

SECTION 02704

PIPELINE PRESSURE AND LEAKAGE TESTING

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes the following:
 - 1. Perform field hydrostatic pressure and leakage testing of water distribution pipes.
- B. Related section includes the following:
 - 1. Section 02630 – DUCTILE IRON PIPE AND FITTINGS

1.2 DEFINITIONS

- A. Leakage - Leakage is defined as total amount of water introduced into pipe during leakage test to maintain test pressure.

1.3 SYSTEM DESCRIPTION

- A. The working pressure of the pipeline ranges between 20 psi and 70 psi.

1.4 SUBMITTALS

- A. Shop Drawings: Submit the following in accordance with Section 01300 - SUBMITTALS:
 - 1. Testing schedule and test procedure.
 - a. Indicate proposed time and sequence of testing on schedule.
 - b. Indicated test procedure requirements as follows:
 - (1) Limits of each pipe tested.
 - (2) Position of all valves during testing.
 - (3) Location of temporary bulkheads.
 - (4) Meter calibration data.
 - (5) Pressure gauge calibration data.
 - (6) A report containing calculations and documentation pertaining to the pressure and leakage testing shall be submitted to the Cambridge Department of

Public Works and the Engineer.

1.5 SEQUENCING AND SCHEDULING

- A. Complete pressure and leakage testing of pipes prior to final cleaning and disinfection; Engineer shall be present during all testing.
 - 1. Notify the City of Cambridge Water Department and the Engineer of time and place of testing at least 3 days prior to commencement of work.

PART 2 – PRODUCTS

2.1 GENERAL

- A Provide test equipment as follows: Piping connections between pipe tested and water source; Equipment, materials, and facilities required to perform specified tests including but not limited to the following:
 - 1. Pumping equipment
 - 2. Calibrated water meter
 - 3. Calibrated pressure gauges
- B. Sectionalizing devices required including but not limited to the following:
 - 1. Flanges
 - 2. Valves
 - 3. Bulkheads
 - 4. Bracing
 - 5. Blocking

PART 3 – EXECUTION

3.1 PREPARATION

- A. Provide blocks, anchors, and supports for pipe before test pressure is applied.

3.2 INSTALLATION

A. Water:

1. Schedule filling of line through the City of Cambridge Water Department and the Engineer at least three (3) days in advance of testing. Do not allow water to enter other parts of the pipeline, not subject to testing, unless approved by the Engineer and the City of Cambridge Water Department. Dispose of test water in a manner approved by the Engineer.

B. Venting:

1. Ensure that air release valves and other venting devices are properly installed and placed in open position when filling pipe with water. Do not close hand-operated vent valves until water flows in an uninterrupted stream from each valve.

3.4 APPLICATION

A. Pressure Testing:

1. All pipe and appurtenances installed shall be hydrostatically tested in accordance with ANSI/AWWA C600, latest version unless stated otherwise herein.
2. Test pressure, expressed in terms of feet of water, applied at any point in pipe equals arithmetic difference between specified test pressure plane elevation and elevation of horizontal center line of pipe at selected location. Multiply value by 0.433 to obtain pounds per square inch. Ensure pressure gauges are accurately calibrated. Do not attempt pressure testing until all air has been vented from the mains.
3. All ductile iron pipe shall be pressure tested at 150 psi for a continuous period of two hours.

B. Leakage Testing:

1. Conduct leakage testing in conjunction with pressure tests. Ensure that joints in piping are watertight and free from visible leaks during leakage test.
2. Leakage Test Pressure: Maintain specified normal operating line pressure for pressure testing of reach during leakage test. Maintain

hydrostatic pressure within plus or minus 5 psi during entire time of leakage measurements.

3. Leakage Measurement: Do not attempt measurement of leakage until trapped air has been vented and constant test pressure has been established. Measure leakage by means of an approved water meter installed in the pressure piping on discharge of the pump. Ensure that water meter is accurately calibrated.

4. Allowable Leakage: Ensure that pipe reach does not exceed the allowable leakage rate. Calculate allowable leakage with following formula:

$Q = 0.0075 \text{ DLN}$ where

Q = allowable leakage in gallons per hour

D = nominal diameter of pipe in inches

L = length of section tested in thousand feet (304.8 meters)

N = square root of avg test pressure in psi (12.25 kgs/sq. meter)

5. Calculate allowable leakage separately for each diameter and add resulting allowable leakage rates to obtain total allowable leakage for entire reach.

3.5 FIELD QUALITY CONTROL

A. Inspection: Locate defective joints and pipe materials during pressure testing.

B. Locate and repair leaking joints and other defective items of work to reduce pipe leakage to an amount acceptable to Engineer, or where applicable, the City of Cambridge Water Department's requirements. All repairs shall be performed at no additional cost to the City of Cambridge Water Department.

PART 4 – COMPENSATION (Not Used)

END OF SECTION 02704

SECTION 02710

REMOVAL OF PROTRUDING SEWER LATERAL

**2710.1 INTERNAL GRINDING OF PROTRUDING EACH
SEWER LATERAL**

PART 1 – GENERAL

1.1 SUMMARY

- A. The Contractor shall furnish all plant, labor, tools, equipment, materials, and supplies as required for removal of protruding sewer laterals.
- B. The Work of this Section shall include internally grinding of sewer laterals indicated in the Contract Drawings or as required by the Engineer.

1.2 RELATED WORK

- A. SECTION 02767- CURED-IN-PLACE PIPELINING AND SECTIONAL LINING

1.3 SUBMITTALS

- A. Submit the following in accordance with Section 01300 – SUBMITTALS:
 - 1. Description of equipment, sequence, and a schedule for the removal of protruding laterals.
 - 2. Confined Space Entry Certifications for all Contractor's personnel entering pipeline or access structures.

1.4 REPAIR OF DAMAGES

- A. Any damages to service laterals or the host pipe during the removal of protruding sewer laterals shall be repaired or replaced with new materials as required to restore damaged items or surfaces to a condition equal to and matching that existing prior to damage or start of work of this Contract and at no additional cost to the Owner.

1.4 QUALITY ASSURANCE

- A. Comply with Section 01400 - QUALITY CONTROL

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REMOVAL OF PROTRUDING
SEWER LATERAL

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- B. Contractor to submit description of construction method for internally grinding of sewer laterals.
- C. All Contractor's personnel entering pipeline or access structures shall be Confined Space Entry trained per OSHA, Title 29 CFR 1910.46 and shall have a copy of their certification available on site at all times.

PART 2 – PRODUCTS

2.1 EQUIPMENT

- A. Protruding sewer lateral removal equipment shall consist of remote controlled hydraulically driven cutters and reamers and remotely operated robotic routers or grinders capable of cutting back protruding sewer service laterals without damage to host pipe.

PART 3 – EXECUTION

- A. Contractor shall perform all work in accordance with municipal, state and federal requirements. Contractor shall obtain all permits required to perform work prior to the commencement of construction.
- B. Internal grinding of protruding sewer services shall be completed prior to cured-in-place pipelining work.
- C. All work associated with removal of protruding sewer laterals shall be accomplished without excavation from existing ground surface, except in areas specifically designated on the Drawings or as approved by the Owner.
- D. At the locations indicated in the Contract Drawing or as required by the Engineer, the existing protruding service laterals shall be internally grinded to the acceptance of the Owner and/or Engineer.
- E. Edges of protruding pipes that have been grinded shall be consistent across the circular face of the edge and parallel to the surface of the host pipe.
- F. The Contractor shall take care to utilize grinding methods that will not break or fracture protruding pipes or the host pipe. The grinded edge of pipes shall not be jagged or fractured. Methods chosen by the Contractor shall not break or damage the portion of a protruding pipe that is to remain.

PART 4 – COMPENSATION

Item 2710.1 – Internal Grinding of Sewer Lateral

METHOD OF MEASUREMENT:

Measurement for payment for Internal Grinding of Protruding Sewer Lateral shall be on based on each lateral service connections grinded to the acceptance of the Engineer and/or Owner, complete as shown on the Contract Drawings.

BASIS OF PAYMENT:

Payment for Internal Grinding of Protruding Sewer Lateral shall be based on the unit price bid for this item in the proposal. Under each price for the item, the Contractor shall furnish all labor, materials, tools, equipment, and incidentals required to internally grind protruding service laterals indicated on the Contract Drawings or as required by the Engineer. Plugging or blocking of sewer flow, shall be considered incidental to the work and shall not be considered for payment elsewhere.

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SECTION 02712

ILLCIT CONNECTIONS SURVEY

2712.1

ILLCIT CONNECTIONS SURVEY

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PART 1 – GENERAL

1.1 SUMMARY

- A. The Contractor shall furnish all plant, labor, tools, equipment, materials, and supplies as required to conduct field survey for verification and confirmation of removal of illicit connections to each existing and proposed storm drain within limits of construction or as otherwise required in the Contract Drawings or by the Engineer.
- B. The Work of this Section shall include testing of each storm drain by flow, dye, or smoke testing, or other methods as acceptable by the Engineer.

1.2 RELATED WORK

- A. SECTION 02609- REINFORCED CONCRETE PIPE
- B. SECTION 02615- DUCTILE IRON PIPE FOR SANITARY AND STORM DRAIN GRAVITY
- C. SECTION 02622 – POLYVINYL CHLORIDE PIPE
- D. SECTION 02727 – PIPE BURSTING
- E. SECTION 02760 – PIPELINE CLEANING AND INTERNAL INSPECTION
- F. SECTION 02767 – CURED-IN-PLACE PIPELINING AND SECTIONAL LINING

1.3 SUBMITTALS

- A. Submit the following in accordance with Section 01300 – SUBMITTALS:
 - 1. Contractor shall submit work plan to the Owner for approval that includes the following:
 - a. Description of equipment, methods, and sequencing of dry weather sampling of storm drains. Dry weather samples shall be tested for the following parameters: fecal coliform, enterococci, oil & grease and surfactants
 - b. Description of methods and products for flow testing, dye testing, and/or smoke testing.
 - 2. Contractor shall submit results from dry weather sampling and testing to the Owner and Engineer for review.

3. Contractor shall prepare and submit log on dry weather sampling and testing that includes the locations of where dry weather samples are collected, dates of dry weather sampling conducted, date and time samples sent and returned from the lab, and observations during sampling (any visible debris or evidence of odors).
4. Contractor shall prepare and submit log to track and document field survey procedures which may include flow testing, dye testing, and smoke testing, or other approved methods. The log shall include the following:
 - a. Date, time, weather of test
 - b. Method(s) of field survey for each test conducted
 - c. Locations where dye, flow, or smoke testing is introduced for testing and observed.
 - d. If applicable, street number where testing is conducted.
 - e. Comments section to log observations and confirmation of illicit connections
5. Contractor shall submit Confined Space Entry Certifications for all Contractor's personnel entering pipeline or access structures.

1.4 QUALITY ASSURANCE

- A. Comply with Section 01400 - QUALITY CONTROL
- B. All Contractor's personnel entering pipeline or access structures shall be Confined Space Entry trained per OSHA, Title 29 CFR 1910.46 and shall have a copy of their certification available on site at all times.

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION

3.1 GENERAL

- A. The field survey shall include tests and observations to identify the source of any illicit sanitary sewer services and sanitary sewer connections to storm drains or as otherwise required in the Contract Drawings. The field survey shall be concluded at the completion of all pipe and structure installation, cured-in-place pipelining and pipebursting activities, repair, replacement and reconnection of services, and testing of installed systems.
- B. Dry weather sampling of existing or new storm drains shall be conducted after a two day period of no precipitation. Dry weather sampling shall start downstream of the project limits and work its way upstream. In the event that

results obtained from a dry weather sample indicate an illicit connection, the Contractor shall further investigate to determine the source and elimination of the illicit connection.

- C. Contractor shall investigate and determine the purpose and source of all lateral connections. Methods shall include, but are not limited to, internal inspections within adjacent buildings, smoke testing and dye testing. Contractor shall record location, size, material and relative invert elevation of each lateral connection with respect to the pipeline. Contractor shall note presence of floor drains or other outlet pipes in adjacent buildings. Contractor shall obtain written approval from the Owner and property owner(s) prior to any testing and/or building entry.
- D. It is the Contractor's responsibility to remove illicit connections within the project limits. Upon completion of field survey and removal of illicit connections, the Contractor shall provide in writing to the Owner a summary of the results of the sanitary survey and confirmation that illicit connections have been removed from the project limits.

PART 4 – COMPENSATION

Item 2712.1 – Illicit Connections Survey

METHOD OF MEASUREMENT:

Measurement for payment for Illicit Connections by Sanitary Survey shall be per the lump sum bid for this item in the proposal and as shown in the Contract Drawings or as required by the Engineer and shall be payable upon completion of work under this bid item.

BASIS OF PAYMENT:

Payment for Illicit Connections Survey shall be based on the lump sum price bid for this item in the proposal. Under the lump sum price for the item, the Contractor shall furnish all labor, materials, tools, equipment, and incidentals required to identify illicit sanitary sewer and sanitary sewer service connections to storm drains within the project limits; collect dry weather samples; transportation and processing fees for testing of samples; flow, dye, and smoke testing; CCTV inspection of storm drains; coordinating with homeowners and residents and all other all incidental work not specifically included for payment elsewhere.

EXCLUSIONS:

The following items are not included for payment herein but are included for payment elsewhere; relocations of illicit sewer connections to sewer system.

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SECTION 02725

PIPE BURSTING

2725.1	PIPE BURSTING 8-INCH SEWER WITH 10-INCH HDPE	LINEAR FOOT
2725.2	PIPE BURSTING 10-INCH SEWER WITH 10-INCH HDPE	LINEAR FOOT
2725.3	LATERAL CONNECTIONS AFTER PIPE BURSTING	EACH

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Furnishing all plant, labor, equipment and materials as well as performing all operations associated with the rehabilitation of existing gravity pipe using a pipe bursting system inside the existing pipeline where indicated on the Drawings and in accordance with municipal, state and federal requirements, including OSHA, and these Specifications.
 - 2. Performing the work in a sequence that is the least disruptive to vehicular and pedestrian traffic and in a manner that shall protect the public from damage to persons and property within the limits and the duration of the work.
 - 3. Pneumatic, hydraulic, or static pipe-bursting equipment systems are acceptable for installation of HDPE sewer piping. Pipe-bursting equipment shall be provided with either front or rear expanders for the proper connection to the polyethylene pipe. Pneumatic bursters shall be used in conjunction with a constant tension hydraulic twin capstain winch; the size of the winch depends on the diameter of the pipe to be replaced. In no case is the constant tension on the winch to exceed 20 tons.

B. Related Sections include the following:

1. Section 01060 – Permits and Regulatory Requirements
2. Section 02760 – Pipeline Cleaning and Internal Inspection.
3. Section 02761 – Flow Bypass.

1.3 REFERENCE STANDARDS

A. Except as otherwise indicated, the current editions of the following apply to the Work of this Section:

1. ASTM D 575 – Standard Test Method for Test Methods for Rubber Properties in Compression
2. ASTM D 618-99 – Standard Practice for Conditioning Plastics for Testing
3. ASTM D 638-99 – Standard Test Method for Tensile Strength of Plastics
4. ASTM D 790-00 – Standard Test Method for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
5. ASTM D 1238-99 – Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer
6. ASTM D 1505-99 – Standard Test Method for Density of Plastics by the Density Gradient Technique
7. ASTM D 1599 – Test for short Rupture of Plastic Pipe, Tubing, and Fittings
8. ASTM D 1928 – Preparation of Compression Molded Test Polyethylene Samples
9. ASTM D 2122 – Determining Dimensions of Thermoplastic Pipe and Fittings
10. ASTM D 2321 – Underground Installation of Thermoplastic Flexible Sewer Pipe

11. ASTM D 2412 – External Loading Characteristics of Plastic Pipe by Parallel Plate Loading
12. ASTM D 2657 – Practice for Heat-Joining Polyolefin Pipe and Fittings
13. ASTM D 2837-98a – Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials
14. ASTM D 3035 – Specification for Polyethylene (PE) Plastic Pipe (SDR_DR) Based on Controlled Outside Diameter
15. ASTM D 3261 – Specification for Polyethylene Plastic Pipe and Fittings Material
16. ASTM D 3350-99 – Standard Specification for Polyethylene Plastic Pipe and Fittings Material
17. ASTM F 477 – Elastomeric Gaskets (Seals) for Joining Plastic Pipe
18. ASTM F 714 – Specification for Polyethylene (PE) Plastic Pipe Based on Outside Diameter (3” and larger)

1.4 SUBMITTALS

- A. Submit the following in accordance with Section 01300 – SUBMITTAL PROCEDURES:
 1. Shop drawings, catalog data, and manufacturer’s technical data showing complete information on material composition, physical properties, and dimensions of new pipe and fittings. Include manufacturer’s recommendations for handling, storage, time for reconnection of laterals, joint welding and repair of pipe and fittings damaged. The shop drawing shall include dimensions of pipes including inside diameter and wall thicknesses, details of pipe joints and gaskets showing cushion packing ring (if required), and laying length of each pipe.
 2. Details and description of construction methods, materials, equipment, and process description, including on-site insertion procedure, access structures and lateral connection details, and water sources. The detailed construction methods shall be agreed upon between the Contractor and the Owner and Engineer.

3. Material Safety Data Sheets (MSDS's) for all materials used during preparation and installation.
4. Written certification from the pipe-bursting provider that the Contractor or Subcontractor is a trained and licensed installer.
5. Engineering calculations for the design of the HDPE pipe thickness per pipe segment. The design calculations shall be checked and approved by a registered Professional Civil Engineer in the State of Massachusetts. Pipe design calculations shall be supported by field analysis and technical assumptions. The Contractor shall submit calculations to show that stresses on proposed pipe during pipe bursting operation are below the rated pipe yield stress limit. Loads used in calculation will include soil dead load (120 pcf soil density), applicable live load, pressure from high water level, and the maximum pushing and/or pulling force imposed by pipe bursting equipment.
6. Confined Space Entry Certifications for all Contractor's personnel entering pipeline or access structures.
7. Contractor shall submit post installation CCTV inspection reports and videos. Post installation reports and CCTV shall be made after pipe installation and reconnection of all laterals and immediately prior to the commissioning stage.
8. Contractor shall submit a work plan to include the following items:
 - a. Name, business address and telephone number of the pipe bursting Contractor.
 - b. List of names and phone numbers of all supervisory personnel involved with the pipe-bursting installation.
 - c. Description of the method and any intended variances from the specified methods.
 - d. Description of surface activities including access structures, staging and insertion locations.
 - e. Construction method(s) and equipment used to penetrate blockages and/or partially collapsed sections of the existing pipeline.
 - f. Method(s) of repair for each location requiring a point repair.

g. Traffic and pedestrian management plan.

9. Written verification at least 2 days before commencing pipe-bursting that the host pipe is free of obstructions and debris and is in suitable condition for bursting.
10. Contractor shall submit complete documentation of qualifications as specified herein.

1.5 QUALITY ASSURANCE

- A. Provide in accordance with Section 01400 and as specified herein.
- B. The contractor shall be certified by the pipe bursting system manufacturer as a fully trained user of the pipe bursting system. Operation of the pipe bursting system shall be performed by trained personnel. Such training shall be conducted by a qualified representative of the pipe bursting manufacturer.
- C. Polyethylene pipe jointing shall be performed by personnel trained in the use of butt-fusion equipment and the recommended methods for new pipe connections. Personnel directly involved with installing the new pipe shall receive training in the proper methods for handling and installing the polyethylene pipe. Such training shall be conducted by a qualified representative of the fusion equipment manufacturer. Installation of other materials shall be performed by personnel qualified by the specific product manufacturer.
- D. The Contractor shall hold the City and the Engineer harmless in any legal action resulting from patent infringements
- E. Pipebursting Contractor Qualifications
 1. The Contractor installing the pipebursting system shall have completed at least five (5) projects, in the United States, within the past three (3) years and projects that included pipebursting installation lengths of at least 300 continuous linear feet and design of at least 10-inch diameter. Note: A combination of projects satisfying each of the above provisions may be acceptable as long as three (3) projects have been successfully completed for each provision.

2. Supervisory personnel shall have a minimum of five (5) years experience and shall have completed at least three (3) projects of similar size and complexity as this project with the United States within the past five (5) years. Attach résumés of each person named. Résumé information shall include, at a minimum, educational background, the number of years in a supervisory capacity and a list of completed projects within the past five (5) years, including project description, complexity and contract total amounts.
- F. Rejection of any subcontractor and/or manufacturer by the Engineer due to insufficient qualifications shall not be grounds for modifications to the Contract Documents such as change in scope, time of completion or contract amount.
 - G. Designated supervisory personnel shall be directly involved with and used on this project. Substitutions of personnel will not be allowed without written authorization of the Engineer.
 - H. All Contractor's personnel entering pipeline or access structures shall be Confined Space Entry trained per OSHA, Title 29 CFR 1910.46 and shall have a copy of their certification available on site at all times.

1.6 REPAIR OF DAMAGES

- A. Any damages to existing utilities and structures during pipe bursting activities shall be repaired or replaced with new materials as required to restore damaged items or surfaces to a condition equal to and matching that existing prior to damage or start of work of this Contract and at no additional cost to the Owner.

1.7 PRODUCTS, MATERIALS, AND EQUIPMENT

- A. Provide in accordance with Section 01600.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Solid Wall High Density Polyethylene Pipe (HDPE)

1. The HDPE replacement pipe shall be manufactured from a high density, high molecular weight polyethylene resin, which conforms to ASTM D-1248 and meets the requirements for Type III, Class B, Grade P34, Category 5, and has a PPI rating of PE 3408, when compounded. The pipe produced from this resin shall have a minimum cell classification of 345434C or D under ASTM D 3350.
2. The wall thickness of the HDPE pipe shall be as determined by the Contractor for the minimum thickness required to meet the structural requirements listed under Design Criteria below, and shall meet the following:

Depth	Minimum Wall Thickness
0 - 12 Feet	SDR 26
Over 12 Feet	SDR 21

3. All pipe shall be made of virgin material. No re-work, except that obtained from the manufacturer's own production of the same formulation shall be used.
4. The pipe shall be homogenous throughout and shall be free of visible cracks, holes, foreign material, blisters, or other deleterious faults.
5. The interior surface of the HDPE pipe shall not be dark or non-reflective in nature that could inhibit proper television inspection.
6. The finished HDPE pipe shall be continuous over the entire length of an insertion run between the insertion pit and reception pit. The HDPE pipe shall be impervious and free of any leakage from the rehabilitated host pipe to surrounding ground, or from the surrounding ground to the inside of the pipe.
7. The manufacturer of the pipe shall supply the OWNER with certificates of compliance indicating conformance for all material and testing requirements furnished under these Specifications.
8. Each standard pipe unit shall be clearly and permanently marked with the date of manufacture, class, production code, and manufacturer's trademark.
9. The Contractor and manufacturer shall exercise extreme care during transportation, handling, storing, and installation of the HDPE pipe to ensure that the pipe is not gouged or otherwise damaged in any way. The Contractor shall store the pipe with a cover to block ultraviolet light in accordance with the manufacturer's recommendations. If the HDPE pipe becomes gouged or otherwise damaged, before or during installation, it shall be replaced or repaired by the Contractor at no additional cost to the Owner.

10. Sizes of the insertion to be used shall be as indicated or specified to renew the sewer to the required flow capacity.

B. Connections to Service and Existing Manholes

1. Connections to service laterals shall be accomplished by means of a compression-fit service connection.
2. Connections to service laterals shall consist of three piece service connection consisting of the following:
 - a. PVC SDR35 Hub Adaptor that conforms to ASTM D3034.
 - b. Securing Clamp with Stainless Steel Band #301, Stainless Steel Screw #305, and Stainless Steel Housing #301.
 - c. Rubber Sleeve that conforms to ASTM F477
3. Connections of the replacement pipe to existing manholes shall be installed with a tight fitting seal with the new or existing manhole. A flexible rubber coupling shall be placed circumferentially on the replacement pipe and encased with a cementitious, non-shrink grout to prevent inflow at the manhole.

2.2 MATERIAL TESTS

- A. A certificate shall be furnished by the manufacturer for all material furnished under this specification. Pipe and fittings may be rejected that do not meet any requirements of this specification.
- B. Defects, which in the opinion of the Owner affect the integrity of strength of pipe, shall be repaired or replaced by the Contractor at no additional cost to the Owner.

2.2 DESIGN CRITERIA

- A. The Contractor shall submit design calculations for the HDPE pipe proposed. The calculations shall be prepared and stamped by a Licensed Professional Engineer in the Commonwealth of Massachusetts. The HDPE pipe shall be designed to withstand the maximum loads that the Contractor anticipates will be exerted on the pipe from the pipe bursting operations, with appropriate factors of safety. These design calculations shall also include all loadings from hydrostatic, earth, and live loads that may be applied to the HDPE pipe.

For the purpose of designing the HDPE for horizontal and vertical loads, the Contractor shall use the conditions indicated below:

1.	Depth Cover Above Crown of Pipe	The greatest of actual depth for each pipe reach.
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2.	Depth of Groundwater Above Crown (Perm.)	Ground surface
3.	Specific Weight of Soil	120 lb. ft.
4.	Wheel Load ²	16,000 lbs.
5.	Railroad Load ³	N/A
6.	Design Temperature	80°F
7.	Deflection Lag Factor, D _L	1.0 (Initial) 1.5 (50 years)
8.	Modulus of Soil Reaction E'	1,200 psi
9.	Ovality Correction Factor	Higher of initial ovality of deteriorated condition or long term deflection.
10.	Long Term Modulus of Elasticity	50 years under constant stress, when submerged in water, to be used for constrained buckling resistance design for combined external loads from groundwater and earth cover.
11.	Minimum Factor of Safety	2.0; N/A for maximum bending strain (Permanent groundwater condition).

- Notes:
- ¹Design of the pipebursting shall be based on prism load on the liner pipe, using the outside diameter of the liner in the calculations.
 - ²Impact factors to be included when depth of cover is less than three (3) feet per values recommended by AASHTO.
 - ³Impact factors to be included when depth of cover is less than ten (10) feet per criteria established by AREA "Manual of Recommended Practice".

- B. The minimum thickness of the HDPE pipe to be installed shall be as determined for the design conditions imposed. Calculations for the determination of the required pipe stiffness or DR shall be the largest pipe stiffness or smallest DR for each pipe installation reach (shaft to termination point), as determined by calculations provided for the following parameters: (1) Maximum Deflection; (2) Minimum Pipe Stiffness or Maximum DR; (3) Ring Bending Strain; and (4) Constrained Buckling Resistance Using Long-Term Modulus of Elasticity. Design Criteria may change for case-by-case design calculations, if approved by the Owner.
- C. The Contractor shall submit test results with respect to the physical characteristics of the HDPE pipe. These tests shall be at no additional cost to the Owner. These tests shall include the following:
 - 1. Tests for Tensile Strength of HDPE pipe material shall be in accordance with ASTM D638. The minimum tensile strength shall be 3,100 psi.
 - 2. Tests for Determination of Environmental Stress Crack Resistance (ESCR) shall be in accordance with ASTM F1248, with a ESCR test equal to 2,000 hours.

2.3 EQUIPMENT

- B. The pipe-bursting tool shall be designed and manufactured to force its way through existing pipe materials by fragmenting the pipe and compressing the old pipe sections into the surrounding soil as it progresses. The bursting unit shall generate sufficient force and compact the existing pipeline. See manufacturer's specifications for appropriate tool sizing for various pipe diameters, as well as parameters of tool sizing for percentage of upsize allowed.
- C. Pneumatic, hydraulic, or static pipe-bursting tool bursting head shall be pulled through the existing sewer by a winch or jack loaded at the reception manhole when installing new HDPE. The bursting unit shall pull the pipe with it as it moves forward. The bursting head shall incorporate a shield/expander to prevent collapse of the hole ahead of the pipe insertion. The pipe-bursting unit shall be remotely controlled.
 - 1. The bursting action of the tool shall increase the external dimensions sufficiently, causing breakage of the pipe at the same time expanding the surrounding ground. This action shall not only break the pipe but also create the void into which the burster can be winched or towed by extension rod and enable forward progress to be made. At the same time, the pipe directly attached to the sleeve on the rear of the burster shall also move forward.
 - 2. For HDPE pipe installations, the burster shall have its own forward momentum which being assisted by winching. A hydraulic winch shall give the burster friction by which it can be moved forward. To form a complete operating system, the burster shall be matched to a constant tension hydraulic winching system.

PART 3 - EXECUTION

3.1 CONSTRUCTION PROCEDURE

- A. Contractor shall perform all work in accordance with municipal, state and federal requirements.
- B. Contractor shall obtain relevant permits required to perform work prior to the commencement of construction.
- C. Pipe-bursting shall be performed with minimum excavation and demolition of existing structures, and the Contractor shall re-establish connections and minimize the disruptions to neighboring homes, traffic, and private property. Excavation for point repairs or emergencies shall be permitted, but only as approved by the Owner and permitting agencies.
- D. The Contractor shall submit a work plan to address the items specified below, unless approved otherwise by the Owner.

1. Safety - The Contractor shall carry out operations under this Section in strict accordance with all applicable OSHA, State, and local standards. Particular attention is drawn to those safety requirements involving work with entry into a confined space. It shall be the Contractor's responsibility to comply with OSHA standards and regulations pertaining to all aspects of the work.
2. Pre-Installation Television Inspection - It shall be the responsibility of the Contractor to video (TV) inspect the sewer pipe immediately before pipe-bursting, to assure that the existing pipe conditions are acceptable for pipe-bursting, and to locate all active service line connections.
3. Cleaning - The Contractor shall clean the host pipe prior to commencing pipe-bursting operations. The cleaning shall be sufficient to conduct pipe-bursting operations and to televise the host pipe to identify and locate service connections. No additional compensation will be made if the pipe is not sufficiently cleaned. The Contractor shall be responsible for the proper transport and disposal of all debris and material cleaned from the drain.
4. Bypassing Drainage - When required for acceptable completion of the pipe-bursting, the Contractor shall provide for continuous drainage flow around the section(s) of pipe designated for the installation of replacement pipe. The pump bypass lines shall be of adequate capacity and size to handle flow.
5. Sags in Line - If pre-installation video (TV) inspection reveals a sag in the existing drain that is greater than one-half the diameter of the existing pipe, it shall be the Contractor's responsibility to install the replacement pipe to result in an acceptable grade without the sag prior to renewing the sewer pipe by pipe-bursting. The Contractor shall take in necessary measures to eliminate these sags, as approved by the Owner by pipe replacement; digging a sag elimination pit and bringing the bottom of the pipe trench to a uniform grade in line with the existing pipe invert or by other measures that shall be acceptable to the Owner.
6. Point Repairs- Point repairs are repairs to the existing sewer required prior to rehabilitation work. Point repairs shall be located during the internal inspection of the sewer. The Contractor shall repair areas requiring "point repair" after cleaning and pre-construction internal inspection is complete prior to commencement of rehabilitation work. Contractor shall submit to the Owner the proposed method(s) of point repair for each area requiring a point repair for review and approval. The Contractor shall notify the Owner not less than 48 hours in advance of making any particular point repair. Work shall include supplying necessary materials, equipment, excavation, sewage diversion in bypassing, dewatering, and labor.

7. Sewer Service Laterals and Connections- Existing service connections shall be located and disconnected before initiating sewer main replacement operations. All services shall be bypass pumped until such time that they can be reconnected.
8. Existing Manholes – If the pipe bursting tool or machine and the replacement pipe is planned to traverse any existing manholes, without interruption during the pipe bursting operation, pipe entrances and exits to the existing manholes shall be opened out to appropriate dimensions required and modifications made to the invert before the pipe bursting prior to commencing pipe bursting operations.

3.2 PREPARATION

- A. Contractor shall perform all preparation operations in accordance with Section 02760 and Section 02761.
- B. Contractor shall clear the line of obstructions such as solids, dropped joints, protruding lateral connections or collapsed pipe that will hinder the installation. If inspection reveals an obstruction that cannot be removed by conventional cleaning equipment, then the Contractor shall make a “point repair” excavation to uncover and remove or repair the obstruction. Such excavation shall be approved in writing by the Engineer prior to the commencement of the work.
- C. Contractor shall investigate and determine the purpose and source of all lateral connections. Methods shall include, but are not limited to, internal inspections within adjacent buildings, smoke testing and dye testing. Contractor shall record location, size, material and relative invert elevation of each lateral connection with respect to the pipeline. Contractor shall note presence of floor drains or other outlet pipes in adjacent buildings. Contractor shall obtain written approval from the Owner and property owner(s) prior to any testing and/or building entry. Contractor shall verify that lateral connections have been installed according to plumbing codes and have traps to prevent the migration of odors into buildings.
- D. Equipment used to perform pipe-bursting shall be located away from buildings in order to minimize noise impact, which under all circumstances shall be less than 70 dB at the source unless otherwise allowed by the Owner due to circumstances beyond the Contractor. A silent engine compartment with the winch shall be provided to reduce machine noise.
- E. The Contractor shall install all pullets, rollers, bumpers, alignment control devices and other equipment required to protect existing manholes and to protect the new pipe from damage during installation. Lubrication may be used as recommended by the manufacturer. Under no circumstances shall the pipe be stressed beyond its elastic limit.

3.3 INSERTION PITS

- A. Prior to commencing any excavation, Contractor shall submit a detailed Plan of Construction to identify the location and number of all proposed insertion pits to the Owner for review. The pits shall be spaced in conformance with the Pipe-bursting manufacturer's recommended maximum allowable insertion force that can be exerted for the installation of the HDPE pipe.
- B. The Contractor shall locate access shafts or insertion pit(s) as shown on the drawings. The use of additional pits or different locations, as shown, must be approved, in writing, by the Engineer prior to construction. Receiving pit locations are not shown on the drawings. Receiving pits shall be located at manholes or structures only and no excavation shall be allowed unless a new manhole is designated on the Drawings or as otherwise approved in writing by the Engineer. Access for receiving pits shall be through existing manholes or structures. All insertion or receiving pits shall be designed to be constructed with wood or steel sheeting, steel plates or steel trench boxes. Shafts or pits shall be designed in conformance with Section 02210 - EARTH EXCAVATION, BACKFILL, FILL, AND GRADING.
- C. The size of access/receiving shafts shall be as small as possible but sufficient to allow access for the Contractor's work. The Contractor is responsible for dewatering of each shaft. The shaft(s) shall be removed and backfilled as soon as practical upon completion of the liner pipe and the surface restored in accordance with the applicable provisions of these specifications.
- D. The Contractor shall minimize the time that a shaft remains open at a particular site. Considerations shall be provided to complete and coordinate all work including cleaning, pre-installation internal inspection, pipe and manhole rehabilitation, grouting, post-installation internal inspection and acceptance so as to minimize disturbances. The Contractor shall recognize that shafts shall not be removed/closed until the rehabilitation pipe has been internally inspected and accepted by the Engineer and it is intended that each shaft shall be removed/closed and backfilled within 21 calendar days from the installation of the shaft.

3.4 INSTALLATION PROCEDURES

- A. The Contractor shall submit information, in detail, of the procedure and the steps to be followed for the installation of the pipe bursting system selected. All equipment and procedures shall be used in strict compliance with the manufacturer's recommendations. Fusion shall be performed by technicians certified by a manufacturer of pipe fusion equipment. Any proposed changes in the installation procedures shall require submittal of revised procedures and acceptance by the Owner.
- B. The polyethylene pipe (HDPE) shall be assembled and joined at the site using a butt-fusion method to provide a leak proof joint. Threaded or solvent-cement joints and connections are not permitted.

- C. As the pipe bursting tool is advanced through the host pipe. Replacement pipe shall be advanced directly behind the tool to fill the void left by the shattered host pipe. Under no circumstances shall the pipe be stressed beyond its elastic limit.
- D. ~~The butt-fused joint shall be true alignment and shall have uniform rollback beads resulting from the use of proper temperature and pressure. The fused joint shall be watertight and shall have tensile strength equal to or greater than that of the pipe. All joints shall be subject to acceptance by the Owner prior to insertion.~~
- E. All joints shall be subject to acceptance by the Engineer and/or Owner prior to insertion. Defective joints shall be cut out and replaced at no additional cost to the Owner. Any section of pipe with a gash, blister, abrasion, nick, scar, or other deleterious fault greater in depth than ten percent (10%) of the wall thickness, shall be no used and shall be removed from the site. A defective area of the pipe may be cut out and the joint fused in accordance with the procedures noted in this section.
- F. Any section of pipe having other defects such as concentrated ridges, discoloration, excessive spot roughness, pitting, variable wall thickness, or any other defect of manufacturing or handling as determined by the Engineer and/or Owner shall be discarded and not used.
- G. Installed HDPE pipe shall be allowed to relax and cool following the installation in accordance with the manufacturer's recommended time, but not less than a minimum of twenty-four (24) hours prior to any reconnection of service lines, scaling of the annulus, or backfilling of the insertion pit, unless otherwise indicated by the Engineer.
- H. When the replacement pipe passes through an existing manhole or terminates at an existing manhole, the top half of the pipe within the existing manhole shall protrude at least 4 inches into the manhole and shall be neatly cut off and not broken or sheered off. The channel in the manhole shall be a smooth continuation of the pipe(s) and shall be merged with other lines or channels. If any, benches and channel cross sections shall be constructed of mortar and brick to provide a smooth transition between inlet and outlet.
- I. Terminal sections of pipe that are jointed within the insertion pit shall be connected with a mechanical coupling, Electro Fusion Couplings (or approved equal), or a non-shear restraint coupling. All couplings shall be in conformance with the manufacturer's installation procedures.
- J. Where excavations for insertion of the replacement pipe are made between two manholes, the ends of the pipe shall be cut smooth and square to the axis so that both ends of the pipe meet and touch uniformly and continuously. A flexible rubber coupling with shear collar or a full circle repair clamp shall be used. Minimum clamp width shall be 12 inches. Approved bedding shall be placed

under all excavated sections of pipe to provide proper support at manhole connections or other areas of pipe repair.

3.5 TESTING

- A. Testing shall be performed by the Contractor after the replacement pipe has been installed. The replacement pipe shall be tested before it has been sealed in place at the manholes, and before any service reconnections have been made. The purpose of this test is to check the integrity of the joints that have been made and to verify the replacement pipe has not been damaged by inserting it through the host pipe.
1. Low Pressure Air Test Procedure - After a manhole-to-manhole section of the pipe has been replaced, and prior to any service lines being connected to the rehabilitated pipe, the pipe shall be plugged at each manhole with pneumatic plugs.
 2. The design of the plugs shall be such that they will hold against the test pressure without requiring external blocking or bracing. One of the plugs shall have three air hose connections; one to inflate the plug, one to attach a gauge for reading the air pressure in the sealed line, and one to introduce air into the sealed line.
 3. Low pressure air shall then be introduced into the sealed line until the internal air pressure reaches 4.0 psig greater than the average back pressure (the design groundwater pressure) on the pipe. At least two minutes shall elapse to allow the pressure to stabilize.
 4. The time required for the internal pressure to decrease from 3.5 to 2.5 psig greater than the average back pressure (groundwater pressure) on the pipe shall not be less than the time shown for a given pipe diameter in the following table:

NEW PIPE DIAMETER (INCHES)	MINIMUM ELAPSED TIME (MINUTES)
8 and smaller	4
10	5
12	6
15 and larger	7

3.6 SERVICE CONNECTIONS

- A. The installed pipe shall be allowed the manufacturer's recommended amount of time, but not less than four (4) hours, for cooling and relaxing due to tensile stressing prior to any reconnection of service lines.

- B. Service connections shall be reconnected to the pipe using connectors as approved by the pipe manufacturer and the Owner and in conformance with the specified installation procedure.

3.6 ACCEPTANCE

- A. Prior to final acceptance, any defects that may affect the integrity or strength of the pipeline in the opinion of the Engineer shall be repaired by the Contractor at no additional cost to the Owner.
- B. Pipeline shall be true to line and grade, with no visual bulges, sags, protrusions, deflections, offset joints, leaking joints, or other visible infiltration, or other defects that would impair the intended use of the completed pipeline.
- C. Final acceptance of work shall not be granted until all defective areas are repaired in accordance with the Pipe Bursting manufacturer's recommendations and to the Owner's satisfaction.
- D. Any repairs required by the Engineer as a result of the post construction internal inspection shall be performed by the Contractor.
- E. Contractor shall perform a post construction internal inspection in accordance with Section 02760. Final acceptance of the work shall not be granted until post installation inspection has been reviewed and approved by the Engineer.
- F. Contractor shall perform testing as specified. Final acceptance of the work shall not be granted until the appropriately formatted testing results have been reviewed and approved by the Engineer.

3.7 CONTRACT CLOSEOUT

- A. Provide in accordance with Section 01700.

PART 4 – COMPENSATION

Item 2725.1 Pipe Bursting 8-Inch Sewer with 10-Inch HDPE

METHOD OF MEASUREMENT:

Measurement for payment for Pipe Bursting 8-inch Sewer with 10-inch HDPE will be based on the actual linear feet 10-inch diameter HDPE pipe installed, cured, tested, and inspected, complete as shown on the Contract Drawings and as measured by the Engineer along the centerline of the pipe between the centers of manholes.

Pipe installed but not successfully tested and accepted shall be paid for at a maximum of 75 percent of the unit prices bid under this item. The remaining 25 percent shall be paid upon receipt of successful test results by the Engineer and acceptance by the Engineer. All reductions in payment due to unsuccessful testing shall be made prior to normal retainage.

BASIS OF PAYMENT:

Payment for Pipe Bursting 8-inch Sewer with 10-inch HDPE will be based on the unit price bid for this item in the proposal. Under the linear foot price for the item, the Contractor shall furnish all labor, materials, tools, equipment, and incidentals required to furnish and install the pipe bursting rehabilitation system in 8-inch diameter as shown on the Contract Drawings or at the requirements of the Engineer. The work includes, but is not limited to; mobilization and demobilization of the pipe bursting operation and equipment; installation, maintenance, and removal of insertion and receiving pits, including layout, excavation; construction dewatering; support of excavation; backfill and grading; flow handling to facilitate the installation of the pipe bursting; homeowner notifications and coordination; heavy duty or light duty pipeline cleaning as may be required by existing conditions; pre and post-installation inspection by closed circuit television; providing photographic documentation; connections and sealing around manhole and structure penetrations; testing; and all incidental work not specifically included for payment elsewhere.

Item 2725.2 Pipe Bursting 10-Inch Sewer with 10-Inch HDPE

METHOD OF MEASUREMENT:

Measurement for payment for Pipe Bursting 10-inch Sewer with 10-inch HDPE will be based on the actual linear feet of 10-inch diameter HDPE installed, tested, and inspected, complete as shown on the Contract Drawings and as measured by the Engineer along the centerline of the pipe between the centers of manholes.

Pipe installed but not successfully tested and accepted shall be paid for at a maximum of 75 percent of the unit prices bid under this item. The remaining 25 percent shall be paid upon receipt of successful test results by the Engineer and acceptance by the Engineer. All reductions in payment due to unsuccessful testing shall be made prior to normal retainage.

BASIS OF PAYMENT:

Payment for Pipe Bursting 10-inch Sewer with 10-inch HDPE will be based on the unit price bid for this item in the proposal. Under the linear foot price for the item, the Contractor shall furnish all labor, materials, tools, equipment, and incidentals required to furnish and install the pipe bursting rehabilitation system in 10-inch diameter as shown on the Contract Drawings or at the requirements of the Engineer. The work includes, but is not limited to; mobilization and demobilization of the pipe bursting operation and equipment; installation, maintenance, and removal of insertion and receiving pits, including layout, excavation; construction dewatering; support of excavation, backfill and grading; flow handling to facilitate the installation of the pipe bursting; homeowner notifications and coordination; heavy duty or light duty pipeline cleaning as may be required by existing conditions; pre and post-installation inspection by closed circuit television; providing photographic documentation; connections and sealing around manhole and structure penetrations; testing; and all incidental work not specifically included for payment elsewhere.

Item 2725.3 – Lateral Connections after Pipe Bursting

METHOD OF MEASUREMENT:

Measurement for payment for Lateral Connections after Pipe Bursting will be based on each lateral service connections reconnected to the rehabilitated host pipe, complete as shown on the Contract Drawings.

BASIS OF PAYMENT:

Payment for Lateral Connections after Pipe Bursting will be based on the unit price bid for this item in the proposal. Under each price for the item, the Contractor shall furnish all labor, materials, tools, equipment, and incidentals required for the reconnection of existing sewer services to the rehabilitated host pipe as shown on the Contract Drawings or at the requirements of the Engineer. Two or more service laterals from several houses coming at one point to the host pipe, through stacks, wyes, and/or tees, shall be considered as one service connection. However, the Owner may move/relocate such service connections so as not to exceed more than two houses per each new connection. The work includes, but is not limited to; excavating or remote cut method for service reconnection; reconnecting the service lateral with the approved liner and fittings; providing service connections, wyes, chimneys, and adaptors homeowner notifications and coordination; testing; and all incidental work not specifically included for payment elsewhere.

END OF SECTION 02725

SECTION 02750

ROOT INTRUSION REMOVAL

2750.1 ROOT REMOVAL AND TREATMENT LINEAR FOOT

PART 1 - GENERAL

1.1 SUMMARY

- A. The work shall be performed in a sequence that is the least disruptive to vehicular and pedestrian traffic and in a manner that shall protect the public from damage to persons and property.
- B. This section includes furnishing all plant, labor, equipment and materials as well as performing all operations associated with the cutting, removal, and chemical treatment of root intrusion as shown on the Contract Drawings or otherwise as required by the Engineer and in accordance with these Specifications.

1.2 RELATED WORK

- A. Division 1 – General Requirements
- B. SECTION 01570 – Maintenance and Protection of Traffic
- C. SECTION 02100 – Tree Protection and Maintenance

1.3 SUBMITTALS

- A. Submit each item in this article according to the conditions of the Contract and Division 1, SECTION 5.01 – SUBMITTALS:
 - 1. Shop drawings and/or manufacturer's descriptive literature indicating materials, equipment and methods to complete root intrusion removal and testing and sealing operations. Details and description of construction methods, equipment, and process description including all pertinent information fro any chemical agents to be used in the operation.
 - 2. Confined Space Entry Certifications for all Contractor's personnel entering pipeline or access structures.
 - 3. Name, business address and telephone number of the firm performing the root intrusion removal (if different from the Contractor).
 - 4. Description of surface activities including access structures, staging and inversion locations.

5. Contractor to submit written evidence that they have obtained pollution liability coverage for the use of chemical agents for root intrusion removal.
6. Contractor to submit qualifications of a Massachusetts State Certified pesticide applicator.

1.4 QUALITY ASSURANCE

- A. The Contractor performing the root intrusion removal shall have completed at least three (3) projects, in the United States, within the past two (2) years and projects that included root intrusion removal. Note: A combination of projects satisfying each of the above provisions may be acceptable as long as two (2) projects have been successfully completed for each provision.
- B. Supervisory personnel shall have a minimum of five (5) years experience and shall have completed at least two (2) projects of similar size and complexity as this project with the United States within the past five (5) years.
- C. Rejection of any subcontractor and/or manufacturer by the Engineer due to insufficient qualifications shall not be grounds for modifications to the Contract Documents such as change in scope, time of completion or contract amount.
- D. Designated supervisory personnel shall be directly involved with and used on this project. Substitutions of personnel will not be allowed without written authorization of the Engineer.
- E. All Contractor's personnel entering pipeline or access structures shall be Confined Space Entry trained per OSHA, Title 29 CFR 1910.46 and shall have a copy of their certification available on site at all times.

1.4 ACCEPTANCE

- A. The Engineer shall inspect and approve the root intrusion removal work. Any pipes damaged by the Contractor during the root intrusion removal work shall be repaired and/or replaced by the Contractor at no additional cost to the Owner.
- B. Final acceptance of work shall not be granted until all damaged areas have been repaired to the satisfaction of the Owner and Engineer.
- C. Contractor shall perform a post construction internal inspection in accordance with Section 271. Final acceptance of the work shall not be granted until post installation inspection has been reviewed and approved by the Engineer.
- D. Contractor shall perform testing as specified.

PART 2 – MATERIALS

2.1 COMPOSITION OF CHEMICAL ROOT TREATMENT

CAM 400/Alewife Floatables
Conformed Set

ROOT INTRUSION REMOVAL
02750-2

- A. The chemical root control agent shall be registered with the EPA and in compliance with all local, state, and federal requirements. The chemical root control shall be labeled for sewer lines. The chemical root treatment material shall not permanently affect the parts of the trees distant from the treated roots.

- B. The chemical root shall contain an active ingredient for controlling root intrusion and deterring their re-growth. The active ingredient shall meet the following requirements:
 - 1. Shall be a Category "E" compound.
 - 2. Shall not be considered a carcinogen, tetratogen, mutagen, or oncogene, based on laboratory testing.
 - 3. Shall be non-volatile
 - 4. Products containing the active ingredient(s) metam-sodium or copper sulfate are not allowed.

- C. The chemical root shall contain a surfactant system to deliver the active ingredient to the target root issue. The surfactant system shall meet the following requirements:
 - 1. Shall produce a dense, small bubble, clinging foam, which sustains its shape for a minimum of one hour.
 - 2. Shall enhance the penetration of herbicide into root masses.
 - 3. Shall contain an Alkylpolyglucoside (formulations of vegetable oil and carbohydrate from agricultural products).
 - 4. Surfactants designed to foam chemically, upon contact with water, shall not be accepted.

2.1 CHEMICAL SEALING MATERIALS

- A. All chemical sealing materials used in the performance of the work specified shall have the following characteristics:
 - 1. While being injected, the chemical sealant shall be able to react/perform in the presence of groundwater.
 - 2. The cured material shall withstand submergence in water without degradation.
 - 3. The resultant sealant (grout) formation shall prevent the passage of water (infiltration) through the sewer pipe joint.
 - 4. The sealant material, after curing, shall be flexible, as opposed to brittle.
 - 5. In place, the sealant formation shall be able to withstand freeze/thaw and wet/day cycles without adversely affecting the seal.
 - 6. The sealant formation shall not be biodegradable.
 - 7. The cured sealant shall be chemically stable and resistant to the mild concentrations of acids, alkalis, and organics found in normal sewage and stormwater.

8. Packaging of component materials shall be compatible with field storage and handling requirements. Packaging must provide for worker safety and minimize spillage during handling.
 9. Mixing of the component materials shall be compatible with field operations and not require precise measurements of the ingredients by field personnel.
 10. Cleanup must be done without inordinate use of flammable or hazardous chemicals.
 11. Residual sealing materials shall be easily removable from the sewer line to prevent reduction of blockage of the sewage flow.
- B. Drain and Sewer Pipe Joint Sealant: The chemical sealing material shall be Avanti AV-100, or approved equal, and consist of an acrylamide base gel sealing material, with the following properties and characteristics:
1. A minimum of 10 percent acrylamide base material by weight in the total sealant mix. A higher concentration of acrylamide base material may be used to increase strength or offset dilution during injection.
 2. The ability to tolerate some dilution and react in moving water during injection.
 3. A viscosity of approximately 2 centipoise, which can be increased with additives.
 4. A constant viscosity during the reaction period.
 5. A controllable reaction time from 10 seconds to 1 hour.
 6. A reaction (curing) which produces a homogeneous, chemically stable, non-biodegradable, firm, flexible gel.
 7. The ability to increase mix viscosity, density, and gel strength by the use of additives.

PART 3 – EXECUTION

3.1 GENERAL

- A. Roots shall be removed by mechanical or hydraulic means and then treated with approved chemical agents to deter re-growth of the roots in the designated sewers where root intrusion is present. Special precautions should be exercised during the cleaning operations to assure virtually complete removal of visible roots from the sewers.
- B. Upon application of chemical agents, the Contractor shall wait a minimum of 5 weeks for chemical agent to take effect. After a minimum of five weeks, the Contractor shall observe treated section of pipe, remove any necessary roots by mechanical or hydraulic means, and test and seal treated section of pipe. Upon successful testing of pipe, the Contractor shall then proceed with any other required work including cured-in-place pipelining.

3.2 ROOT INTRUSION REMOVAL

- A. Procedures may include devices such as rodding machines, expanding root cutters and

porcupines, hydraulic procedures such as high-pressure jet cleaners, and chemical agents.

- B. Contractor shall perform all work in accordance with municipal, state and federal requirements. Contractor shall obtain all permits required to perform work prior to the commencement of construction.
- C. All work associated with root intrusion removal operations shall be accomplished without excavation from existing ground surface, except in areas specifically designated on the Drawings or as approved by the Owner.
- D. Application of any approved chemical root treatment shall be in accordance with the Manufacturer's printed instructions.
- E. All roots removed from the sewers shall be hauled away and disposed by the Contractor at the Contractors expense.

3.3 PIPE JOINT TESTING

- A. Pipe joint testing shall be performed at segments of pipe where chemical treatment was applied and where cured-in-place pipelining is not required. Pipe joint testing shall be performed to identify those sewer pipe joints that are defective (allowing groundwater to enter the sewer system) and that can be successfully sealed by the internal pipe joint sealing process.
- B. The basic equipment used shall consist of a television camera, joint testing device (such as a packer), and test monitoring equipment. The equipment shall be constructed in such a way as to provide means for introducing a test medium, under pressure, into the VOID area created by the expanded ends of the joint-testing device, and a means for continuously measuring the actual static pressure of the test medium within the VOID area only. VOID pressure data shall be transmitted electronically from the VOID to the monitoring equipment. All test monitoring shall be aboveground and in a location to allow for simultaneous and continuous observation of the television monitor and test monitoring equipment by the Owner.
- C. Joint test pressure shall be equal to one-half (½) psi (3.447 Kpa) per vertical foot (304.8mm) of pipe depth or 3 psi (20.684 Kpa), whichever is greater (not exceeding a test pressure of 10 psi [68.948 Kpa]).

3.4 AIR TEST PROCEDURE

- A. The testing device shall be positioned within the line in such a manner as to straddle the pipe joint to be tested.
- B. The testing device end elements (sleeves) shall be expanded so as to isolate the joint from the remainder of the line and create a VOID area between the testing device and the pipe joint. The ends of the testing device shall be

expanded against the pipe with sufficient inflation pressure to contain the air within the VOID without leakage past the expanded ends.

- C. Air shall then be introduced into the VOID area until a pressure equal to or greater than the required test pressure is observed with the VOID pressure monitoring equipment. If the required test pressure cannot be developed (due to joint leakage), the joint will have failed the test and shall be sealed as specified.
- D. After the VOID pressure is observed to be equal to or greater than the required test pressure, the air flow shall be stopped. If the VOID pressure begins to decay within 15 seconds (due to joint leakage), the joint will have failed the test and shall be sealed as specified.
- E. Prior to starting the pipe joint testing, a control test shall be performed on a section of sound sewer pipe between pipe joints, and a test performed as specified. This procedure shall demonstrate the equipment is functioning properly; the packer is capable of developing a proper seal against the pipe walls; and the packer is capable of isolating a joint. Should it be found that the barrel of the sewer pipe will not meet the joint test requirements, the Contractor shall make the necessary modifications until a successful control test is performed.
- F. Upon completing the testing of each individual joint, the packer shall be deflated with the void pressure meter maintaining the established air test pressure. Should the void pressure meter fail to drop to zero (0), the Contractor shall be instructed to clean his equipment of residual grout material or make the necessary equipment repairs to provide for an accurate void pressure reading. Joints that fail to meet the specified test criteria shall be re-tested and/or re-sealed until the test criteria can be met in order to receive payment.
- G. During the joint testing work, records shall be kept which include:
 - 1. Identification of the manhole section tested;
 - 2. The test pressure used;
 - 3. Location (footage) of each joint tested, and location of any joints not tested and reason for not testing;
 - 4. A statement indicating the test results for each joint tested; and
 - 5. Test pressure achieved and maintained for each joint passing the air test.

Copies of these records shall be bound and presented to the Engineer for his/her records.

3.5 INSTALLATION

- A. Joint sealing shall be performed to seal sewer pipe joints which have leakage rates of one-quarter ($\frac{1}{4}$) gallon per minute (.94635 Liter per minute) or more, utilizing the internal joint sealing method. Joint sealing shall be applied to segments of pipe that received chemical root treatment but cured-in-place pipelining is not required. This method shall only be used on sewer pipe sections in sound physical condition.
- B. The basic equipment shall consist of a closed-circuit television system, necessary chemical sealant container, pumps, regulators, valves, hoses, etc., and joint sealing packers for the various sizes of sewer pipes. The packer shall be cylindrical and have a diameter less than the pipe size, and have cables attached at each end to pull it through the line.
- C. Joints showing visible leakage or joints that have failed the joint test specified shall be sealed as specified. Joint sealing shall be accomplished by forcing chemical sealing materials into or through faulty joints by a system of pumps, hoses, and sealing packers. Jetting or driving pipes from the surface that could damage or cause undermining of the pipelines shall not be performed. Uncovering the pipe by excavation of pavement and soil (which would disrupt traffic, undermine adjacent utilities and structures, and cause further damage to the pipelines being repaired) shall not be permitted. The packer shall be positioned over the faulty joint by means of a measuring device and the closed-circuit television camera in the line. The packer ends (end element, sleeves) shall be expanded using controlled pressure. The expanded ends shall seal against the inside periphery of the pipe to form a VOID area at the faulty joint, now completely isolated from the remainder of the pipeline. Into this isolated area, sealant materials shall be pumped through the hose system at controlled pressures, which are in excess of groundwater pressures to the point of refusal. Refusal shall be defined as the point of blow-by on the packer bladders at any point after a minimum of one-quarter ($\frac{1}{4}$) gallon (.94635 Liters) of sealant per inch (25.4mm) diameter has been pumped into the defective joint. The pumping unit, metering equipment, and the packer device shall be designed so that proportions and quantities of materials can be regulated in accordance with the type and size of the leak being sealed.
- D. Upon achieving refusal at each joint, the packer shall be deflated, moved away from the joint to break away the doughnut of gel formed by the packer VOID. The injection port on the packer shall be cleared with a quick burst of pressure test fluid, such that the VOID pressure meter reads zero pressure. The packer shall then be re-positioned on the joint, re-inflated, and the joint re-tested as specified. Should the VOID pressure meter not read zero, the Contractor shall clean his equipment of residual grout material or make the necessary equipment repairs/adjustments to produce accurate VOID pressure readings. Joints that fail to meet the specified test criteria shall be re-sealed and re-tested until the test criteria can be met in order to receive payment.

- E. Residual sealing materials that extend into the pipe, reduce the pipe diameter, or restrict the flow shall be removed from the joint. The sealed joints shall be left reasonably "flush" with the existing pipe surface. If excessive residual sealing materials accumulate in the line (and/or if directed by the Owner), the manhole section shall be cleaned to remove the residual materials.
- F. No joint shall be considered sealed unless, while under continual pressure, a minimum of one-quarter ($\frac{1}{4}$) gallon (.94635 Liter) per inch (25.4mm) of pipe diameter has been applied (i.e., two gallons (7.5708 Liters) for 8-inch (203.3mm) pipe). This is to insure that sufficient chemical has been dispersed into the soil surrounding the joint and that a temporary seal has not been made by applying a minimum amount of chemical to the void and joint area inside the pipe. Sealant shall be pumped "to resist"; sealant volume shall not exceed one-half ($\frac{1}{2}$)gallon (1.8927 Liters) per inch (25.4mm) diameter without authorization from the Owner.
- G. Gel times shall not be less than 20 seconds, unless approved by the Owner. No testing or chemical grouting of pipe joints shall be allowed in the absence of the Owner.
- H. Included in the records for joint sealing shall be the test pressure before and after sealing. The amount of grout material used to seal the joint shall also be recorded.
- I. Upon completion of the testing and sealing, the Contractor shall provide color photos to the Owner to document and confirm roots have been removed and voids have been sealed.

PART 4 – COMPENSATION

Item 2750.1 --- Root Removal and Treatment

METHOD OF MEASUREMENT:

Measurement for Root Removal and Treatment shall be based on the linear foot of sewer pipe segment treated for roots with a chemical control product and tested and sealed as shown on the Contract Drawings or as otherwise approved by the Engineer.

BASIS OF PAYMENT / INCLUSIONS:

Payment for Root Removal and Treatment shall be based on the linear foot of pipe treated for removal of roots by mechanical or hydraulic means, application of chemical root treatment, and testing and sealing. Under the per linear foot price for this item, the Contractor shall furnish all labor, materials, tools, equipment, and incidentals associated with removing roots, applying chemical root treatment, and testing and sealing of segment of sewer pipe indicated on the Contract Drawings or as required by the Engineer. Work includes mobilizing and demobilizing equipment for removal of roots by mechanical or hydraulic means, for application of chemical root treatment, and for testing

and sealing; application of plugging or blocking of sewer flow; bypassing for CCTV inspections; CCTV inspections; digital video recordings and inspection report; application of chemical root treatment; testing and sealing of treated segment of pipe; removal and disposal of roots and other debris from application of chemical root treatment and or sealant; and any intended or accidental chemical cleanup required shall be considered incidental to the work and shall not be considered for payment elsewhere.

SPECIAL NOTES/EXCLUSIONS:

Payment for removal of roots by heavy or light cleaning prior to installation of cured-in-place pipelining are not included in this item and shall be paid for elsewhere.

END OF SECTION 02750

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SECTION 02760

PIPELINE CLEANING AND INTERNAL INSPECTION

**2760.1 CLEANING AND CCTV OF 8-INCH LINEAR FOOT
SEWER FROM STATION 4000+00 to 4002+10**

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Furnishing all plant, labor, equipment and materials, as well as performing all operations associated with pipeline cleaning within the pipelines indicated on the Drawings in accordance with these Specifications.
2. Furnishing all plant, labor, equipment and materials, as well as performing all operations associated with pre and post construction closed-circuit television inspection of the pipelines indicated on the Drawings in accordance with these Specifications.
3. Performing the work in a sequence that is the least disruptive to vehicular and pedestrian traffic and in a manner that shall protect the public from damage to persons and property.

B. Related Sections include the following:

1. Section 02761 – FLOW BYPASS

1.3 SUBMITTALS

A. General: Submit each item in this article according to the conditions of the Contract and Division 1, SECTION 01300 – SUBMITTALS:

1. Shop drawings and/or manufacturer's descriptive literature indicating materials, equipment and methods to complete pipeline cleaning operations.
2. Shop drawings and/or manufacturer's descriptive literature indicating materials, equipment and methods to complete internal inspection operations to complete internal inspection operations.

PIPELINE CLEANING
AND INTERNAL INSPECTION

3. A representative sample DVD showing the quality of work obtained by the assembly prior to internal inspection and cleaning.
 4. Two copies of inspection reports for both pre and post construction internal inspections.
 5. Confined Space Entry certifications for all personnel entering pipeline or access structures.
- B. Contractor shall submit complete documentation of qualifications as specified herein.

1.4 QUALITY ASSURANCE

- A. Provide in accordance with Section 01400 – QUALITY CONTROL and as specified herein.
- B. The Contractor cleaning and internally inspecting the pipeline shall have completed at least three projects of similar size and complexity as this project in the United States within the past three years. Contractor may employ the services of a subcontractor that specializes in this work to fulfill this requirement.
- C. Rejection of any subcontractor and/or manufacturer by the Engineer due to insufficient qualifications shall not be grounds for modifications to the Contract Documents such as change in scope, time of completion or contract amount.
- D. All Contractor's personnel entering pipeline or access structures shall be Confined Space Entry trained per OSHA, Title 29 CFR 1910.46 and shall have a copy of their certification available on site at all times.

1.5 PRODUCTS, MATERIALS AND EQUIPMENT

- A. Provide in accordance with Section 01600 – PRODUCTS, MATERIALS, AND EQUIPMENT.

PART 2 - PRODUCTS

2.1 CLEANING

- A. Contractor shall use mechanical, hydraulically-propelled, and/or high-velocity cleaning equipment, which does not exert internal pressures great

PIPELINE CLEANING AND INTERNAL INSPECTION

enough to damage the pipelines and associated structures. Selection of the cleaning equipment shall be based on the condition of the pipeline at the time work is scheduled to commence.

B. Equipment shall include the following systems:

1. High pressure water of sufficient capacity and volume to remove debris from the pipe and structure walls as approved by the Engineer.
2. Motorized equipment complete with belt booster clutch, overload clutch or other means or devices that shall prevent damage to the pipeline and associated structures. Direct drive shall not be permitted.
3. Standard mechanical equipment including a combination of rodding machines, boring machines, bucket machines, hydraulic balls, B-liners, cones, ferrets or similar equipment. Direct drive shall not be permitted.
4. High pressure, hydraulically-propelled equipment and chemical compounds as approved by the Engineer.
5. Mechanical cutting devices suitable for the removal of roots, gaskets, protruding services, etc.
6. Footage metering devices for location of all equipment, devices and points of reference on measuring target that is known at all times at the ground level.

2.2 CLOSED CIRCUIT TELEVISION INSPECTION

A. Camera and vehicle assembly:

1. Industry standard for internally inspecting pipelines within the range of diameters applicable to this project.
2. Remote-controlled, robotic assembly capable of view 360° of pipeline interiors. At areas of interest, camera shall be capable of rotating its lens to obtain a more direct viewing angle.
3. Capable of operation in 100 percent humidity conditions.

4. Capable of being moved through the pipeline in either direction at a slow rate by means of manual cable winches or motorized mechanical equipment of indirect drive type.
 5. Capable of slowing down and stopping at areas of interest.
 6. Provide high intensity light feature for recording purposes.
 7. Capable of measuring the camera's position within the pipeline accurate 0.10 feet.
- B. During the internal inspection of pipelines, the Owner and the Engineer shall have the ability to view the pipe interior as it is being inspected on a TV monitor set up in a command center.
- C. DVD:
1. DVD recordings shall, by electronic means, display continuously and simultaneously generated transparent digital information to include the date, time, pipeline section number, corresponding station numbers and direction of camera relative to flow.

Example: Time: 4:14:08 PM
 Date: 5/7/02

 ELM ST.
 MH #2 to MH #3 (Downstream)
 STATION 2+50.7
 2. Inspections shall be documented on DVD formatted discs. The DVD shall be in color and capable of being played on a DVD player.

PART 3 – EXECUTION

3.1 GENERAL

- A. Contractor shall perform all work in accordance with municipal, state and federal requirements including OSHA.
- B. Contractor shall obtain all permits required to perform work prior to the commencement of construction at no additional cost to the Owner.

- C. Contractor shall locate and uncover all manholes and/or access structures required to complete the work in accordance with this Section.
- D. Contractor shall maintain existing flows around the work during cleaning operations in accordance with Section 02761 – FLOW BYPASS.

3.2 PIPELINE CLEANING

- A. Contractor shall clean the pipeline to facilitate inspection and construction.
- B. Contractor shall protect the pipeline from damage that could be inflicted by use of cleaning equipment. Any damage inflicted, regardless of technique, shall be repaired by the Contractor to the requirements of the Owner, at no additional cost to the Owner.
- C. All sludge, dirt, sand, rocks, grease, and other solid or semi-solid materials that may cause an obstruction or impede the inspection and/or construction shall be removed and disposed off site during cleaning operations in watertight containers in conformance with all applicable federal, state and municipal laws and regulations, at no additional cost to the Owner. All materials that will not cause an obstruction or impede the inspection and/or construction shall be flushed downstream.
- D. Contractor shall manage, transport and dispose of waste materials collected and removed from the pipeline during cleaning operations in accordance with Section 02080 – SOIL AND WASTE MANAGEMENT and Section 02095 – TRANSPORTATION AND DISPOSAL OF SOIL AND FILL MATERIAL.
- E. If during cleaning operations an obstruction is encountered, the Contractor shall prosecute cleaning operations and supplement with either high pressure water or needle hammer to remove. Contractor shall limit the amount of water pressure used to prevent any structural damage to the existing pipelines and structures. Should the obstruction prevent the pipeline from being cleaned, the Engineer shall be notified immediately. If, in the opinion of the Engineer, a point repair is required to facilitate cleaning, Contractor shall perform the repair and clean through said repair upon its completion. No additional compensation shall be paid to the Contractor for any portion of the pipe which requires re-cleaning after successful completion of the repair.
- F. Contractor shall limit the use of water from hydrants to operations pertaining only to pipeline cleaning or other operations allowed in these Specifications.

PIPELINE CLEANING AND INTERNAL INSPECTION

If water from fire hydrants is deemed necessary by the Contractor to avoid delay in normal work procedures, the water shall be conserved.

- G. No fire hydrants shall be obstructed at any time, nor shall a hydrant be used for the work described in these Contract Documents, unless a reduced pressure backflow preventor is furnished and installed by the Contractor and prior approvals have been obtained from the Owner and Municipal Fire Department. The Contractor shall be responsible for all related charges for the set-up, including the water usage bill.
- H. Contractor shall re-clean the pipeline, if in the opinion of the Engineer, materials have washed into the pipeline after acceptance of the cleaning and prior to construction at no additional cost to the Owner.

3.3 CLOSED CIRCUIT TELEVISION INSPECTION

- A. Contractor shall stop and focus the camera at locations where one or more of the following points of interest are observed:
 - 1. Inflow/Infiltration sources.
 - 2. Construction defects, discolorations, wrinkles, etc.
 - 3. Structural defects including broken pipe, collapsed pipe, cracks or abnormalities.
 - 4. Abnormal joint conditions such as root intrusion, protruding lateral connections, in-line pipe size changes and/or material changes.
 - 5. Mineral deposits, grease, obstructions, etc.
 - 6. Lateral connections; plugged or open.
 - 7. Offset joints or misalignments:
 - 8. Manholes, access structures, etc.
 - 9. Any other locations where the conditions may affect construction operations.
 - 10. Any other location as required by the Engineer.
- B. If, in the opinion of the Engineer, certain conditions may impede construction, Contractor shall perform a point repair.

PIPELINE CLEANING AND INTERNAL INSPECTION

- C. The Contractor shall provide and maintain access to the system, including inflow control and dewatering within pipelines and associated structures as well as all other work required to perform the internal inspections to the satisfaction of the Engineer.

3.4 INSPECTION REPORTS

- A. At the conclusion of each internal inspection, the Contractor shall provide a summary report highlighting results of the investigations and summarizing conditions and points of interest as specified herein. All documentation shall be cross-referenced by stationing to enable the reviewer to identify a particular location.
- B. The pre construction inspection report shall detail and document areas requiring point repairs. Recommendations for repairs as described by the Contractor shall be submitted to the Engineer.
- C. The post construction inspection report shall detail the condition of constructed items and describe recommendations for repairs of any defects.
 - 1. All areas where the construction is defective due to workmanship, chemical deterioration, or other, shall be identified by the Contractor.
 - 2. If repairs are required, the Contractor shall produce a second post construction inspection report.

3.5 ACCEPTANCE

- A. Acceptance of the pipeline cleaning shall be made upon the successful completion of the television inspection. If, in the opinion of the Engineer, cleaning has not been completed in accordance with these Specifications, the Contractor shall be required to re-clean and re-inspect the pipe until the cleaning is shown to be satisfactory, at no additional cost to the Owner.
- B. Internal inspection operations, both pre and post construction, shall be considered for acceptance upon receipt by the Engineer of the following:
 - 1. Two copies of the internal inspection reports
 - 2. Two copies of the DVD discs showing pipelines and associated structures inspections.

3.6 PROJECT CLOSEOUT

- A. Provide in accordance with SECTION 01701 – PROJECT CLOSEOUT.

PART 4 – COMPENSATION

Item 2760.1 --- Cleaning and CCTV of 8-Inch Sewer From Station 4000+00 to 4002+10

METHOD OF MEASUREMENT:

Measurement for payment for Cleaning and CCTV of 8-Inch Sewer from Station 4000+00 to 4002+10 shall be based on the actual length of sewer cleaned and inspected from centerline of manhole to centerline of manhole. Verification of adequate cleaning shall be made by television inspection.

BASIS OF PAYMENT:

Payment for Cleaning and CCTV of 8-Inch Sewer from Station 4000+00 to 4002+10 will be based on the unit price bid for this item in the proposal. Under the linear foot price for Cleaning and CCTV of 8-Inch Sewer From Station 4000+00 to 4002+10, the Contractor shall furnish all labor, materials, tools, equipment, and incidentals required to clean and CCTV the existing 8-Inch sewer as the location specified. The work includes, but is not limited to; heavy and light cleaning sewer, use of mechanical cleaning equipment, bypass pumping, plugging or blocking of sewer flow, water for cleaning of sewer, television inspection work; digital video recordings; CCTV inspection report; grease removal, and the storage, transportation, and disposal of any material retrieved from sewer cleaning. All digital recordings and CCTV inspection reports shall be given to the Owner upon completion of the project.

SPECIAL NOTES ON EXCEPTIONS:

This item includes cleaning of 8-inch sewer between Station 4000+00 and 4002+10. Cleaning and CCTV for other locations in the Contract Documents shall be paid for elsewhere. Payment for pre and post CCTV inspection for pipebursting and cured-in-place pipelining activities shall be paid for elsewhere.

END OF SECTION 02760

SECTION 02761

FLOW BYPASS

2761.1

FLOW BYPASS

LUMP SUM

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Furnishing all plant, labor, equipment and materials, as well as performing all operations associated with handling bypass flows from the existing system around the work indicated on the Drawings in accordance with these Specifications.
2. Maintaining flow from main pipelines without interruption of service, and maintaining flow in lateral connections with minimal interruption of service.
3. Performing the work in a sequence that is the least disruptive to vehicular and pedestrian traffic and in a manner that shall protect the public from damage to persons and property.

B. Related Sections include the following:

1. Section 01500 - TEMPORARY FACILITIES AND CONTROLS

C. Contractor shall design the bypass flow handling system.

1.2 SUBMITTALS

A. General: Submit each item in This Article according to the Conditions of the Contract and Division 1, SECTION 01300 – SUBMITTALS:

1. Shop drawings and/or manufacturer's descriptive literature indicating materials, equipment and methods to complete bypass flow handling operations.
2. Work plan including the following items:
 - a. Location, configuration and routing of bypass flow handling pipes and hoses.
 - b. Staging area(s) for pumps and other equipment.

- c. Upstream flow collection location and/or bulkheads.
 - d. Downstream discharge location.
 - e. Method of protecting structures that accept discharge flows.
 - f. Traffic management plan.
 - g. Roadway crossing details including hose ramps or trench details.
 - h. Noise pollution abatement plan.
3. List of 24-hour emergency telephone numbers at which the Contractor may be reached.
- B. Contractor shall submit a Certificate of Design (refer to SECTION 01300 – SUBMITTALS) for the bypass flow handling system and shall be responsible for the design of the following system components:
- 1. Gravity Bypass
 - 2. Pumps.
 - 2. Generators and power sources.
 - 3. Suction and discharge piping.
 - 4. Temporary pipe supports and anchoring.
 - 5. Pipe plugging and bulkheads.
 - 6. Noise control equipment.
 - 7. Calculation of average and maximum daily flows.
 - 8. Calculations of static lift, friction losses, flow velocity and flow rate.
 - 9. Systems testing and start-up.
 - 10. Maintenance of system for off-construction hours.
 - 11. Contingency plan and equipment for system failures.

- C. Contractor shall submit complete documentation of qualifications as specified herein.

1.3 QUALITY ASSURANCE

- A. Provide in accordance with Section 01400 – QUALITY ASSURANCE and as specified.
- B. The Contractor designing and installing the bypass flow handling system shall have completed at least five projects of similar size and complexity as this project in the United States within the past three years. Contractor may employ the services of a subcontractor that specializes in this work to fulfill this requirement.
- C. Rejection of any subcontractor and/or manufacturer by the Engineer due to insufficient qualifications shall not be grounds for modifications to the Contract Documents such as change in scope, time of completion or contract amount.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Provide in accordance with Section 01600 – PRODUCTS, MATERIALS, AND EQUIPMENT.

PART 2 - PRODUCTS

2.1 EQUIPMENT

- A. The bypass flow handling equipment shall be of sufficient size and material to convey existing flows from one access structure to the designated discharge downstream of the work without overflow, spillage or discharge to the surrounding environment.
- B. Contractor shall be fully equipped to operate and respond to any repair or replacement of the system (24 hours per day and 7 days per week) while the bypass flow handling system is in use.
- C. The Contractor shall have adequate standby equipment available and ready for immediate operation and use in the event of emergency or breakdown. One standby pump for each size pump utilized.
- D. Contractor shall incorporate noise reduction equipment to minimize impact on the surrounding environment. Such measures shall include insulated enclosures, hospital grade silencers or mufflers, equipment modifications and/or special equipment to limit noise to 80 dBA at seven feet or 60 dBA at the nearest residence or business.

2.2 DESIGN CRITERIA

Contractor shall verify flow conditions in the existing system prior to the commencement of construction. Below is a summary of existing peak flows in the combined sewers. The Contractor is advised that the summary that follows of peak flows in the combined sewers are modeled/predicted peak flows and are best available estimates only. The Contractor is still responsible for the design of a system to handle actual flow rates and adequately dispose of any excess flow. The Owner having provided the information below does not relieve the Contractor of any responsibility with respect to the design, construction, maintenance and performance of the flow handling system. The Contractor shall have no claim for additional compensation by reason of delay or inconvenience in adapting its operations to the need for maintaining existing flows.

A. FLOW HANDLING AT CONTRACT 4 ALEWIFE FLOATABLES SITES

During dry weather flow handling operations, the Contractor shall not adversely affect existing level of sanitary service on sewers tributary to those accepting bypass flows.

Wet weather from events equivalent to or greater than the 3-month storm event surcharge the existing 29"x37" Met Sewer and 66" MWRA relief sewer that receive flows from the CAM 002, CAM 401B, and 18" Massachusetts Avenue sewer catchments. During wet weather flow handling operations, the Contractor shall reinstate the hydraulic capacity of existing sewers such that combined sewer overflow events are allowed to occur to relieve the systems. Existing combined sewer overflow weir elevations shall be maintained during all flow handling operations until completion of proposed floatables control improvements.

1. FOR IMPROVEMENTS AT CAM 002 DIVERSION STRUCTURES (WORK ZONE #1) (SEE SHEETS C-14 AND TMP-5)

Peak flow in 38"Wx42"H combined sewer upstream of CAM 002 regulator

Dry weather flow = 3.3 MGD

Dry weather flow tributary to CAM 002 may be diverted upstream at Massachusetts Avenue and Churchill Avenue from manhole D41CMH2507 on the existing 38"Wx42"H combined sewer to manhole S71SMH7015 on the existing 18" sewer. An existing 15" pipe connects the two structures but is currently bulkheaded. The Contractor may temporarily unblock this connection.

Peak flows discharged by CAM 002A combined sewer overflow

3-month flow = 5.0 MGD

6-month flow = 8.4 MGD

2-year flow = 15.1 MGD

Combined sewer overflows are activated according to the modeling estimates above. Sufficient capacity shall be provided via temporary pipe to convey wet weather flows through or around the worksite to the CAM 002A outfall for a 2-year storm as estimated above.

2. FOR IMPROVEMENTS NEAR CAM 002 REGULATOR STRUCTURE
(WORK ZONE #2) (SEE SHEETS C-14 AND TMP-6)

Peak flow in 38"Wx42"H combined sewer upstream of CAM 002 regulator on
Massachusetts Avenue

Dry weather flow = 3.3 MGD

Dry weather flow may be diverted upstream of the CAM 002 regulator at the proposed diversion manhole on the 38"Wx42"H combined sewer to the proposed drop manhole over the 66" MWRA relief sewer detailed in the contract documents.

Peak flows discharged by CAM 002A combined sewer overflow

3-month flow = 5.0 MGD

6-month flow = 8.4 MGD

2-year flow = 15.1 MGD

Combined sewer overflows are activated according to the modeling estimates above. Sufficient capacity shall be provided via temporary pipe to convey wet weather flows through or around the worksite to the CAM 002A outfall for a 2-year storm as estimated above.

3. FOR IMPROVEMENTS AT CAM 401B (WORKZONE #3) (SEE SHEET C-15
AND TMP-7)

Peak flow in 33"Wx42"H combined sewer upstream of CAM 401B regulator

Dry weather flow = 1.3 MGD

Dry weather flow tributary to CAM 401B may be diverted upstream from combined sewer manhole S71SMH2015 (Massachusetts Avenue and Magoun Street) to S71SMH7005 (Massachusetts Avenue and Gladstone Street).

The outlet from S71SMH2010 (Massachusetts Avenue and Columbus Street) can be bulkheaded. Dry weather flows from Columbus Street can be allowed to reverse toward Magoun Street for interception and conveyance to S71SMH7005 (Massachusetts Avenue and Gladstone Street).

Peak flows discharged by CAM 401B combined sewer overflow

3-month flow = 6.2 MGD

6-month flow = 7.5 MGD

2-year flow = 9.8 MGD

Combined sewer overflows are activated according to the modeling estimates above. Sufficient capacity shall be provided via temporary pipe to convey wet weather flows to the CAM 401B outfall for a 2-year storm as estimated above.

4. FOR IMPROVEMENTS AT COMBINED SEWER MANHOLE S71SMH2015
(MASSACHUSETTS AVENUE AND MAGOUN STREET) (SEE SHEET C-16)

Peak flow tributary to S71SMH2015

Dry weather flow = 1.0 MGD (from Massachusetts Avenue 30"Wx34"H combined sewer)

Dry weather flow = 0.8 MGD (from Magoun Street 27"Wx35"H combined sewer)

Dry weather flow in the Massachusetts Avenue 30"Wx34"H combined sewer may be diverted upstream of S71SMH2015 at combined sewer manhole S71SMH2020 (Massachusetts Avenue and Brookford Street) by pumping to catchbasin D41CBN2511 which discharges to a CAM 002 combined sewer manhole D41CMH2507 (Massachusetts Avenue and Churchill Avenue).

Dry weather flow in the Magoun Street 27"Wx35"H combined sewer may be bulkheaded at combined sewer manhole S71SMH2015 and allowed to reverse direction toward sewer manhole S71SMH2415 (Magoun Street and Whittemore Avenue). An existing masonry bulkhead in sewer manhole S71SMH2415 must be removed prior to utilizing this bypass approach. Dry weather flow can loop back around to Massachusetts Avenue at S71SMH2010 due to relief provided by the Madison Avenue 18" sewer and Columbus Avenue 27"Wx34"H combined sewer.

Peak flows discharged by CAM 401B combined sewer overflow

3-month flow = 6.2 MGD

6-month flow = 7.5 MGD

2-year flow = 9.8 MGD

Combined sewer overflows are activated downstream of S71SMH2015 at CAM 401B according to the modeling estimates above. Sufficient capacity shall be provided via temporary pipe to convey wet weather flows through or around the worksite toward the CAM 401B outfall for a 2-year storm as estimated above.

PART 3 – EXECUTION

3.1 PREPARATIONS

- A. Contractor shall perform all work in accordance with municipal, state and federal requirements.
- B. Contractor shall obtain all permits required to perform work prior to the commencement of construction at no additional cost to the Owner.
- C. Prior to the commencement of construction, Contractor shall perform all possible preparatory work. The Contractor shall, at all times, conduct operations to interfere as little as possible with existing flows.
- D. Prior to start-up of bypass flow handling system, Contractor shall notify, in writing each property owner whose service shall be shutdown albeit temporarily. Contractor shall prepare notifications in accordance with Owner's requirements.
- E. The Contractor shall protect water resources, wetlands and other natural resources.

3.2 GENERAL

- A. Contractor shall design the layout and routing of the bypass flow handling system to minimize disturbance to public and private land and to maintain access for pedestrians and traffic. Traffic shall be maintained throughout the bypass operations according to applicable standards and local requirements.
- B. If excavation is required across roadways, all work shall be performed in accordance with municipal and/or state requirements.
- C. Contractor shall furnish, install, maintain and operate all temporary facilities such as dams, pumping equipment, conduits and all other labor and equipment necessary to intercept the flow before it reaches points where it would interfere with the work.
- D. Contractor may utilize pipelines in an existing parallel system as an alternative to installing a full bypass flow handling system pending approval by the Engineer and the Owner. Contractor shall submit a Certificate of Design prior to utilizing the parallel system and shall restore the parallel system to pre-construction conditions upon completion of construction.
- E. Contractor shall design, furnish and install individual bypass flow handling systems for flowing lateral connections or high occupancy buildings.
- F. The Contractor shall protect existing facilities from damage, during pumping activities.

- G. Plugging or blocking of flows shall incorporate a primary and secondary plugging device. When plugging is no longer required for performance of the work, it is to be removed in a manner that permits flows to slowly return to normal without surge, surcharge or other major disturbance.

3.3 CONTRACT CLOSEOUT

- A. Provide in accordance with Section 01701.

PART 4 – COMPENSATION

Item 2761.1 --- Flow Bypass

METHOD OF MEASUREMENT:

Measurement for payment for Flow Bypass will be based on a percent of the Lump Sum bid calculated by dividing the elapsed time to date by the original Contractual construction time limit as approved by the Engineer.

BASIS OF PAYMENT:

Payment for Flow Bypass will be based on the unit price bid for this item in the proposal. Under the Lump Sum price for Flow Bypass, the Contractor shall furnish all labor, materials, tools, equipment, and incidentals required to furnish, install, move, maintain and remove gravity or pumped flow bypasses complete as required to handle existing flows while completing the required elements of the Work at all locations. The work includes, but is not limited to; design of the bypass systems; pumps; suction hoses; discharge hoses; generators; install and remove temporary bulkheads; gravity bypasses including furnishing and installing pipe of all sizes at all depths; excavation for buried hoses or pipe; furnish and placing backfill around buried hoses and pipe; preparation of subgrade; temporary pavement over buried hoses or pipe; ramps; protection of bypass measures; emergency service during non-work hours; manning pumps or other bypasses as may be required; fittings, couplings and appurtenances; connections to existing and proposed pipes and structures; protection of discharge locations; and all incidental work not specifically included for payment elsewhere required to bypass existing flows in all storm drain, combined sewer or sanitary sewer.

SPECIAL NOTES ON EXCEPTIONS:

Items not included for payment herein include, but are not limited to; permanent bulkheads; and water main bypasses, and bypass pumping for CCTV inspections.

END OF SECTION 02761

SECTION 02767

CURED-IN-PLACE PIPELINING
AND SECTIONAL LINING

2767.1	FULL LENGTH CURED-IN PLACE PIPELINING-8-INCH	LINEAR FOOT
2767.2	FULL LENGTH CURED-IN PLACE PIPELINING-10-INCH	LINEAR FOOT
2767.3	FULL LENGTH CURED-IN PLACE PIPELINING-15-INCH	LINEAR FOOT
2767.4	FULL LENGTH CURED-IN PLACE PIPELINING-18-INCH	LINEAR FOOT
2767.6	FULL LENGTH CURED-IN PLACE PIPELINING-25-INCH x 34-INCH	LINEAR FOOT
2767.7	SECTIONAL CURED-IN-PLACE PIPELINING 8-INCH DIAMETER	LINEAR FOOT
2767.8	SECTIONAL CURED-IN-PLACE PIPELINING 10-INCH DIAMETER	LINEAR FOOT
2767.9	SECTIONAL CURED-IN-PLACE PIPELINING 12-INCH DIAMETER	LINEAR FOOT
2767.10	SECTIONAL CURED-IN-PLACE PIPELINING 24-INCH DIAMETER	LINEAR FOOT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:

1. Furnishing all plant, labor, equipment and materials as well as performing all operations associated with the installation of cured-in-place pipelining (CIPP) and inside the existing pipeline where indicated on the Drawings and in accordance with municipal, state and federal requirements, including OSHA, and these Specifications.
2. This specification includes work associated with fiberglass-reinforced cement liner as indicated in the Contract Drawings on sheet C-16.
3. This specification is also to provide for the reconstruction of a particular section of sewer pipe without excavation. The reconstruction will be accomplished using a non-woven fabric tube of particular length and a thermoset resin with physical and chemical properties appropriate for the application. The tube within a translucent inversion bladder is vacuum impregnated with the resin then placed inside a protective carrying device and winched into the existing sewer. When the carrying device is properly positioned, the end is opened and the resin saturated tube is inverted through the damaged section using air or water pressure by the action of the inversion bladder. Once the tube/resin composite is cured, the inversion bladder and the carrying device are removed.
4. Performing the work in a sequence that is the least disruptive to vehicular and pedestrian traffic and in a manner that shall protect the public from damage to persons and property within the limits and the duration of the work.
5. Handling and disposal of discharge water from CIPP curing operation.

B. Related Sections include the following:

1. Section 01060 –PERMITS AND REGULATORY REQUIREMENTS
2. Section 02710 – REMOVAL OF PROTRUDING SEWER LATERAL
3. Section 02760 – PIPELINE CLEANING AND INTERNAL INSPECTION
4. Section 02761 – FLOW BYPASS

1.3 SUBMITTALS

- A. Submit the following in accordance with Section 01300 – SUBMITTAL PROCEDURES:
1. Shop drawings and/or manufacturer’s descriptive literature indicating materials, equipment and methods to complete CIPP operations.
 - a. Details and description of construction methods, materials, equipment, and process description, including on-site and off-site tube wet out, insertion procedure, curing and cool down procedure, access structures and lateral connection details, method of cutting lateral connections, method for sealing ends of liner and lateral cut-outs, water sources and method of cure-water/steam discharge.
 - b. Material Safety Data Sheets (MSDS’s) for all materials used during preparation and installation.
 - c. Certification stating that the Contractor is fully licensed by the CIPP manufacturer (if different).
 - d. Method(s) and equipment for repairs of any uncured areas, defects, test sample section repairs or other deformities in the completed product.
 - e. Certified copies of all test reports on the properties of the selected resin by the material manufacturer indicating that the supplied materials conform with the design criteria.
 - f. Description of odors anticipated as a result of the curing process and methods to mitigate odors to prevent migration outside of the pipeline.
 - g. Confined Space Entry Certifications for all Contractor’s personnel entering pipeline or access structures.
- B. Contractor shall submit design calculations. The submittal shall provide documentation supporting the basis of the values used in the design calculations. The calculations shall be prepared and stamped by a Professional Engineer registered in the Commonwealth of Massachusetts. For pulled-in systems, the Contractor shall submit design calculations for the maximum allowable pulling force on tube.
- C. Contractor shall submit curing logs within 24 hours of cool-down completion for each inversion indicating temperature readings at sensors in intervals of at least 1/2 hour.

- D. Contractor shall submit final CIPP testing reports as specified herein.
- E. Contractor shall submit a work plan to include the following items:
 - 1. Name, business address and telephone number of the CIPP installer and/or manufacturer (if different from the Contractor).
 - 2. List of names and phone numbers of all supervisory personnel involved with the CIPP installation.
 - 3. Description of the method and any intended variances from the specified methods.
 - 4. Description of surface activities including access structures, staging and inversion locations.
 - 5. Construction method(s) and equipment used to penetrate blockages and/or partially collapsed sections of the existing pipeline.
 - 6. Method(s) of repair for each location requiring a point repair.
 - 7. Description of techniques used to determine purpose and source of all lateral connections using such methods as smoke testing, dye testing, internal inspection and/or building investigation.
 - 8. Detailed action plan and description of techniques and equipment used in the event of odor migration into public and/or private property (indoors as well as outdoors).
 - 9. Traffic and pedestrian management plan.
- F. Contractor shall provide a certification stating that the sources of all lateral connections identified during internal inspection have been investigated within the pipeline as well as in adjacent buildings and structures and that the Contractor has secured these connections to prevent the migration of odors.
- G. Contractor shall submit complete documentation of qualifications as specified herein.
- H. The Contractor shall submit a written description of curing water disposal method.

1.4 QUALITY ASSURANCE

- A. Provide in accordance with Section 01400 and as specified herein.

- B. The Contractor installing the CIPP system shall have completed at least five (5) projects, in the United States, within the past three (3) years and projects that included CIPP installation lengths of at least 300 continuous linear feet, on-site or off-site wet-out or resin impregnation of the liner tube, and design of at least 36-inch diameter CIPP with wall thickness based on a fully deteriorated condition. Note: A combination of projects satisfying each of the above provisions may be acceptable as long as three (3) projects have been successfully completed for each provision.
- C. Supervisory personnel shall have a minimum of five (5) years experience and shall have completed at least three (3) projects of similar size and complexity as this project with the United States within the past three (3) years. Attach résumés of each person named. Résumé information shall include, at a minimum, educational background, the number of years in a supervisory capacity and a list of completed projects within the past three (3) years, including project description, complexity and contract total amounts.
- D. Rejection of any subcontractor and/or manufacturer by the Engineer due to insufficient qualifications shall not be grounds for modifications to the Contract Documents such as change in scope, time of completion or contract amount.
- E. Designated supervisory personnel shall be directly involved with and used on this project. Substitutions of personnel will not be allowed without written authorization of the Engineer.
- F. All Contractor's personnel entering pipeline or access structures shall be Confined Space Entry trained per OSHA, Title 29 CFR 1910.46 and shall have a copy of their certification available on site at all times.

1.5 PRODUCTS, MATERIALS, AND EQUIPMENT

- A. Provide in accordance with Section 01600.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Cured-In-Place Liner and Sectional Liner shall consist of the following:
 - 1. Designed and constructed in accordance with ASTM F1216 for "Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube", and these Specifications.

2. Fabricated to a size that, when installed, shall neatly fit the internal circumference of the existing pipeline. Allowances shall be made for circumferential stretching during installation.
3. Consisting of one or more layers of flexible needled felt, or an equivalent woven, nonwoven or combination material.
4. Capable of carrying resin withstanding installation pressures and curing temperatures. Curing the liner shall form a continuous, hard, impermeable, tight-fitting lining between each installed reach.
5. The finished product in place shall meet the minimum chemical resistance requirements for domestic sanitary sewer applications as listed in table X2.1 of ASTM F1216. Exposure shall be for a minimum of 30 days at 73.4°F (23°C). During this period, CIPP test specimens shall lose no more than 20 percent of their initial flexural strength and flexural modulus when tested in accordance with Section 8 of ASTM F1216.
6. For glass fiber reinforced liner materials, the Contractor shall provide chemical resistance test reports required under ASTM 3681 "Chemical Resistance of 'Fiberglass' (Glass-Fiber, Thermosetting-Resin) Pipe in a Deflected Condition" as indicated herein.

B. Resin

1. General purpose, unsaturated, styrene-based resin and catalyst system, an epoxy resin and hardener, or an epoxy vinyl ester resin and catalyst system, or other approved material compatible with the inversion/installation process that provides cured physical strength properties specified herein.

C. Fiberglass Reinforced Concrete Liner

1. Fiberglass reinforced concrete liner shall be Aluminaliner or approved equal. Refer to Sheet C-16 in the Contract Drawings for additional requirements.

D. Lateral Connection and End Sealing

1. The sealing material shall be an acrylamide based gel with a minimum of ten (10) percent acrylamide base material by weight in the total sealant mix. The chemical sealing material shall have a viscosity of approximately two (2) centipoises, which can be increased with additives, and a controllable reaction time from ten (10) seconds to one (1) hour. The application of the sealant shall be

through a lateral sealing packer. Joint sealing shall be accomplished by forcing chemical sealing materials through the lateral packer into the surrounding soil through the leaking joint, crack or other lateral defect. Final acceptance of the sealed lateral will be accomplished via an air test of the joint or a visual inspection to verify that water is not leaking through the repaired lateral connection.

2.2 DESIGN CRITERIA

A. General

1. The CIPP shall be designed to have sufficient structural strength to support all dead loads, live loads, and groundwater load imposed, including 100 year flood elevation requirements, with the assumption that the existing pipeline is fully deteriorated and cannot share any loading or contribute to structural integrity of the CIPP.
5. The properties of the CIPP, when cured, shall have the following minimum values:

<u>Property</u>	<u>ASTM Test Method</u>	<u>Initial¹ psi</u>	<u>Long Term² psi</u>
Flexural Strength	D790	4,500	NA
Flexural Modulus	D790 & D2990	300,000	150,000

Notes: ¹Initial values are determined by ASTM D790.

²Long term value is defined as fifty (50) years and is determined by ASTM D2990.

B. Design Performance Limits and Design Parameters

1. The CIPP shall be designed such that the lining shall not fail, collapse, buckle, crack or delaminate under load. The maximum long-term fifty (50) years calculated deflection under all loads shall not exceed five (5) percent. For glass fiber reinforced liner pipe, the bending strain fifty (50) years developed shall not exceed the higher of the minimum long-term value in ASTM D3262 for the pipe stiffness supplied or that substantiated by long-term strain tests done in accordance with ASTM D3681 using 1.0 *N* sulfuric acid.

C. The following design parameters shall be used:

1.	Depth Cover Above Crown of Pipe	The greatest of actual depth for each pipe reach.
2.	Depth of Groundwater Above Crown	Ground surface

	(Perm.)	
3.	Specific Weight of Soil	120 lb. ft.
4.	Wheel Load ²	16,000 lbs.
5.	Railroad Load ³	N/A
6.	Design Temperature	80°F
7.	Deflection Lag Factor, D _L	1.0 (Initial) 1.5 (50 years)
8.	Modulus of Soil Reaction E'	1,200 psi
9.	Ovality Correction Factor	Higher of initial ovality of deteriorated condition or long term deflection.
10.	Long Term Modulus of Elasticity	50 years under constant stress, when submerged in water, to be used for constrained buckling resistance design for combined external loads from groundwater and earth cover.
11.	Minimum Factor of Safety	2.0; N/A for maximum bending strain (Permanent groundwater condition).
12.	Deflection Coefficient, K _x	0.103
13.	Shape Factor	6

- Notes:
- ¹Design of the CIPP shall be based on prism load on the liner pipe, using the outside diameter of the liner in the calculations.
 - ²Impact factors to be included when depth of cover is less than three (3) feet per values recommended by AASHTO.
 - ³Impact factors to be included when depth of cover is less than ten (10) feet per criteria established by AREA "Manual of Recommended Practice".

- D. The minimum thickness of the CIPP shall be as determined for the design conditions imposed. Calculations for the determination of the required liner pipe stiffness shall be the largest pipe stiffness for each CIPP installation reach (inversion/installation manhole to termination point), as determined by calculations provided for the following parameters: (1) Maximum Deflection; (2) Minimum Pipe Stiffness; and (3) Constrained Buckling Resistance Using Long Term Modulus of Elasticity.

PART 3 - EXECUTION

3.1 GENERAL

- A. Contractor shall perform all work in accordance with municipal, state and federal requirements.
- B. Contractor shall obtain relevant permits required to perform work prior to the commencement of construction.

- C. The length of the CIPP shall equal the length indicated on the Drawings unless otherwise required by the Engineer. The Contractor shall verify the internal pipe diameter/dimension(s) and lengths in the field prior to liner impregnation.
- D. All work associated with CIPP operations shall be accomplished without excavation from existing ground surface, except in areas specifically designated on the Drawings or as approved by the Owner.
- E. Individual inversions/installations may be performed via one or more existing access structures as determined by the Contractor and as approved by the Owner.
- F. The CIPP shall be performed with minimal excavation or demolition of existing structures. Excavation for point repairs or emergencies shall be permitted, but only as approved by the Owner.
- G. Contractor shall review all existing conditions data prior to the commencement of construction including TV logs attached in the appendices of these Specifications.
- H. Contractor shall commence CIPP operations at the beginning of a period of at least three (3) days of anticipated dry weather and as required by the Engineer.

3.2 PREPARATION

- A. Contractor shall perform all preparation operations in accordance with Section 02760 and Section 02761.
- B. Contractor shall clear the line of obstructions such as solids, dropped joints, protruding lateral connections or collapsed pipe that will hinder the installation. If inspection reveals an obstruction that cannot be removed by conventional cleaning equipment, then the Contractor shall make a "point repair" excavation to uncover and remove or repair the obstruction. Such excavation shall be approved in writing by the Engineer prior to the commencement of the work. Point repairs shall be defined as repairs to the existing pipeline that are required to facilitate renewal work. Point repairs shall be identified during internal inspection. The Contractor shall perform point repairs after cleaning and pre-installation internal inspection has been complete. The Contractor shall notify the Engineer not less than 48 hours in advance of making any such point repairs.
- C. Contractor shall investigate and determine the purpose and source of all lateral connections. Methods shall include, but are not limited to, internal inspections within adjacent buildings, smoke testing and dye testing. Contractor shall record location, size, material and relative invert elevation of

each lateral connection with respect to the pipeline. Contractor shall note presence of floor drains or other outlet pipes in adjacent buildings. Contractor shall obtain written approval from the Owner and property owner(s) prior to any testing and/or building entry. Contractor shall verify that lateral connections have been installed according to plumbing codes and have traps to prevent the migration of odors into buildings.

3.3 INSTALLATION

A. Full Length Cured-in Place Pipe:

1. Contractor shall install a resin impregnated flexible felt tube inverted/installed into the existing pipe utilizing a vertical inversion standpipe and hydrostatic head method, air pressure inversion method, pulled-in and inflate method or other method approved by the Engineer.
2. Curing shall be accomplished by circulating hot water, steam or other approved methods to cure the resin into a hard, impermeable pipeline. When cured, the new material shall extend over the length of the inversion/installation reach in a continuous, tight-fitting, watertight pipe-within-a-pipe.
3. The Contractor shall designate the locations where the reconstruction tube will be vacuum impregnated prior to installation. The Contractor shall allow the Engineer and the Owner to inspect the materials and "wet-out" procedure. A catalyst system compatible with the resin and reconstruction tube shall be used.
4. The wet-out reconstruction tube shall be inserted through an existing access structure or other access point by approved techniques/processes of the Contractor. Tubes that are pulled in place shall be done in a manner that shall not damage the tube. The winch shall be equipped with a dynamometer to record the pulling forces required during installation. Pull forces shall not exceed manufacturer's recommendations that shall be based on a maximum longitudinal stretch of five (5) percent of the total tube length. Inversion heads for tubes that are inverted in place shall not exceed manufacturer's recommendations so as not to overstress the tube material or exceed 5% longitudinal stretch. Progressive rounding of the liner shall be performed, prior to curing, to eliminate all trapped water between the liner and the existing pipeline.
5. After inversion/installation is completed, the Contractor shall supply a suitable heat source and fluid recirculation equipment or other approved methods. The equipment shall be capable of delivering hot water/steam throughout the section by means of a pre-strung hose to uniformly raise the water/steam temperature above the temperature required to effect a cure for

the resin. This temperature shall be determined by the CIPP manufacturer and based on the resin/catalyst system employed.

6. The heat source shall be fitted with suitable monitors to gauge the temperature of the incoming and outgoing water/steam supply. Another such gauge shall be placed between the impregnated reconstruction tube and the pipe invert at the terminating manhole to determine the temperatures during cure. Water/steam temperature in the line during the cure period shall be recommended by the resin manufacturer.
7. Initial cure shall be deemed to be completed when inspection of the exposed portions of cured liner appear to be hard and sound and the remote temperature sensor indicates that the temperature is of a magnitude to realize an exotherm. The cure period shall be of a duration recommended by the resin manufacturer, as modified for the CIPP process, during which time the recalculation of the water/steam and cycling of the heat exchangers to maintain the temperature continues.
8. The Contractor shall cool the hardened pipe to a temperature below 100 degrees F before relieving the static head. Cool-down may be accomplished by the introduction of cool water into the inversion standpipe to replace water being drained from a small hole made in the downstream end. If Contractor elects to drain cure-water via the upstream end, the water shall be pumped to a discharge location approved by the Owner at no additional cost to the Owner. Care shall be taken in the release of the static head so that a vacuum shall not develop that could damage the newly installed pipeline. Contractor shall verify with the Owner that discharging the cure-water directly into the existing system is acceptable. If deemed unacceptable, Contractor shall collect and pump cure-water to a location to be determined by the Contractor and approved by the Owner.
9. After completion of pipe line curing, the Contractor shall dispose of curing water in accordance with all federal, state, and local requirements. Curing water discharged to a municipal or MWRA sewer shall be in accordance with the requirements of 360 CMR 10: MWRA Sewer Use Regulations. The Contractor shall note all time requirements that may be needed for approval by MWRA. The point of discharge to the MWRA sewer system shall be designated by the MWRA Field Operations Department. Alternatively, the Contractor may elect to transport the curing water off site for disposal utilizing a uniform hazardous waste manifest. The transporter shall be appropriately licensed and the disposal facility shall be a licensed wastewater treatment facility. The Contractor shall sample and analyze appropriate samples as required by the disposal facility.
10. Contractor shall mitigate all odors onto public or private property due to renewal operations immediately after notification from the Owner or the

Engineer including, but not limited to, forced-air ventilation and/or chemical cleaning of buildings at no additional cost to the Owner. If odors persist on public or private property to a point that air sampling and/or associated testing is required by the Owner, the Engineer or a regulatory agency, the Contractor shall perform this work at no additional cost to the Owner.

11. Contractor shall repair all uncured areas, defects, test sample section repairs or other deformities in the liner during inversion operations in accordance with the manufacturer's recommendations.
12. The finished CIPP shall be continuous over the entire length of an inversion/installation run and be as free as commercially practicable from visual defects such as foreign inclusions, dry spots, pinholes, wrinkles, delamination, or other deformities.

B. Sectional Cured-in Place Liner:

1. The tube shall be inspected for tears and frayed sections. The tube, in good condition, shall be vacuum impregnated with the thermoset resin. The resin shall be introduced into the tube creating a slub of resin at the beginning of the tube. A set of calibration rollers shall assist the resin slug to move through the tube. All air in the tube shall be removed by vacuum allowing the resin to thoroughly impregnate the tube. All resin shall be contained to ensure no public property or persons are exposed to the liquid resin. A resin impregnated sample (wick) shall be retained by the installer to provide verification of the curing process taking place in the host pipe.
2. The saturated tube along with the inversion bladder shall be inserted into the carrying device. The entire carrying device shall be pulled into the pipe using a cable winch. The pull shall be considered complete when the end of the launching device is aligned with the beginning of the section being reconstructed.
3. The resin and tube shall be completely protected during the pull. No resin shall be lost by contact with manhole walls or the pipe during the pull. The resin shall not be contaminated or diluted by exposure to dirt, debris, or water during the pull. The resin that provides a structural seal shall not contact the pipe until positioned at the point of repair.
4. The installer shall be capable of viewing the beginning of the liner contacting the host pipe verifying the exact placement of the liner. Video documentation, of the placement prior to curing, shall be provided to the Owner. No measuring from a CCTV counter or estimating shall be allowed.

5. The tube shall be inverted out of the carrying device by controlled air or water pressure. The installer shall be capable of viewing the entire liner contacting the host pipe from the beginning to the end of the liner verifying the entire damaged section has been covered by the liner. The tube shall be held tightly in place against the wall of the host pipe by the pressure until the cure is complete.
 6. Where sectional liners overlap, each section of sectional liner line be equal in length with a minimum overlap of 12 inches.
- C. Fiberglass reinforced concrete cement liner shall be installed per manufacturer's written installation procedures.

3.4 SYSTEM REINSTATEMENT

- A. Once a section of liner has been cured completely, the Contractor shall reinstate all access structures located along its alignment. For intermediate access structures, the Contractor shall cut the top portion of the liner to match the opening in the riser section providing a smooth, clean cut and continuous transition. At inversion/installation or termination access structures, the Contractor shall extend the liner a sufficient distance into the structure to allow for a smooth, clean cut to match the configuration of the riser and base sections. Any nominal annular gap between the liner and the host pipe shall be filled with a resin mixture and/or epoxy compatible with the CIPP liner and the terminated ends of the liner shall be beveled to allow for a smooth transition.
- B. Lateral connections shall be reestablished with a cutting device specifically designed for cutting CIPP. The exact location and number of lateral connections shall be determined during the internal inspection(s) and/or in the field. The Contractor shall reconnect all lateral connections to the liner pipe, including those unoccupied, abandoned, or from vacant lots, unless otherwise required by the Engineer. Shape of pipeline cut-out shall match shape of lateral connection.
- C. Lateral connections shall be reinstated by experienced operators so that no blind attempts are made in the liner. Location shall be re-verified carefully with pre-construction videotapes for accuracy, especially where dimples are not defined or clearly ascertained. The cut shall be smooth and circular with no jagged edges. The hole shall be a maximum of 100 percent and a minimum of 95 percent of the lateral pipe inside diameter. It shall be properly aligned and be concentric to the existing connection.
- D. The Contractor shall minimize the time that an inversion/installation access point remains open. Consideration shall be provided to complete and coordinate all work including pipeline cleaning, pre installation internal

inspection, pipeline renewal and post installation internal inspection to minimize disturbance to adjacent property owners.

3.5 TESTING

- A. For each individual length of CIPP installed, the Contractor shall prepare at least one (1) "flat plate" sample in accordance with ASTM F1216, Section 8.1.1 for testing at a laboratory approved by the Engineer. For each separate length of CIPP installed, the Contractor shall also prepare at least one (1) "restrained" sample in accordance with ASTM F1216 Section 8.1.2 for testing at a laboratory approved by the Engineer.
- B. "Flat Plate" samples tested in accordance with ASTM F1216, Section 8.1.1 shall be considered as passing if the arithmetic mean of the samples, as defined in ASTM D790, is greater than or equal to parameters set forth in this Section after the arithmetic mean is reduced to 80% of its original calculated value.
- C. Samples secured as specified shall be tested to verify that the pipe flexural modulus and flexural strength of the CIPP is at least equal to that required by the approved design submittal, and the wall thickness is at least equal to that required in the approved design submittal. Wall thickness shall be verified at each inversion, intermediate manhole(s), and termination access at four equidistant points around the perimeter.
- D. If any sample fails the verification tests specified, the Contractor shall take five (5) additional samples throughout the length of the inversion/installation and retested to ensure the specified criteria has been met. If any sample fails these retests, the entire inversion/installation length shall be rejected.
- E. Any rejected inversion/installation shall be relined or replaced by the Contractor at no additional cost to the Owner. The Contractor shall submit method of repair of the rejected inversion/installation length for review and approval by the Owner prior to constructing any repair work. Any samples taken from within the final completed liner pipe shall be repaired by the Contractor, in accordance with the shop drawings, at no expense to the Owner.
- F. Contractor shall submit curing water test reports as required by any discharge permit requirements.
- G. Contractor shall submit the names, addresses and EPA identification number of the transporter and disposal facility in the event a disposal facility is used. Test results and disposal documentation from this facility shall also be submitted.

3.6 ACCEPTANCE

- A. Prior to final acceptance, any defects that may affect the integrity or strength of the pipeline in the opinion of the Engineer shall be repaired by the Contractor at no additional cost to the Owner.
- B. Pipeline shall be true to line and grade, with no visual bulges, sags, protrusions, wrinkles transverse to the flow, deflections, offset joints, leaking joints, or other visible infiltration, or other defects that would impair the intended use of the completed pipeline.
- C. Final acceptance of work shall not be granted until all defective areas are repaired in accordance with the CIPP manufacturer's recommendations and to the Owner's satisfaction.
- D. Any repairs required by the Engineer as a result of the post construction internal inspection shall be performed by the Contractor.
- E. Contractor shall perform a post construction internal inspection in accordance with Section 02760. Final acceptance of the work shall not be granted until post installation inspection has been reviewed and approved by the Engineer.
- F. Contractor shall perform testing as specified. Final acceptance of the work shall not be granted until the appropriately formatted testing results have been reviewed and approved by the Engineer.

3.7 CONTRACT CLOSEOUT

- A. Provide in accordance with Section 01700.

PART 4 – COMPENSATION

Item 2767.1 Full Length Cured-In-Place Pipelining – 8-Inch

METHOD OF MEASUREMENT:

Measurement for payment for Full Length Cured-in-Place Pipelining -8-inch be based on the actual linear feet of 8-inch pipe cured-in-place pipelining rehabilitation system installed, cured, tested, and inspected, complete as shown on the Contract Drawings and as measured

by the Engineer along the centerline of the pipe between the centers of manholes or the defined limits of the rehabilitation.

Pipe installed but not successfully tested and accepted and service laterals within each pipe reach shall be paid for at a maximum of 75 percent of the unit prices bid under this item. The remaining 25 percent shall be paid upon receipt of successful test results by the Engineer and acceptance by the Engineer. All reductions in payment due to unsuccessful testing shall be made prior to normal retainage.

BASIS OF PAYMENT:

Payment for Full Length Cured-in-Place Pipelining -8-inch will be based on the unit price bid for this item in the proposal. Under the linear foot price for the item, the Contractor shall furnish all labor, materials, tools, equipment, and incidentals required to furnish and install the cured-in-place pipelining rehabilitation system in the 8-inch pipe as shown on the Contract Drawings or at the requirements of the Engineer. The work includes, but is not limited to; mobilization and demobilization of the pipe bursting operation and equipment; installation, maintenance, and removal of insertion and receiving pits, including layout, excavation; construction dewatering; support of excavation, backfill and grading; flow handling to facilitate the installation of the cure-in-place pipelining; homeowner notifications and coordination; heavy duty or light duty pipeline cleaning as may be required by existing conditions; pre and post-installation inspection by closed circuit television; providing photographic documentation; reconnecting and sealing around service connections or other pipe penetrations; connections and sealing around manhole and structure penetrations; testing; and all incidental work not specifically included for payment elsewhere.

Item 2767.2 Full Length Cured-in-Place Pipelining – 10-Inch

METHOD OF MEASUREMENT:

Measurement for payment for Full Length Cured-in-Place Pipelining – 10-Inch will be based on the actual linear feet of 10-inch pipe cured-in-place pipelining rehabilitation system installed, cured, tested, and inspected, complete as shown on the Contract Drawings and as measured by the Engineer along the centerline of the pipe between the centers of manholes or the defined limits of the rehabilitation.

Pipe installed but not successfully tested and accepted and service laterals within each pipe reach shall be paid for at a maximum of 75 percent of the unit prices bid under this item. The remaining 25 percent shall be paid upon receipt of successful test results by the Engineer and acceptance by the Engineer. All reductions in payment due to unsuccessful testing shall be made prior to normal retainage.

BASIS OF PAYMENT:

Payment for Full Length Cured-in-Place Pipelining – 10-Inch will be based on the unit price bid for this item in the proposal. Under the linear foot price for the item, the Contractor shall furnish all labor, materials, tools, equipment, and incidentals required to furnish and install the cured-in-place pipelining rehabilitation system in the 10-inch pipe as shown on the Contract Drawings or at the requirements of the Engineer. The work includes, but is not

limited to; mobilization and demobilization of the pipe bursting operation and equipment; installation, maintenance, and removal of insertion and receiving pits, including layout, excavation; construction dewatering; support of excavation, backfill and grading; flow handling to facilitate the installation of the cure-in-place pipelining; homeowner notifications and coordination; heavy duty or light duty pipeline cleaning as may be required by existing conditions; pre and post-installation inspection by closed circuit television; providing photographic documentation; reconnecting and sealing around service connections or other pipe penetrations; connections and sealing around manhole and structure penetrations; testing; and all incidental work not specifically included for payment elsewhere.

Item 2767.3 Full Length Cured-In-Place Pipelining – 15-Inch

METHOD OF MEASUREMENT:

Measurement for payment for Full Length Cured-in-Place Pipelining -15-inch be based on the actual linear feet of 15-inch pipe cured-in-place pipelining rehabilitation system installed, cured, tested, and inspected, complete as shown on the Contract Drawings and as measured by the Engineer along the centerline of the pipe between the centers of manholes or the defined limits of the rehabilitation.

Pipe installed but not successfully tested and accepted and service laterals within each pipe reach shall be paid for at a maximum of 75 percent of the unit prices bid under this item. The remaining 25 percent shall be paid upon receipt of successful test results by the Engineer and acceptance by the Engineer. All reductions in payment due to unsuccessful testing shall be made prior to normal retainage.

BASIS OF PAYMENT:

Payment for Full Length Cured-in-Place Pipelining -15-inch will be based on the unit price bid for this item in the proposal. Under the linear foot price for the item, the Contractor shall furnish all labor, materials, tools, equipment, and incidentals required to furnish and install the cured-in-place pipelining rehabilitation system in the 15-inch pipe as shown on the Contract Drawings or at the requirements of the Engineer. The work includes, but is not limited to; mobilization and demobilization of the pipe bursting operation and equipment; installation, maintenance, and removal of insertion and receiving pits, including layout, excavation; construction dewatering; support of excavation, backfill and grading; flow handling to facilitate the installation of the cure-in-place pipelining; homeowner notifications and coordination; heavy duty or light duty pipeline cleaning as may be required by existing conditions; pre and post-installation inspection by closed circuit television; providing photographic documentation; reconnecting and sealing around service connections or other pipe penetrations; connections and sealing around manhole and structure penetrations; testing; and all incidental work not specifically included for payment elsewhere.

Item 2767.4 Full Length Cured-In-Place Pipelining – 18-Inch

METHOD OF MEASUREMENT:

Measurement for payment for Full Length Cured-in-Place Pipelining -18-inch be based on the actual linear feet of 18-inch pipe cured-in-place pipelining rehabilitation system installed,

cured, tested, and inspected, complete as shown on the Contract Drawings and as measured by the Engineer along the centerline of the pipe between the centers of manholes or the defined limits of the rehabilitation.

Pipe installed but not successfully tested and accepted and service laterals within each pipe reach shall be paid for at a maximum of 75 percent of the unit prices bid under this item. The remaining 25 percent shall be paid upon receipt of successful test results by the Engineer and acceptance by the Engineer. All reductions in payment due to unsuccessful testing shall be made prior to normal retainage.

BASIS OF PAYMENT:

Payment for Full Length Cured-in-Place Pipelining -18-inch will be based on the unit price bid for this item in the proposal. Under the linear foot price for the item, the Contractor shall furnish all labor, materials, tools, equipment, and incidentals required to furnish and install the cured-in-place pipelining rehabilitation system in the 15-inch pipe as shown on the Contract Drawings or at the requirements of the Engineer. The work includes, but is not limited to; mobilization and demobilization of the pipe bursting operation and equipment; installation, maintenance, and removal of insertion and receiving pits, including layout, excavation; construction dewatering; support of excavation, backfill and grading; flow handling to facilitate the installation of the cure-in-place pipelining; homeowner notifications and coordination; heavy duty or light duty pipeline cleaning as may be required by existing conditions; pre and post-installation inspection by closed circuit television; providing photographic documentation; reconnecting and sealing around service connections or other pipe penetrations; connections and sealing around manhole and structure penetrations; testing; and all incidental work not specifically included for payment elsewhere.

Item 2767.6 Full Length Cured-In-Place Pipelining – 25-Inch X 34-Inch

METHOD OF MEASUREMENT:

Measurement for payment for Full Length Cured-in-Place Pipelining -25-inch X 34-inch be based on the actual linear feet of 25-inch x 34-inch pipe cured-in-place pipelining rehabilitation system installed, cured, tested, and inspected, complete as shown on the Contract Drawings and as measured by the Engineer along the centerline of the pipe between the centers of manholes or the defined limits of the rehabilitation.

Pipe installed but not successfully tested and accepted and service laterals within each pipe reach shall be paid for at a maximum of 75 percent of the unit prices bid under this item. The remaining 25 percent shall be paid upon receipt of successful test results by the Engineer and acceptance by the Engineer. All reductions in payment due to unsuccessful testing shall be made prior to normal retainage.

BASIS OF PAYMENT:

Payment for Full Length Cured-in-Place Pipelining -25-inch X 34-inch will be based on the unit price bid for this item in the proposal. Under the linear foot price for the item, the Contractor shall furnish all labor, materials, tools, equipment, and incidentals required to furnish and install the cured-in-place pipelining rehabilitation system in the 25-inch x 34-

inch pipe as shown on the Contract Drawings or at the requirements of the Engineer. The work includes, but is not limited to; mobilization and demobilization of the pipe bursting operation and equipment; installation, maintenance, and removal of insertion and receiving pits, including layout, excavation; construction dewatering; support of excavation, backfill and grading; flow handling to facilitate the installation of the cure-in-place pipelining; homeowner notifications and coordination; heavy duty or light duty pipeline cleaning as may be required by existing conditions; pre and post-installation inspection by closed circuit television; providing photographic documentation; reconnecting and sealing around service connections or other pipe penetrations; connections and sealing around manhole and structure penetrations; testing; and all incidental work not specifically included for payment elsewhere.

Item 2767.7 Sectional Cured-in-Place Pipelining – 8-Inch diameter

METHOD OF MEASUREMENT:

Measurement for payment for Sectional Cured-in-Place Pipelining-8-inch diameter will be based on the linear feet of 8-inch host pipe rehabilitated with cured-in-place pipelining complete as shown on the Contract Drawings and as measured by the Engineer along the centerline of the pipe between the defined limits of the rehabilitation.

Pipe installed but not successfully tested and accepted and service laterals within each pipe reach shall be paid for at a maximum of 75 percent of the unit prices bid under this item. The remaining 25 percent shall be paid upon receipt of successful test results by the Engineer and acceptance by the Engineer. All reductions in payment due to unsuccessful testing shall be made prior to normal retainage.

BASIS OF PAYMENT:

Payment for Cured-in-Place Pipelining 8-inch diameter will be based on the unit price bid for this item in the proposal. Under the linear foot price for the item, the Contractor shall furnish all labor, materials, tools, equipment, and incidentals required to furnish, install, cure, test, and inspect the cured-in-place pipelining rehabilitation system in the 8-inch diameter pipe as shown on the Contract Drawings or at the requirements of the Engineer. The work includes, but is not limited to; mobilization and demobilization of the pipe bursting operation and equipment; installation, maintenance, and removal of insertion and receiving pits, including layout, excavation; construction dewatering; support of excavation, backfill and grading; flow handling to facilitate the installation of the cure-in-place pipelining; homeowner notifications and coordination; heavy duty or light duty pipeline cleaning as may be required by existing conditions; pre and post-installation inspection by closed circuit television; providing photographic documentation; reconnecting and sealing around service connections or other pipe penetrations; connections and sealing around manhole and structure penetrations; testing; and all incidental work not specifically included for payment elsewhere.

Item 2767.8 Sectional Cured-In-Place Pipelining – 10 inch diameter

METHOD OF MEASUREMENT:

Measurement for payment for Sectional Cured-in-Place Pipelining-10-inch diameter will be based on the linear feet of 10-inch host pipe rehabilitated with cured-in-place pipelining complete as shown on the Contract Drawings and as measured by the Engineer along the centerline of the pipe between the defined limits of the rehabilitation.

Pipe installed but not successfully tested and accepted and service laterals within each pipe reach shall be paid for at a maximum of 75 percent of the unit prices bid under this item. The remaining 25 percent shall be paid upon receipt of successful test results by the Engineer and acceptance by the Engineer. All reductions in payment due to unsuccessful testing shall be made prior to normal retainage.

BASIS OF PAYMENT:

Payment for Sectional Cured-in-Place Pipelining 10-inch diameter will be based on the unit price bid for this item in the proposal. Under the linear foot price for the item, the Contractor shall furnish all labor, materials, tools, equipment, and incidentals required to furnish, install, cure, test, and inspect the cured-in-place pipelining rehabilitation system in the 10-inch diameter pipe as shown on the Contract Drawings or at the requirements of the Engineer. The work includes, but is not limited to; mobilization and demobilization of the pipe bursting operation and equipment; installation, maintenance, and removal of insertion and receiving pits, including layout, excavation; construction dewatering; support of excavation, backfill and grading; flow handling to facilitate the installation of the cure-in-place pipelining; homeowner notifications and coordination; heavy duty or light duty pipeline cleaning as may be required by existing conditions; pre and post-installation inspection by closed circuit television; providing photographic documentation; reconnecting and sealing around service connections or other pipe penetrations; connections and sealing around manhole and structure penetrations; testing; and all incidental work not specifically included for payment elsewhere.

Item 2767.9 Sectional Cured-In-Place Pipelining – 12 inch diameter

METHOD OF MEASUREMENT:

Measurement for payment for Sectional Cured-in-Place Pipelining-12-inch diameter will be based on the linear feet of 12-inch host pipe rehabilitated with cured-in-place pipelining complete as shown on the Contract Drawings and as measured by the Engineer along the centerline of the pipe between the defined limits of the rehabilitation.

Pipe installed but not successfully tested and accepted and service laterals within each pipe reach shall be paid for at a maximum of 75 percent of the unit prices bid under this item. The remaining 25 percent shall be paid upon receipt of successful test results by the Engineer and acceptance by the Engineer. All reductions in payment due to unsuccessful testing shall be made prior to normal retainage.

BASIS OF PAYMENT:

Payment for Sectional Cured-in-Place Pipelining 12-inch diameter will be based on the unit price bid for this item in the proposal. Under the linear foot price for the item, the Contractor shall furnish all labor, materials, tools, equipment, and incidentals required to furnish, install,

cure, test, and inspect the cured-in-place pipelining rehabilitation system in the 12-inch diameter pipe as shown on the Contract Drawings or at the requirements of the Engineer. The work includes, but is not limited to; mobilization and demobilization of the pipe bursting operation and equipment; installation, maintenance, and removal of insertion and receiving pits, including layout, excavation; construction dewatering; support of excavation, backfill and grading; flow handling to facilitate the installation of the cure-in-place pipelining; homeowner notifications and coordination; heavy duty or light duty pipeline cleaning as may be required by existing conditions; pre and post-installation inspection by closed circuit television; providing photographic documentation; reconnecting and sealing around service connections or other pipe penetrations; connections and sealing around manhole and structure penetrations; testing; and all incidental work not specifically included for payment elsewhere.

Item 2767.10 Sectional Cured-In-Place Pipelining – 24 inch diameter

METHOD OF MEASUREMENT:

Measurement for payment for Sectional Cured-in-Place Pipelining-24-inch diameter will be based on the linear feet of 24-inch host pipe rehabilitated with cured-in-place pipelining complete as shown on the Contract Drawings and as measured by the Engineer along the centerline of the pipe between the defined limits of the rehabilitation

Pipe installed but not successfully tested and accepted and service laterals within each pipe reach shall be paid for at a maximum of 75 percent of the unit prices bid under this item. The remaining 25 percent shall be paid upon receipt of successful test results by the Engineer and acceptance by the Engineer. All reductions in payment due to unsuccessful testing shall be made prior to normal retainage.

BASIS OF PAYMENT:

Payment for Sectional Cured-in-Place Pipelining 24-inch diameter will be based on the unit price bid for this item in the proposal. Under the linear foot price for the item, the Contractor shall furnish all labor, materials, tools, equipment, and incidentals required to furnish, install, cure, test, and inspect the cured-in-place pipelining rehabilitation system in the 24-inch diameter pipe as shown on the Contract Drawings or at the requirements of the Engineer. The work includes, but is not limited to; mobilization and demobilization of the pipe bursting operation and equipment; installation, maintenance, and removal of insertion and receiving pits, including layout, excavation; construction dewatering; support of excavation, backfill and grading; flow handling to facilitate the installation of the cure-in-place pipelining; homeowner notifications and coordination; heavy duty or light duty pipeline cleaning as may be required by existing conditions; pre and post-installation inspection by closed circuit television; providing photographic documentation; reconnecting and sealing around service connections or other pipe penetrations; connections and sealing around manhole and structure penetrations; testing; and all incidental work not specifically included for payment elsewhere.

ATTACHMENT
TO SECTION 02767
REQUIREMENTS FOR THE DISCHARGE OF CIPP CURING WATER TO A MUNICIPAL OR
MWRA SEWER

1. Authorization to discharge the CIPP curing water to a municipal or MWRA sewer shall be obtained from the MWRA prior to beginning the discharge operation.
2. No release of curing water shall be allowed prior to sampling the water to ensure compliance with MWRA Sewer Use Regulations, 360 CMR 10.021-10.024. Sampling and analysis shall be completed by a DEP certified testing laboratory, using wastewater methods appearing in 40 CFR 136. Minimum scope of analysis shall include VOA, ABN, TSS, sulfide, and ammonia. MWRA shall specify what parameters are to be sampled depending on the site and specific process conditions.
3. Results of analyses shall be sent to the Project Manager of Permitting at MWRA via facsimile at 617-371-1604.
4. Water from the CIPP curing operation shall be treated to comply with the MWRA Sewer Use Regulations, including the Specific Discharge Limitations/Local Limits contained in 360 CMR 10.023-10.024 at the discharge point, prior to mixing with other wastewater streams. Sampling shall be conducted after treatment prior to discharge to the sewer system. Treated wastewater shall be held on-site until MWRA provides authorization to proceed with the discharge.
5. The water from the CIPP curing operation shall contain no solids or viscous substances in quantities that could cause obstruction to flow in sewers, or cause other interferences with the operation of the sewer system. Substances include, but are not limited to, sand, mud, wood, stone, or marble dust pursuant to 360 CMR 10.023(8).
6. The proposed measured flow, in gallons, of treated wastewater from the CIPP curing operation, prior to mixing with other wastewater streams, shall be submitted to the Project Manager of Permitting at MWRA via facsimile at 617-371-1604.
7. The MWRA shall be notified of significant changes to the discharge flow, or proposed times and duration of discharge or of any accidental spills, releases of chemicals, or contaminated water to the sanitary sewer system.
8. Contractor/Permittee shall cease the discharge as directed by MWRA Operations management as required during wet weather or high flow conditions. MWRA may require that the discharge be stopped immediately if it is determined that the discharge is having an actual or potential adverse impact on the operation of MWRA sewer systems.

END OF SECTION 02767

SECTION 02890

STREET LIGHTING

2890.1 REMOVE AND RESET STREET LIGHT EACH

PART 1 – GENERAL

1.1 SUMMARY

- A. Removal and resetting of existing street lights shall include the dismantling, removal, and reinstallation of existing street lights where directed by the Engineer or Owner.

PART 2 – PRODUCTS

Not Used.

PART 3 – EXECUTION

3.1 GENERAL

- A. Removal of existing street light poles; heads and their accessories shall be done in a manner that will not damage the material.
- B. Poles and bases shall be separated from one another without damage to either unit. The shaft shall be unscrewed from base.
- C. Underground conduit, foundations, and other materials not reused shall be removed and properly disposed of.
- E. Any damages to the light pole and heads that are to remain operational shall be fully restored at no additional cost to the Owner.

PART 4 – COMPENSATION

2890.1 – Remove and Reset Street Light

METHOD OF MEASUREMENT:

Measurement for payment for Remove and Reset Street Light will be based on the number of existing street lights removed and reset complete, as determined by the Engineer.

BASIS OF PAYMENT / INCLUSIONS:

Payment for work under Remove and Reset Street Lights will be based on the unit price bid for this item in the proposal and shall include full compensation for all labor, materials, equipment, and any other incidental costs necessary for the satisfactory completion of this work including but not limited to disconnecting the existing street light from the foundation; the removal of the existing light head from the existing pole as necessary; disconnect power and wiring; remove, transport and stockpile the existing street light pole and head; protect the existing street light pole and head; furnish and install new PVC conduit (up to 4-in and up to 30 l.f.); furnish and install new handhole; furnish and install wiring; removal and disposal of the existing foundation, wiring, conduit and handholes as required; furnish and install new pre-cast concrete light pole base; all connections of wiring to existing power sources and to the relocated pole; transport the pole and light head from the stockpile area back to the site; installation of the pole onto the base including all hardware; reinstallation of the head onto the existing pole including all hardware; furnish and install new bulbs; and all other work not included for payment elsewhere.

END OF SECTION 02890

SECTION 02900

LANDSCAPING

2900.1

RAIN GARDEN

EACH

PART 1 – GENERAL

1.1 SUMMARY

- A. This section includes providing loam, fertilizer, seed, plants, rain garden, and related work as indicated and specified. Refer to section 02910 for tree planting requirements.

1.2 RELATED WORK

- A. Section 01630 – RESTORATION OF GROUNDS AND CLEANING UP
- B. Section 02100 – SITE PREPARATION

1.3 SHOP DRAWING SUBMITTALS

- A. Shop Drawings: Submit the following in accordance with Section 01300 - SUBMITTALS:
 - 1. Certify, invoice, and order plants for each shipment grown, free of disease and insect pests. Submit certificates to Engineer.
 - 2. Prior to placement of any mulch, deposit, at a location on site suitable to Engineer, 1/2 cu. yd. sample of mulch for examination. After mulch sample is reviewed by the Engineer, provide mulch conforming to accepted sample.
 - 3. Submit to Engineer a sample of proposed soil separator mat and manufacturer's specification for mat.
 - 4. Submit with seed, certificates concerning seed mixture, purity, germinating value, and crop year identification.
 - 5. Submit test samples of loam to a certified soils consultant to determine fertilizer and lime requirements and return two copies of results for implementation.
 - 6. For hydroseeding, provide written description containing seed analysis, fertilizer, and lime addition data.

7. Submit list of plant material to be used and source.
8. Prior to end of maintenance period, furnish two copies of written maintenance, instructions for maintenance and care of installed plants and lawn areas.

1.4 QUALITY ASSURANCE

- A. Investigate sources of supply and make assurances that plants will be supplied as indicated in Schedule of Plant Material in sizes, variety and quality noted and specified before submitting bid. Failure to take this precaution will not relieve responsibility for furnishing and installing plant material in accordance with Contract requirements and without additional expense to Owner.
- B. Upon delivery and before planting, Engineer will observe plants. Evaluation and approval by Engineer of plants is for quality, size and variety only and in no way impairs the right of rejection for failure to meet other requirements during progress of work.
- C. General:
 1. Provide only nursery grown plants having been transplanted at least once and growing in a nursery for at least two years. Allow Engineer to determine fitness of any plant.
 2. Provide container-grown stock in containers long enough for root system to develop sufficiently to hold soil together firm and whole when removed from container. Use no plants loose in the container.
 3. Check plant material prior to commencing of planting operations. Plant no material prior to inspection by Engineer. Notify Engineer at least 48 hours in advance of all planned planting operations and identify specific material and its location.
 4. Furnish suitable quantities of water, hose and appurtenances.
 5. Use loam, having prior vegetative growth that did not contain toxic amounts of either acid or alkaline elements.
 6. Begin maintenance after each portion of lawn is seeded and continue for minimum of 45 days.

7. Correct defective work as soon as possible within guarantee period. Repair or replace seeded areas, plants, and shrubs which, in judgment of Engineer, have not survived and grown in a satisfactory manner, for a period of one year after acceptance.
8. Provide as specified seedings or plantings replacements of the same type and size as specified.
9. Dry loam test samples to constant weight at temperature of 230 deg. F, plus or minus 9 degrees.
10. The Engineer reserves the right to test and reject any material not meeting specifications by utilizing tests in accordance with methods adopted by the Association of Official Agricultural Chemists. Costs for these tests shall be paid by the Contractor.

1.5 STORAGE AND HANDLING OF MATERIALS

- A. Store plants in ground or other acceptable media if not to be planted within 4-hrs. Protect roots of plant material from drying or other possible injury. Water plants as necessary until planted.
- B. Do not drop plants. Do not pick up container or B & B (ball and burlap) plants by stem or trunks.

1.6 WARRANTY

- A. Provide as specified.
- B. Guarantee new plant material through one full growing season after plants are installed. Guarantee plants replaced under this for one full growing season from date of replacement.
- C. Repair damage to plants or lawns during plant replacement. Guarantee lawn areas for duration of one full year after seeding to be alive and in satisfactory growth at end of guarantee period.
- D. For purpose of establishing an acceptable standard, scattered bare spots, none of which is larger than 1 sq. ft. will be allowed up to a maximum of 3% of lawn area.

PART 2 – PRODUCTS

2.1 STAKES

- A. Wood stakes, minimum of 2-in. by 2-in. square and 8 in length, of uniform size, straight, reasonably free from knots, treated with wood preservative and painted green.

2.2 METAL EDGE STRIPS AND STEEL STAKES

- A. 1/4-in. by 5-inch steel plate edge strips, painted green.
- B. 16-in. tapered steel stakes.

2.3 MAT

- A. 1/4-in. to 1/2-in. thick mat consisting of lime or silicate glass fibers with average fiber diameter to 9 microns and 2-in. to 4-in. strands of fiber bonded with phenol formaldehyde resin, 100 percent textile glass fiber, roll type, water permeable with a minimum thickness of 1/4-in., a maximum thickness of 1/2-in, and a density of not less than 3 pounds per cubic foot.

2.4 LOAM

- A. Fertile, friable, natural topsoil typical of locality, without admixture of subsoil, refuse or other foreign materials, and obtained from well-drained arable site. Free of stumps, roots, heavy or stiff clay, stones larger than 1 inch in diameter, lumps, coarse sand, noxious weeds, sticks, brush or other deleterious matter.
- B. Not less than 4 percent nor more than 20 percent organic matter as determined by loss on ignition of oven-dried samples.

2.5 LIME, FERTILIZER AND SEED

- A. Ground agricultural limestone containing not less than 85 percent of total carbonates.
- B. Commercial type fertilizer, uniform in composition, free flowing, conforming to state and federal laws, and at least 50 percent of nitrogen derived from natural organic sources of ureaform and containing following percentages by weight: Nitrogen 10 percent, Phosphorus 10 percent, Potash 10 percent.

C. Turf grass seed, clean, high in germinating value and latest year's crop mixture as follows:

Name	Minimum proportion by weight	Percent purity	Percent germination
Kentucky bluegrass	20%	87%	85%
Merio Kentucky bluegrass	20%	87%	85%
Red Chewings Fescue	45%	98%	85%
Manhattan Rye	15%	98%	90%

D. Turf grass seed, clean high in germinating value and of the latest year's crop mixed as follows:

Name	Minimum proportion by weight
Creeping Red Fescue	50%
Domestic Ryegrass	20%
Redtop	5%
Kentucky Bluegrass	25%

E. Weeds shall not exceed 0.25 percent.

2.6 SOD

- A. Established, nursery grown Kentucky or Merion Bluegrass sod, vigorous, well rooted, healthy turf, free from disease, insect pests, weeds, other grasses, stones, and any other harmful or deleterious matter.
- B. Sod harvested by machine at uniform soil thickness of approximately 1 inch but not less than 3/4 of an inch. Measurement for thickness excludes top growth and thatch. Prevent tearing, breaking, drying or any other damage.

2.7 CRUSHED STONE

- A. Crushed stone made from light colored granite. Stone screened to insure uniformity of size. No flat, elongated stone used. Size of stone in mowing strips and other areas as indicated on drawings, conforming to following requirements:

Size of square screen	Percent passing
1-1/4 inch	95% minimum
3/4 inch	15% maximum

2.8 PEAT MOSS

- A. Shredded, loose, substantially free of mineral and waste matters. Minimum organic matter by weight on a dry basis: 80 percent.

2.7 MULCH

- A. Shredded pine bark free of wood chips, stones, branches, or other deleterious material. Bark shredded in strips not larger than 3-inches in any dimension and aged for a period of not less than six months after removal from original logs.

PART 3 – EXECUTION

3.1 GENERAL

- A. It is the intent of this specification that existing trees within grading and seeding limits, not disturbed by building operations, be saved and protected, except where specified to be removed. Tree clearing, protection, and planting shall be performed based on the applicable specification sections and as indicated in the drawings or by the Engineer. Engineer requires variations required in grading on the job.

3.2 PLANTING SEASON

- A. Recommended Spring Planting Season: From time soil can be worked until following dates at end of planting season:
 - 1. Lawns - April 15.
- B. Recommended Fall Planting Season: Commence and terminate at time listed below:
 - 1. Lawns - August 1 to October 1.
- C. Perform actual planting only when weather and soil conditions are suitable in accordance with locally accepted practice.

3.3 PROTECTION

- A. Protect seeded and planted areas against damage by trespass and other causes. Protect work until accepted. Replace, repair, restake, or replant as required by Engineer, and at own expense, seeding or planting which is damaged.

- B. If planting is done after lawn preparation, protect lawn areas, repair damage resulting from planting operations.
- C. Wherever landscape work must be executed in conjunction with construction of other work, arrange a schedule of procedures that will permit execution of landscape work as specified.

3.4 PLANTING PITS

- A. Excavate with vertical sides and in accordance with following requirements:
 - 1. Plant shrubs in pits 12 inches greater in width than diameter of root ball or container and minimum of 18 inches deep below finished grade, or as necessary to properly set plant at finished grade.
 - 2. Adjust depth of planting beds and pits to provide minimum of 8 inches of planting soil mixtures under roots of all plants.
 - 3. Set plants in center of pits, plumb and straight and at level that top of root ball is 1 inch lower than surrounding finished grade after settlement.
- B. Compact topsoil mixture thoroughly around base of root ball to fill all voids, when plant material is set. Cut all burlap and lacing and remove from top 1/3 of root ball. Do not pull burlap from under any root ball. Backfill tree and shrub pits halfway with planting soil mixture and thoroughly puddle before backfilling tree or shrub pit. Water tree or shrub again, when each backfill operation is complete.

3.5 PLANTING SOIL MIXTURE

- A. Thoroughly mix all loam used in backfilling planting pits, with peat moss at rate of 2 parts loam to 1 part peat moss, to obtain required planting soil mixture.

3.6 PLANTING

- A. Thoroughly compact topsoil planting mixture around root balls and water. Immediately after plant pit is backfilled, form a shallow saucer slightly larger than pit with ridge of soil to facilitate and contain watering. After planting, cultivate soil in all shrub beds between shrub pits. Grub out sod or other growth and remove from bed area. Rake bed area smooth and neat and outline. Mulch all tree pits and shrub beds with a minimum of 3

inches of shredded pine bark mulch as indicated on drawings. Do not use admixture of wood chips in mulch.

3.7 BARK MULCH SURFACES

- A. Mulch, with shredded pine bark, all tree pits, shrub pits and beds, and all areas planted with ground cover, immediately after planting operations are completed.
 - 1. For tree and shrub pits and beds, provide a minimum 3 in. of mulch.
 - 2. For ground cover beds, provide a minimum 2 in. of mulch.
- B. Limit mulching for trees and individual shrubs to pit area inside of saucer and for shrub, tree and ground cover beds and panels planted with multiple trees. Define limits of beds in turf areas or where no building wall or curb exists by installed metal edging as indicated.

3.8 METAL EDGE STRIPS

- A. Install metal edge strips around all edges of mowing strips and planting beds as indicated. Fasten metal edge strips securely in place with tapered steel stakes driven through slots punched in strip at 30-in. (76.2cm) intervals. Set edge strips to finished grades indicated.

3.9 MOWING STRIPS AND AREAS OF CRUSHED STONE

- A. Construct mowing strips adjacent to all exterior building and structure walls where indicated on drawings. Provide mowing strips with metal edge strips.
- B. Install mat under crushed stone and pin in place.
- C. Place 6-in. minimum layer of crushed stone between edge strip and building or structure. Consolidate stone as required by the Engineer.

3.10 LOAM

- A. Spread loam on areas to be seeded, to required depth indicated on Contract Drawings or as required by Engineer, fine grade and compact. Specified depth shall be that after compaction.

3.11 LIME, FERTILIZER AND SEEDING

- A. Apply lime by mechanical means at rate of 50 pounds per 1,000 sq. ft., or as soil analysis recommends. Apply fertilizer at rate of 50 pounds per 1,000 sq. ft., or as soil analysis recommends.
- B. If any delays in seeding lawn areas cause weeds to grow on surface or loam is washed out prior to sowing seed, remove weeds or replace loam and reestablish finish grades without additional compensation. Sow seed at rate of 4 pounds per 1,000 sq. ft. on calm day, by mechanical means. Sow one-half of seed in one direction, and other half at right angles to original direction. Rake seed lightly into loam, to depth of not more than 1/4 inch and compact by means of an acceptable lawn roller weighing 100 to 150 pounds per linear foot of width.
- C. Water lawn areas adequately at time of sowing and daily thereafter with fine spray, and continue throughout maintenance and protection period. Loam, lime, fertilize and seed required areas outside of perimeter same as lawn areas. Apply seed at rate of 80 pounds per acre. Rake seed lightly, after sowing, into top 1/4 in. of loam, and compact by suitable rollers weighing 100 to 150 pounds per linear foot of width.

3.12 SOD

- A. Install sod not more than 48 hours after cutting. Provide lime, fertilizer, etc, preparation for sod same as stated above for seed.

3.13 CRUSHED STONE

- A. Place crushed stone to depth of 6 inches, and thoroughly consolidate by means of suitable vibrator or mechanical tamper. Add stone, as necessary, after tamping or vibrating to finish depth of 6 inches.

3.14 CLEAN-UP

- A. Remove soil or similar material which has been brought onto paved areas, keeping these areas clean. Upon completion of planting, remove excess soil, stones and debris which has not previously been cleaned up and legally dispose of off-site.
- B. Prepare lawns and planting areas for final inspection. Protect slopes and embankments against erosion until work is accepted. Repair eroded portions of seeded or sodded areas by refilling, resodding, remulching and reseeding as required by condition and as required by the Engineer. Protection may be by installation of sod strips or other methods.

3.15 MAINTENANCE

- A. Maintain lawn areas and other seed areas at maximum height of 2-1/2 inches by mowing at least three times. Weed thoroughly once and maintained until time of final acceptance. Reseed and refertilize with original mixtures, watering or whatever is necessary to establish over entire area of lawn and other seeded areas a close stand of grasses specified, and reasonably free of weeds and undesirable coarse native grasses.
- B. Begin maintenance immediately after each portion of lawn is seeded and continue for minimum of 45 days or until final acceptance of work. Water, mulch, weed, prune, spray, fertilize, cultivate and otherwise maintain and protect all plants.
- C. Reset settled plants to proper grade and position, and restore planting saucers and remove dead material. Tighten and repair guys.

3.16 FINAL INSPECTION

- A. Upon written request by the Contractor, the Engineer shall inspect all lawn areas to determine completion of contract work. This request must be submitted at least 10 days prior to the anticipated date. The lawns will become acceptable if they show a uniform, thick, well developed stand of grass that may be occupied by the Owner for their intended use. When acceptance is made in writing to the Contractor, the Contractor's responsibility for maintenance shall terminate.
- B. The Contractor shall furnish to the Owner complete written instructions for maintenance of all lawn areas at time of acceptance. Acceptance of the lawn area shall not occur before acceptance of the entire facility.

PART 4 – COMPENSATION (Not Used)

Item 2900.1 --- Rain Garden

METHOD OF MEASUREMENT:

Measurement for payment for Rain Garden will be for the number of rain gardens as shown on the Contract Drawings or as required by the Engineer furnished and installed complete. Payment for these items shall be payable upon completion of work under this bid item.

BASIS OF PAYMENT:

Payment for Rain Garden shall be based on each rain garden installed complete for this item in the proposal. Under the unit price for this item, the Contractor shall

furnish all labor, materials, tools, equipment, and incidentals required for the installation of a rain garden. The work includes, but is not limited to; saw cutting bituminous and cement concrete; excavation; construction dewatering; furnishing and placing backfill per one of the approved methods; furnish, install and compact gravel road sub-base; furnish and install mulch; furnish and install 4-inch PVC roof drain lateral; purchasing and delivering, offloading, receiving, handling and caring for all native plants in the laydown area and work sites, transportation between the laydown area and work sites, furnishing and delivering prepared backfill soil, mulch, and fertilizer packet, planting of native plants, installation of aeration/watering devices, pruning, staking, guying, wrapping, mulching, weeding, watering, cleanup, tree planting establishment work and care, maintenance replacement, and for all labor, equipment, tools and incidentals necessary to complete the work, and for the Contractor's and Owner's representative costs of selecting and tagging the trees, and for the one (1) year guarantee and replacement if required; and all incidental work not specifically included for payment elsewhere.

END OF SECTION 02900

6. The term "Contractor" means the person, firm or corporation entering into the Contract with the Owner to construct and install improvements embraced in this Contract.
7. The term "Contract Documents" means and shall include the following: Invitation to Bid; Bid Requirements; Contract Forms; Bonds and Certificates; Conditions of Contract; Addenda; if any; Technical Specifications; and Drawings.
8. The words "required", "permitted", "ordered", "designated", "prescribed", or words of like import shall mean the direction, requirement, permission, order, designation, prescription, etc. of the Owner or the Owner's representatives, and similarly, the words "approved", "acceptable", "satisfactory", or words of like import, shall mean approved by, or acceptable or satisfactory to the Owner's authorized representative, subject in each case to the final determination of the Owner unless otherwise expressly stated.
9. The terms "City" means the City of Cambridge, Massachusetts, within which the work of this Contract is to be carried out.
10. The term "MHD Standard Specifications" or "Standard Specifications" refers to the latest edition of the Massachusetts Highway Department Standard Specifications for Highways and Bridges, including supplements and amendments.

1.6 DESCRIPTION OF WORK

- A. Contractor is to furnish all labor, materials, equipment and transportation required to complete all the tree planting work in strict accordance with these specifications and applicable drawings. Work shall include but not be limited to:
 1. Submitting samples of materials and/or analyses for approval.
 2. Securing necessary permits and approvals.
 3. Excavating, removing unsuitable material and back-filling of tree planting area.
 4. Furnishing specified tree plant materials for installation and all necessary tree planting operations including fertilizing, mulching, watering, staking and guying (omit spraying).
 5. Furnishing and installing Iron Edge along the edge of tree pits located within brick sidewalk areas. The Iron Edge shall meet the specifications contained in section 02524 "Curbs, Walks, and Driveways."

6. Cleaning up of sites at the end of planting operations.
7. Maintaining, protecting, weeding, pruning damaged or broken limbs, and replacing dead trees during the guarantee period.

PART 2 – PRODUCTS

2.1 TOPSOIL

- A. Contractor shall provide all topsoil required to complete the tree planting operation. Topsoil shall be a natural, fertile, friable loam typical of cultivated topsoil of the locality, containing at least 10% and not more than 20% decayed organic matter (humus). Topsoil shall be free of sub-soil, large stones, earth clods, sticks, stumps, clay lumps, roots, or other objectionable, extraneous matter or debris. Topsoil shall not be by test either excessively acid or alkaline nor contain toxic substances. Topsoil shall not be delivered or used for planting while in a frozen or muddy condition. Name of supplier and sample to be approved by the City Arborist.

2.2 FERTILIZER

- A. Fertilizer shall be a complete, slow-release, root contact packet, 16-8-16, or equal, and a standard product complying with State and Federal Fertilizer Laws. Name of supplier and sample to be approved by the City Arborist.

2.3 WATER

- A. Water furnished by the Contractor will be free of ingredients harmful to humans and plant life. The Contractor will supply hoses and other watering equipment required for the work.

2.4 MULCH

- A. Mulch shall consist of clean, organic plant material. The mulch must be free of dirt and materials deleterious to plant life. Name of supplier and sample to be approved by the City Arborist.

2.5 STAKING

- A. Stakes will be wood, 2" x 3" in size, pointed at one end. Tree ties shall be black polyester straps. Both must be approved by the City Arborist.

2.6 AERATION/WATERING DEVICE

- A. Aeration/watering device shall be model RWS-G Root Watering System by RainBird, Inc. or approved equivalent product. Devices shall consist of a grate retainer constructed from high-grade polymer with UV resistant thermoplastic inhibitors. The

grate retainer shall fasten to a basket weave canister. The canister shall be a high grade polymer rigid mesh cylinder 34" in length. Canisters shall be fitted with a sand sock filter.

2.7 TREE PLANTING MATERIALS

- A. Plant Identification and Standards: The nomenclature used in the plant list generally conforms to that of the current edition of Standardized Plant Names, as adopted by the American Joint Committee on Horticultural Nomenclature. All tree plantings shall conform to the varieties and sizes specified in the Plant List, and to the code of standards set forth in the current edition of American Standard for Nursery Stock. Substitutions will not be permitted without the consent of the City Arborist.
- B. Plant List: The Contractor shall supply the plants necessary to complete the work as intended. Where the size of a plant on the Plant List is a variation between a minimum and maximum dimension, the sizes of the plants furnished will be equal to the average of the two dimensions. Where a single dimension is given, this dimension represents the minimum size of the plants to be furnished.
- C. General Trees: All tree plantings shall be nursery-grown whether balled and burlapped or container grown. The tree plantings shall be typical of their species and variety. Trees shall be straight, symmetrical with a crown having a persistent main leader, be growing from a single, healthy root system with no girdling roots. All tree plantings shall be sound and healthy free from defects, disfiguring knots, sun scald, and injuries or abrasions of the bark. They shall be free of plant diseases, pests, scale and all forms of infestations, and possess a normal balance between height and spread. Pruning wounds over ¾ inch in diameter must be completely callused over.
- D. Tree Limb Structure: All limbs on large trees maturing over 30 feet must originate on the trunk at 7 feet above the top of root ball. Small trees maturing less than 30 feet must have limbs that start no lower than 5 feet. All trees will be selected by the City Arborist.

2.8 PLANT ROOT BALLS

- A. All tree plantings either balled and burlapped or container grown shall retain root systems as solid units. The diameter and depth of the balls of soil must be sufficient to encompass the fibrous and feeding root system necessary for the healthy development of each tree planting. No tree planting shall be accepted when the ball of earth surrounding its roots has been badly cracked or broken, either before or during the process of planting. The tree plantings and root balls shall remain intact as a unit during all operations. All tree plantings that cannot be planted right away must be protected and watered.

2.9 PLANT LABELS

- A. Plant labels shall be provided by the Contractor for each tree and shall be durable, legible labels, stating the correct tree name and size, in weather resistant ink or embossed process lettering, and can be removed at end of Contract.

PART 3- EXECUTION

3.1 TREE PLANTING SEASON

- A. Tree planting can occur under normal, favorable weather conditions. Tree planting will not be permitted as determined by the City Arborist under adverse weather conditions such as when the ground is frozen or during extreme heat.

3.2 TREE PLANT SECTION

- A. The City Arborist will select and tag all specified tree planting material at the nursery locations.

3.3 TREE PLANT DELIVERY

- A. The Contractor will inspect and approve all trees at the nursery(ies) prior to pick up. However, this does not alter the right of the City Arborist to inspect and reject unsuitable trees delivered to the planting site.

3.4 TREE PLANT STORAGE

- A. Tree plantings shall be delivered to the Contractor's storage site and to the tree planting site in a well-watered and vigorous condition. All unplanted tree plantings shall be protected at all times from sun and drying winds. Care must be taken so as not to damage bark, break branches, or cause injury to the tree.

3.5 GENERAL TREE PLANTING

- A. Prior to tree planting, the City Arborist will supply in writing to the Contractor specified tree planting locations showing the tree selected and approved.
- B. Tree planting areas may need pavement removal as required by the City Arborist. All materials excavated from the tree planting areas and considered detrimental to the growth of the trees, such as an existing tree or stump, sidewalk paving, rocks, sub-soil and debris, shall not be reused for fill or in the planting operation, and must be removed from the site.
- C. Any unexpected obstructions at the site that interfere with the tree planting operation will be communicated to the City Arborist to determine a solution before planting occurs.

- D. Soil of very poor quality or heavy clay encountered by the Contractor must be reported to the City Arborist for removal and amended as required.

3.6 TREE INSTALLATION

- A. Trees shall be plumb, faced to give best appearance, and planted at the center of the planting areas.
- B. Trunk flare must be visible and free of adventitious roots.
- C. Place the tree in the planting hole so that the top of the root ball where the trunk flare is visible is 2" above the established sidewalk level.
- D. Any non-degradable materials used in wrapping the root ball must be entirely and carefully removed so as not to disturb the roots. Cut as much of the degradable burlap and rope from around the top of the ball as possible. If a wire basket is present after the root ball is securely in place, cut off as much wire as possible. Carefully cut containers and remove plant balls keeping the root ball intact. All materials cut away from the root balls must be removed from the site.
- E. Install watering/aeration loop before back-filling according to the requirements and approval of the City Arborist.

3.7 AERATION/WATERING DEVICES

- A. Devices shall be evenly spaced and positioned against the root ball or root mass. Two units shall be provided per tree. Units shall be placed vertically with the top even with the ground surface. Areas surrounding the devices shall be backfilled with soil after placement.

3.8 FERTILIZING

- A. Insert approved slow-release plant packets, number according to the caliper of the tree with the approval of the City Arborist before back-filling.

3.9 BACK-FILLING

- A. Carefully backfill by hand the approved topsoil in layers and water each layer thoroughly to fill all voids and allow to settle. Finish back-filling to a depth that finished grade level at settlement will be at established sidewalk level.
- B. Surround each tree with a shoulder of topsoil to form a temporary saucer, 3 inches deep and equal to the diameter of the planting hole.

3.10 WATERING

- A. At the time of planting judiciously flood plants with water. The Contractor will also

include in his base bid costs for watering trees twice a week exclusive of Saturdays, Sundays and holidays for a period of 30 days from the date of planting.

3.11 MULCHING

- A. Immediately after tree planting operations are complete, the planting areas shall be covered with 2 inches of approved mulch. Keep mulch away from the base of the tree so that the mulch is not in contact with the trunk flare.

3.12 STAKING

- A. Place 2 or 3 wood stakes equally spaced, not higher than ½ the height of the tree, to avoid root damage or damage to the watering/aeration loop. Line up stakes parallel to the curb line and planting area and at a reasonable distance from the trunk to prevent movement of the tree and root system.

3.13 PRUNING

- A. Prune only badly bruised, broken, or crossing limbs.

3.14 CLEAN UP

- A. After completion of the work, the Contractor shall remove all debris, materials, rubbish, and excess soil from the site and dispose of them as required by the City Arborist.

3.15 BACKFLOW PREVENTION DEVICES

- A. When hydrants are being used, the Cambridge Water System must be protected with backflow prevention devices as per Massachusetts Department of Environmental Protection (DEP) Regulations 310 CMR 22.22 and as per the Cambridge Water Department Cross Connection Control Program. Backflow prevention devices must also be used during street sweeping, sewer flushing, paving operations and hookups for any other purpose.

3.16 MAINTENANCE

- A. Maintenance shall begin immediately after tree planting and shall continue until final inspection and acceptance. Maintenance will include: watering, re-mulching, weeding, repositioning stakes, removal of dead or broken limbs, maintaining the planting saucer, etc. Watering by the Contractor for the remainder of the guarantee period should be at least once a week or as acceptable to the City Arborist.

3.17 GUARANTEE

- A. Trees will be guaranteed for a minimum period of time of one (1) year after the initial acceptance. Trees planted in spring shall be alive and in satisfactory growth on June 1

of the following year. If planted in the fall, trees shall be alive and in satisfactory growth on October 1 of the following year.

3.18 REPLACEMENTS

- A. During the guarantee period, dead, unsightly or unhealthy trees should be removed promptly and replaced by the Contractor as required by the City Arborist.
- B. Vandalized trees should be brought to the attention of the City Arborist.

3.19 INSPECTION AND ACCEPTANCE

- A. Written notices requesting all inspections must be received by City Arborist at least five days prior to anticipated inspection dates. All work in the Contract shall be found in neat, clean and safe condition.

3.20 SEMI-FINAL INSPECTION

- A. The Contractor may offer for acceptance the entire project or a completed readily defined area, if approved by the City Arborist. Semi-Final inspection will be made by the City Arborist upon completion of all work included herein.

3.21 SEMI-FINAL ACCEPTANCE

- A. The City Arborist will notify Contractor in writing of acceptance in whole or in part of work, exclusive of maintenance and possible replacement of trees subject to guarantee, or of requirements for completion if deficiencies exist. Work will not be submitted for payment without the City Arborist's written acceptance.

3.22 FINAL INSPECTION AND ACCEPTANCE

- A. At end of maintenance and Guarantee Period, and upon written application from the Contractor, the City Arborist shall determine acceptability of completed work.
- B. Dead, missing or unhealthy trees shall be replaced during next planting season. If a substantial number of plants are unsatisfactory, missing or dead, acceptance will not be granted until replacements are made and the Contractor's responsibility for the maintenance and guarantee will be extended.

PART 4 – COMPENSATION

Item 2910.1 --- Tree Planting

METHOD OF MEASUREMENT:

Measurement for payment for tree planting will be for the number of trees of the specified kind and size furnished and planted by the Contractor and accepted in accordance with these Specifications. Payment for these items will not occur until the tree is planted and accepted.

BASIS OF PAYMENT:

The unit price per tree planted shall be full compensation for purchasing and delivering, offloading, receiving, handling and caring for all trees in the laydown area and work sites, transportation between the laydown area and work sites, furnishing and delivering prepared backfill soil, mulch, and fertilizer packets, removal of existing surface material at tree pit location, digging of pits, removal of excavated materials, planting of trees, installation of aeration/watering devices, pruning, staking, guying, wrapping, mulching, weeding, watering, cleanup, tree planting establishment work and care, maintenance replacement, and for all labor, equipment, tools and incidentals necessary to complete the work, and for the Contractor's and Owner's representative costs of selecting and tagging the trees, and for the one (1) year guarantee and replacement if required.

END OF SECTION 02910

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