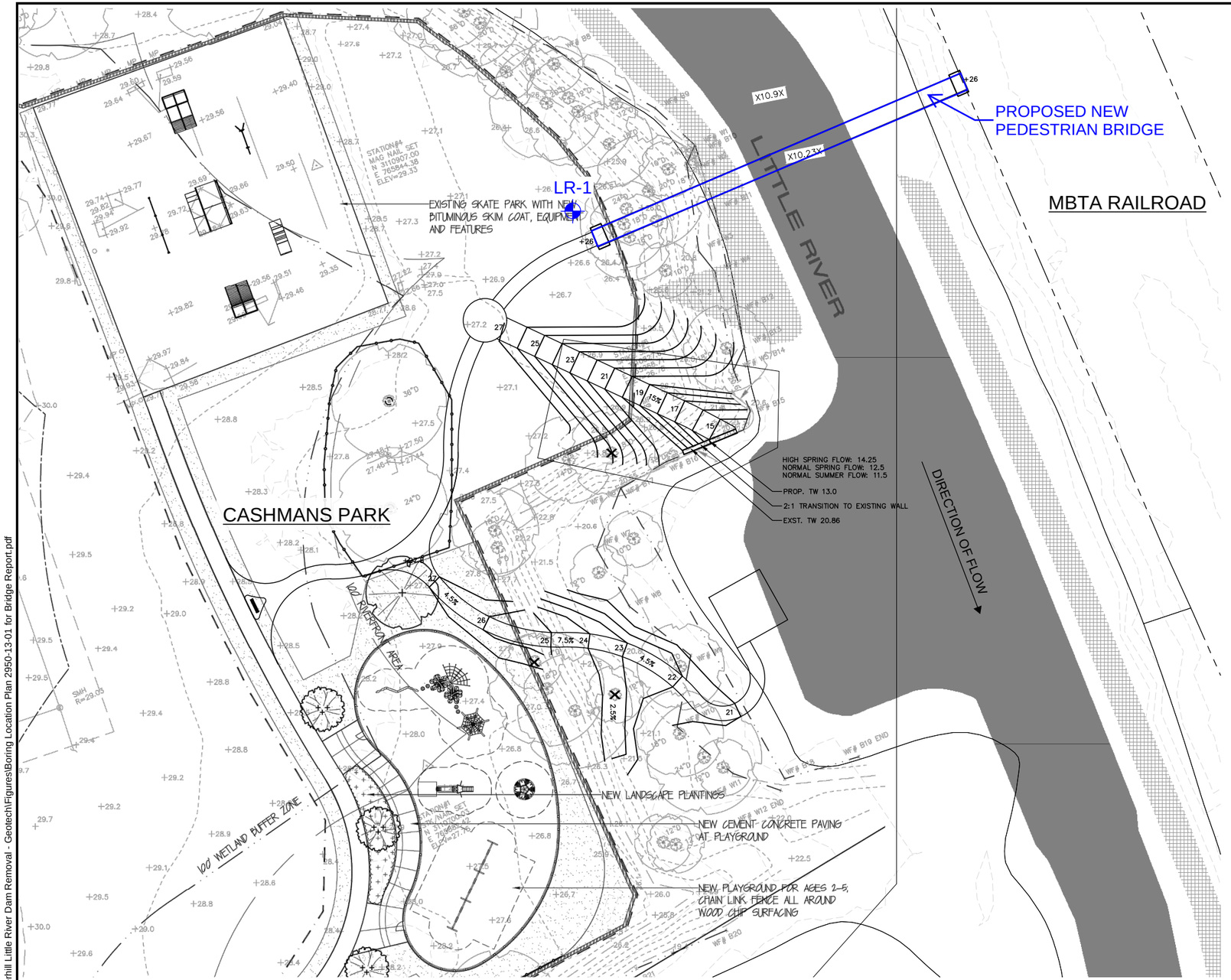
LITTLE RIVER PEDESTRIAN BRIDGE
HAVERHILL, MASSACHUSETTS

SITE LOCUS

Topographic Map Quadrant: HAVERHILL, MA
Map Version: 1987
Current As Of: 1987
Date: MAY 2022

PROJECT No. J2950-13-01

FIGURE No. 1



BORING LOCATIONS (FEET)					
BORING	**NORTHING**	**EASTING**	**STATION**	**OFFSET**	**SURFACE EL.**
LR-1	3,110,892	765,931	N/A	N/A	26
LR-2	3,110,733	765,959	N/A	N/A	20
LR-3	3,108,661	766,556	N/A	N/A	24

SCALE IN FEET
1" = 40'

0' 20' 40' 80'

LEGEND:

APPROXIMATE SOIL BORING LOCATION PERFORMED BY SEABOARD DRILLING ON 1/24 AND 1/25/2022, OBSERVED BY O'REILLY, TALBOT & OKUN ASSOCIATES

NOTES:

1. NORTHING AND EASTING IN US SURVEY FEET, IN REFERENCE TO STATE PLANE ZONE MA M-2001
2. BASE MAP PROVIDED TO OTO IN ELECTRONIC FORMAT. ORIGINAL DRAWING TITLED "CONCEPT PLAN CASHMAN`S PARK" SHEET CON-01 BY FUSS & O`NEILL, DATED NOVEMBER 2021
3. SAMPLE LOCATIONS ARE SHOWN ACCORDING TO TAPED MEASUREMENTS TAKEN FROM EXISTING SITE FEATURES
4. ALL DATA IS TO BE CONSIDERED ACCURATE ONLY TO THE DEGREE IMPLIED BY THE METHODS USED IN THE DEVELOPMENT OF THIS PLAN

PROJECT FILE NO. 2950-13-01

massDOT
Massachusetts Department of Transportation
Highway Division

BORING PLAN OF PROPOSED BRIDGE IN HAVERHILL

PEDESTRIAN BRIDGE OVER LITTLE RIVER

MASSACHUSETTS DEPARTMENT OF TRANSPORTATION
HIGHWAY DIVISION

SCALE: 1" = 40'-0" FEBRUARY, 2022

BRIDGE NO. NOT YET DESIGNATED

O:\2900\2950 Fuss & O'Neill\13-01 Haverhill Little River Dam Removal - Geotech\Figures\Boring Location Plan 2950-13-01 for Bridge Report.pdf

APPENDIX C

Tables

Table 1
Soil Properties & Design Parameters

Soil Property/ Design Parameter	Fill and Native Fine-Grained Soils	Very Dense Fine to Medium Sand	Fractured Bedrock
Elevation Encountered	21 to -14 feet	-14 to -29 feet	Below -29 feet
Angle of Internal Friction, ϕ	---	38 degrees	40 degrees
Cohesion, *c*	---	0 psf	0 psf
Unit Weight (dry), γ	105 pcf	125 pcf	140 pcf
Subgrade Modulus, *k*	---	280 $lb/in^2/in$	---
Grout to Ground Bond Strength	---	25 psi	75 psi
Note: Unconsolidated material (fill and varved silt and clay) should be neglected in the determination of axial geotechnical pile capacity.			

Table 2
Recommended Requirements for Use as Engineered Fill

Sieve Size	Engineered Fill			
	M1.03.0 Type B Gravel Borrow	Gravel Base Course	Granular Fill	Crushed Stone
	Percent Finer by Weight			
3 inch	100	100	100	---
1 ½ inch	---	70-100	---	---
1 inch	---	---	---	100
¾ inch	---	50-85	---	90-100
½ inch	50-85	---	---	10-50
⅜ inch	---	---	---	0-20
No. 4	40-75	30-60	---	0-5
No. 8	---	---	---	---
No. 10	---	---	30-90	---
No. 16	---	---	---	---
No. 30	---	---	---	---
No. 40	8-28	---	10-70	---
No. 50	---	---	---	---
No. 100	---	---	---	---
No. 200	0-10	0-10	0-15	---

Notes:
1. Values in *italics* do not meet criteria for use as Crushed Stone.
2. Values in parentheses do not meet criteria for use as Granular Fill.
3. Values with an asterisk (*) do not meet criteria for use as Gravel Base Course.
4. Values in **bold** do not meet criteria for use as M1.03.0 Type B Gravel Borrow.

APPENDIX D

Boring Logs

O'Reilly, Talbot & Okun
ENGINEERING ASSOCIATES

BORING LOGS

SUMMARY OF THE BURMISTER SOIL CLASSIFICATION SYSTEM (MODIFIED)

RELATIVE DENSITY (of nonplastic soils) OR CONSISTENCY (of plastic soils)

STANDARD PENETRATION TEST (SPT)
Method: Samples were collected in accordance with ASTM D1586-99, using a 2" diameter split spoon sampler driven 24 inches. If samples were collected using direct push methodology (geoprobe), SPTs were not performed and relative density/consistency were not reported. **N-Value**: The number of blows with a 140 lb. hammer required to drive the sampler the middle 12 inches. **WOR**: Weight Of Rod (depth dependent) **WOH**: Weight Of Hammer (140 lbs.)

COHESIONLESS SOILS		COHESIVE SOILS	
BLOWS/FOOT (SPT N-Value)	RELATIVE DENSITY	BLOWS/FOOT (SPT N-Value)	CONSISTENCY
0-4	Very loose	<2	Very soft
4-10	Loose	2-4	Soft
10-30	Medium dense	4-8	Medium
30-50	Dense	8-15	Stiff
>50	Very dense	15-30	Very stiff
*Based upon uncorrected field N-values		>30	Hard

MATERIAL: (major constituent identified in CAPITAL letters)

COHESIONLESS SOILS		
MATERIAL	FRACTION	GRAIN SIZE RANGE
GRAVEL	Coarse	3/4" to 3"
	Fine	1/4" to 3/4"
SAND	Coarse	1/16" to 1/4"
	Medium	1/64" to 1/16"
	Fine	Finest visible & distinguishable particles
SILT/CLAY	see adjacent table	Cannot distinguish individual particles
COBBLES	3" to 6" in diameter	
BOULDERS	> 6" in diameter	
Note: Boulders and cobbles are observed in test pits and/or auger cuttings.		

COHESIVE SOILS		
SMALLEST DIAMETER	PLASTICITY	IDENTITY
None	Nonplastic	**SILT**
1/4" (pencil)	Slight	**Clayey SILT**
1/8"	Low	**SILT & CLAY**
1/16"	Medium	**CLAY & SILT**
1/32"	High	**Silty CLAY**
1/64"	Very High	**CLAY**
Wetted sample is rolled in hands to smallest possible diameter before breaking.		

ORGANIC SILT: Typically gray to dark gray, often has strong H2S odor. May contain shells or shell fragments. Light weight.

Fibrous PEAT: Light weight, spongy, mostly visible organic matter, water squeezed readily from sample. Typically near top of layer.

Fine grained PEAT: Light weight, spongy, little visible organic matter, water squeezed from sample. Typically below fibrous peat.

DEBRIS: Detailed contents described in parentheses (wood, glass, ash, crushed brick, metal, etc.)

BEDROCK: Underlying rock beneath loose soil, can be weathered (easily crushed) or competent (difficult to crush).

ADDITIONAL CONSTITUENTS

TERM	% OF TOTAL
and	35-50%
some	20-35%
little	10-20%
trace	1-10%

COMMON TERMS

Glacial till: Very dense/hard, heterogeneous mixture of sand, silt, clay, sub-angular gravel. Deposited at base of glaciers, which covered all of New England.

Varved clay: Fine-grained, post-glacial lake sediments characterized by alternating layers (or varves) of silt, sand and clay.

Fill: Material used to raise ground, can be engineered or non-engineered.

COMMON FIELD MEASUREMENTS

Torvane: Undrained shear strength is estimated using an E285 Pocket Torvane (TV). Values in tons/ft^2.

Penetrometer: Unconfined compressive strength is estimated using a Pocket Penetrometer (PP). Values in tons/ft^2.

RQD: Rock Quality Designation is determined by measuring total length of pieces of core 4" or greater and dividing by the total length of the run, expressed as %. 100-90% excellent; 90-75% good; 75-50% fair; 50-25% poor; 25-0% very poor.

PID: Soil screened for volatile organic compounds (VOCs) using a photoionization detector (PID) referenced to benzene in air. Readings in parts per million by volume.

O'Reilly, Talbot & Okun
ENGINEERING ASSOCIATES

LOG OF BORING LR-1

PROJECT	Little River - Dam Removal and River Restoration			CONTRACTOR	Seaboard Environmental Drilling		
JOB NUMBER	2950-13-01	FINAL DEPTH (ft)	75.0	DRILLING EQUIPMENT	B-53 Truck Mounted Rig		
LOCATION	Haverhill, MA	SURFACE ELEV (ft)	26.0	FOREMAN	Dale G.	CASING	
START DATE	1/24/2022	DISTURBED SAMPLES	17	HELPER	Mike K.	CASE DIAMETER	4"
FINISH DATE	1/25/2022	UNDISTURBED SAMPLES	--	BIT TYPE	Roller Bit with Wash	HAMMER WGT	300 lb
ENGINEER/SCIENTIST	Jhonatan Escobar	WATER LEVEL		ROD TYPE	A (1 5/8" O.D.) & N (2 3/8" O.D.)	HAMMER DROP	30"
BORING LOCATION	Near proposed western bridge abutment	FIRST (ft)	--	SAMPLER	2" O.D. Split Spoon	ROCK CORING INFORMATION	
		LAST (ft)	--	HAMMER TYPE	Automatic	TYPE	Diamond Bit
		TIME (hr)	--	HAMMER WGT/DROP	140 lb / 30"	SIZE	2"

DEPTH (ft)/ SAMPLES	SAMPLES: PENETR. RESIST. (bl / 6 in)	SAMPLES: REC. (in)	SAMPLES: TYPE/ NO.	SAMPLES: FIELD TEST DATA	SAMPLE DESCRIPTION (MODIFIED BURMISTER)	PROFILE DEPTH (ft) ELEV.	REMARKS/ WELL CONSTRUCTION
	19/11/5/6	6/24	S-1 (0-2')	0.1 PPM	Medium dense, dark brown, fine SAND, some silt, trace organics (roots), trace medium sand, trace debris (coal), damp (FILL)	GRANULAR FILL	
	6/11/16/20	12/24	S-2 (2-4')	0.0 PPM	Top 3": Medium dense, light brown, fine to medium SAND, little silt, trace gravel, damp (FILL) Bottom 9": Medium dense, light brown, fine to medium SAND, little coarse sand, trace gravel, trace silt, dry (FILL)		
5'	23/16/9/10	16/24	S-3 (4-6')	0.0 PPM	Top 5": Medium dense, dark brown, fine to medium SAND, little coarse sand, trace silt, trace debris (coal ash), trace gravel, damp (FILL) Middle 8": Medium dense, light brown, fine to medium SAND, little coarse sand, little gravel, trace silt, wet	5.0 21.0 FINE TO MEDIUM SAND	
	7/10/12/14	20/24	S-4 (6-8')	0.0 PPM PP=2.75 TV=0.75 TSF	Bottom 3": Very stiff, light brown, clayey SILT, little fine sand, damp Very stiff, light brown with significant rust staining, SILT and CLAY, trace fine sand, wet at top (Perched) (Varved)	VARVED SILT AND CLAY	
10'	14/14/14/14	18/24	S-5 (8-10')	0.0 PPM PP=3.0 TV=0.95 TSF	Very stiff, gray, SILT and CLAY, trace fine sand, damp (Varved)		
	3/3/3/3	20/24	S-6 (10-12')	0.0 PPM PP=1.5 TV=0.65 TSF	Medium, gray, CLAY and SILT, trace (-) fine sand (Varved)		2
15'						15.0 11.0	
	2/1/1/1	16/24	S-7 (15-17')	0.0 PPM	Very loose, gray, SILT and fine SAND (Varved)	SILT AND FINE SAND	
20'						20.0 6.0	
	3/1/WOH 12"	16/24	S-8 (20-22')	0.0 PPM	Very soft, gray, clayey SILT, some fine sand (Varved)	VARVED SILT AND CLAY	
25'							
	WOH 24"	18/24	S-9 (25-27')	0.0 PPM PP=0.25 TV=0.15 TSF	Very soft, gray, SILT and CLAY, trace fine sand (varved)		

Remarks:
1. Soil screened in field using MiniRAE Lite photoionization detector (PID) referenced to benzene in air. Readings in parts per million by volume.
2. Began open hole drilling at 12', drove casing at 40' due to caving in of boring.
3. Drove roller bit from 55-66' through weathered bedrock.
4. Began coring activities at 66', with 0 psi of down pressure throughout coring
5. Rock Quality Designation (RQD) is determined by summing the length of all rock core pieces longer than 4", then dividing by the length of the coring run.
6. Rock Mass Quality (RMQ) is determined based upon the RQD %.

PROJECT NO.
2950-13-01

LOG OF BORING
LR-1

O'Reilly, Talbot & Okun
ENGINEERING ASSOCIATES

Job No. 2950-13-01

LOG OF BORING LR-1

DEPTH (ft)/ SAMPLES	SAMPLES: PENETR. RESIST. (bl / 6 in)	SAMPLES: REC. (in)	SAMPLES: TYPE/ NO.	SAMPLES: FIELD TEST DATA	SAMPLE DESCRIPTION (MODIFIED BURMISTER)	PROFILE DEPTH (ft) ELEV.	REMARKS/ WELL CONSTRUCTION
						VARVED SILT AND CLAY continued	
30'	WOH 18"/2	20/24	S-10 (30-32')	0.0 PPM PP=0.5 TV=0.25 TSF	Very soft, gray, SILT and CLAY, trace fine sand (Varved)		
35'	WOH 12"/2/3	24/24	S-11 (35-37')	0.0 PPM PP=0.75 TV=0.4 TSF	Top 16": Very soft, gray, SILT and CLAY, trace fine sand (Varved) Bottom 8": Very soft, gray to light brown, SILT and CLAY, little fine sand (Varved)		
40'	19/47/50 for 2"	11/14	S-12 (40-41.2')	0.0 PPM	Very dense, light brown, fine to medium SAND, some gravel, little silt,	40.0 -14.0 FINE TO MEDIUM SAND	
45'	35/47/40/47	19/24	S-13 (45-47')	0.0 PPM	Very dense, gray to light brown, fine to medium SAND, trace (+) silt, trace gravel		
50'	33/47/45/44	18/24	S-14 (50-52')	0.0 PPM	Very dense, gray to light brown, fine to medium SAND, trace silt (1/4" silt seam at center)		
55'	50 for 1"	1/1	S-15 (55-55.1')	0.0 PPM	Gray, weathered BEDROCK	55.0 -29.0 WEATHERED BEDROCK	3
60'							

O'Reilly, Talbot & Okun
ENGINEERING ASSOCIATES

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LOG OF BORING LR-1

DEPTH (ft)/ SAMPLES	SAMPLES: PENETR. RESIST. (bl / 6 in)	SAMPLES: REC. (in)	SAMPLES: TYPE/ NO.	SAMPLES: FIELD TEST DATA	SAMPLE DESCRIPTION (MODIFIED BURMISTER)	PROFILE DEPTH (ft) ELEV.	REMARKS/ WELL CONSTRUCTION
65'						WEATHERED BEDROCK continued	
	Drill Rate (Min/Feet)					66.0 -40.0	
	8.33	34/57	C-1 (66-70.75')	0.0 PPM	RQD = 0% RMQ = Very Poor Total run time = 35.35 minutes	BEDROCK	4
	10.25						
	6.43						
	7.23						
70'	3.10 for 9"						
	8.25	22/51	C-2 (70.75-75')	0.3 PPM	RQD = 0% RMQ = Very Poor Total run time = 63.63 minutes		
	10.00						
	14.40						
	15.25						
75'	15.73 for 3"				End of exploration at 75'	75.0 -49.0	
80'							
85'							
90'							
95'							

APPENDIX E

Photographs

Photograph 1 – Boring LR-1, core C-1

Photograph 2 – Boring LR-1, core C-1 top

Photograph 3 – Boring LR-1, core C-1 bottom

Photograph 4 – Boring LR-1, core C-2 overview