

SECTION 01050**FIELD ENGINEERING****PART 1 GENERAL****1.01 SUMMARY**

- A. This Section describes methods and requirements for field engineering including examination of sites and conditions of construction; establishment of project control monumentation, lines, grades, and easements; connections to existing facilities; and preparation of Redline Drawings.
- B. Perform all field engineering required, including, but not limited to, construction layout and construction survey on the basis of primary survey controls furnished by the Authority for the proper examination and preparation of the sites for the installation of the Work as well as post-construction surveys for the preparation of Redline Drawings.
- C. Horizontal Control is based on NAD 83 State Coordinate System (SPCS83) – Massachusetts Mainland, US Feet. Elevations are based on the Boston City Base (BCB) Datum.
 - 1. The BCB Datum elevation is 6.46 feet equals 0.00 feet NAVD 88 Mean Sea Level.

1.02 RELATED SECTIONS

- A. Section 01046 – Control of Work
- B. Section 01300 – Submittals

1.03 CODES AND STANDARDS

- A. Federal Geographic Data Committee, National Spatial Data Infrastructure:
 - 1. FGDC-STD-007: Geospatial Positioning Accuracy Standards, Parts 1 – 5
- B. Massachusetts Board of Registration of Professional Engineers and Land Surveyors:
 - 1. 250 CMR 6.00: Land Surveying Procedures and Standards

1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01300 – Submittals:
 - 1. Survey:
 - a. Proof of Qualifications of Professional Engineer or Professional Land Surveyor

licensed in the Commonwealth of Massachusetts before starting survey work.

- b. Detailed description of proposed survey method(s), network diagrams, and equipment type, accompanied by Manufacturer's literature specifying accessories, calibration procedures, requirements, and frequencies.
- c. Documentation verifying accuracy of survey work including, but not limited to, survey field books, sketches, drawings, and layouts.
- d. Layout sketch signed and stamped by the Contractor's Massachusetts-Licensed Registered Professional Engineer, or by the Contractor's Massachusetts-Licensed Registered Professional Land Surveyor, within 14 days of completion of each survey, certifying that the elevations and locations of the Work are in conformance with the Contract Documents.
- e. A complete and accurate log of control and survey work, including documentation verifying accuracy of survey work as it progresses, and upon completion of the Work, including, but not limited to, survey field books, sketches, drawings, calculations, and layouts.
- f. Maps showing final centerline, station, and other Contractor-installed monumentation for Authority approval.

2. Redline Documents:

- a. Provide Redline Drawings in accordance with Section 01300 – Submittals.

1.05 QUALITY ASSURANCE

- A. Survey Accuracy Requirements – The land and underground surveys shall be compatible with the project feature placement tolerances specified and indicated in the Contract Documents. This includes tolerances for excavation and pipe placement to be in accordance with 250 CMR 6.00 – Land Surveying Procedures and Standards and FGDC-STD-007: Geospatial Positioning Accuracy Standards, Parts 1 – 5, and shall be as specified in this Section.
- B. Prior to commencing construction, verify all existing grades and building elevations and submit actual elevations if actual elevations differ from the elevations indicated.

1.06 QUALIFICATIONS

- A. Planning and execution of work shall be performed and supervised by a Licensed Professional Engineer Registered in the Commonwealth of Massachusetts, or by a Licensed Professional Land Surveyor Registered in the Commonwealth of Massachusetts, having experience with having experience with two (2) projects of similar type and cost to this project which required application of similar survey

procedures and techniques within the last five (5) years.

1.07 DELIVERY, STORAGE, AND HANDLING (NOT USED)

1.08 PROJECT/SITE CONDITIONS (NOT USED)

1.09 DEFINITIONS

- A. Field Engineering – Includes, but is not limited to, field layout and surveying required to be performed by the Contractor to examine the sites prior to installation and for execution of the Work.

1.10 TOLERANCE (NOT USED)

1.11 PROJECT RECORD DOCUMENT

- A. Maintain a complete and accurate log of control and survey work as it progresses.
- B. Maintain during Work one (1) set of each of the following documents electronically, on site, in order to record actual revisions to the Work:
 - 1. Contract Drawings
 - 2. Redline Drawings
 - 3. Contract Specifications
 - 4. Addenda
 - 5. Change Orders and other modifications to the Contract Documents
 - 6. Working Drawings
 - 7. Reviewed Shop Drawings, product data, and samples
 - 8. Redlined Shop Drawings and product data
 - 9. Point to point interconnection diagrams for all field wiring
 - 10. Written interpretations and clarifications
 - 11. Field Orders
 - 12. Field Test Reports, verified as specified
 - 13. Photographs

14. Permits

- C. Maintain Redline Documents concurrent with construction progress and separate from the documents used for construction.
- D. Specifications: Legibly mark and record at each Product section a description of the actual Products installed including the following:
 - 1. Manufacturer's name, address and telephone number and Product model and serial number.
 - 2. Product substitutions or alternates utilized.
 - 3. Modifications.
 - 4. Cross references to equipment tag numbers.
- E. Redline Drawings and Redline Shop Drawings: Upon commencement of Work, the Authority will provide the Contract Drawings in electronic format. The Contractor and the Subcontractors shall electronically, and legibly, mark these Contract Drawings, and all Shop Drawings, to record actual construction, including the following items. Physically verify as-built dimensions and locations through field measurement during and following construction. Annotate the Redline Drawings with each location at which as-built data was recorded, the date of observation, and initials of observer. Highlight changes made since the previous submittal by boldly encircling the change and by describing the change in the revision block at the bottom of the drawing:
 - 1. Measured depths of foundations in relation to finished floor datum.
 - 2. Measured horizontal and vertical locations of underground utilities and appurtenances referenced to permanent surface improvements.
 - 3. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work.
 - 4. Field changes of dimension and detail.
 - 5. Details not on original Contract Drawings.
 - 6. Field changes to Manufacturer's Shop Drawings.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Verify locations of survey control points prior to starting work.
- B. Verify horizontal and vertical position of reference points by field traverse to two (2) other reference points prior to each use of reference point.
- C. Notify the Authority of any discrepancies immediately upon discovery.

3.02 SURVEY REFERENCE POINTS**A. Primary Survey Reference Points:**

- 1. Establish basic survey control and reference points.
- 2. The horizontal control datum for survey for the site is indicated on the Contract Drawings.
- 3. Protect survey control points prior to starting site work; preserve permanent reference points during construction.
- 4. Report to the Authority immediately upon discovering the loss or destruction of any reference point or relocation required because of changes in grades or other reasons.
- 5. Replace dislocated survey control points based on original survey control at no additional cost to the Authority.
- 6. Notify the Authority immediately if any field conditions are observed to be different from those indicated on the Contract Drawings, including any required utility relocations not indicated.
- 7. Do not disturb, or excavate within 5 feet of, any survey monument within the limits of the Work under the Contract. Cease work at such places until the monument has been referenced or reset or otherwise disposed of. If the authorities having jurisdiction order or permit the removal of any such survey monument, the Contractor shall take it up and preserve it and, if required, remove it to a location designated by the Authority.

B. Secondary Survey Reference Points:

- 1. From the Authority's primary survey control and from the alignments and grades required for the completed Work, establish accurately all line and grade marks necessary for the execution of the construction and installation throughout the

Work in accordance with the Contract Documents. Particular care shall be exercised in transferring lines and elevations from the ground surface to the grades for shafts, chambers, tunnels, and other underground facilities. The Contractor's Massachusetts-Licensed Registered Professional Engineer, or the Contractor's Massachusetts-Licensed Registered Professional Land Surveyor, shall perform this work and be responsible for the accuracy of all line and grade marks and of the alignments and grades of the completed work. Any imperfect or erroneous construction resulting from incorrect lines and grades or alignment and installation shall be replaced by the Contractor with construction satisfactory to the Authority, at no additional cost to the Authority. When so directed, copies of the Contractor's survey records, notes, and sketches shall be delivered to the Authority.

3.03 SURVEY REQUIREMENTS

- A. Provide field engineering services. Utilize recognized engineering survey practices.
- B. Establish three (3) permanent bench marks on site, referenced to the Authority's established control points. Record locations, with horizontal and vertical data, on the Redline Drawings.
- C. Establish elevations, lines and levels. Locate and lay out by instrumentation:
 - 1. Site improvements including pavements; stakes for grading, fill and topsoil placement; utility locations, slopes, and invert elevations.
 - 2. Grid or axis for structures.
 - 3. Building foundations, column locations, ground floor elevations, and equipment centerlines and elevations.
 - 4. Verify layouts every three (3) months.
- D. Verify dimensions and locations of existing structures in the field before the fabrication or installation of any material or equipment.
- E. Take all measurements and perform all computations necessary to determine the quantities to be used as a basis for payment under the unit price and lump sum items.
- F. After all Work under the Contract is completed, furnish the Authority with all Redline Drawings indicating all the pertinent elevations, orientations, alignments, and geometry of the structures constructed.
- G. The Authority will have the right, at any time, to determine the accuracy and completeness of the lines and grades, elevations, and orientations established and the alignments and installations made, to determine the accuracy and completeness of the measurements taken and the computations performed in determining the quantities

to be paid for under the various unit price and lump sum items, and to take all other measurements necessary for the inspection, record, and payment. Provide 14 days advance notice to the Authority of the times and places at which it intends to do work, to enable the Authority to check the Contractor's line and grade marks, and to check and take necessary measurements. Provide such materials and give such assistance to the Authority as may be required for such checking, for inspection, and for taking measurements for record and payment, and shall carefully preserve the benchmarks and control points established by the Authority.

- H. The Authority may draw the Contractor's attention to errors or omissions in lines or grades and in measurements and computations for payment, but no failure on the part of the Authority to point out such errors or omissions shall give the Contractor any right to claim against the Authority or shall in any way relieve the Contractor of its obligations according to the terms of the Contract.

3.04 GLOBAL POSITIONING (GPS) STANDARDS

- A. GPS coordinates shall be tied into the Massachusetts State Plane Coordinate System, US Feet.
- B. GPS measurements shall have 0.39 inch (1.0 centimeter) accuracy, with 95 percent confidence interval less than or equal to 0.39 inch (1.0 centimeter) in accordance with FGDC-STD-007: Geospatial Positioning Accuracy Standards.

3.05 REDLINE DRAWINGS

- A. Maintain Redline Drawings showing as-built locations and dimensions of work.
- B. The as-built information on the Redline Drawings shall include the following:
 - 1. For water lines: horizontal and vertical locations at every joint, at all changes in grade or direction, and at all fittings, valves, service connections and hydrants. Prior to backfilling, obtain GPS coordinates tied into the Massachusetts State Plane Coordinate System at all joints, couplings, flange adapters, valves, and fittings.
 - a. Provide pipeline joint deflections and offset distances at all joints.
 - 2. For structures (including manholes, chambers and vaults), show the outside dimensions of the base structure. Show the locations of all valves and piping. Also provide the coordinates of the bottom center of the structure itself and coordinates of the cover. For vaults and square/rectangular structures, provide as-built coordinates of all top corners of the structure. Obtain and indicate the GPS coordinates tied into the Massachusetts State Plane Coordinate System at all structures.

3. Include the location of any existing utility that differs from the location indicated on the Contract Drawings.
4. Include the location of any utility not indicated but encountered during the Work.
5. Include all materials left in place from earth support operations including:
 - a. The elevation of the top and bottom of any earth support system left in place.
6. Show the locations of all trees removed. Identify species and caliper.
7. Show the locations of all trees installed. Identify species and caliper.
8. For surface restoration: provide as-built topographic survey of the final condition of all work zones, including all surface features, limits of all surface materials (e.g., bituminous concrete, grass, concrete), and 1-foot contours.
9. All as-built information shall be surveyed by the Contractor's Massachusetts-Licensed Registered Professional Engineer, or by the Contractor's Massachusetts-Licensed Registered Professional Land Surveyor, shall be based on the ground survey, and shall be completed in accordance with the standards established in 250 CMR 6.02.
10. All horizontal measurements, irrespective of survey method, shall be to a minimum accuracy of 0.39 inch (1.0 centimeter), with 95 percent confidence interval less than or equal to 0.39 inch (1.0 centimeter).
11. Vertical measurements shall be to the nearest hundredth of a foot.

**** END OF SECTION ****