DIVISION 2 - SITE WORK

SECTION 02020

EROSION AND SEDIMENT CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. This Section specifies equipment and materials for an erosion and sediment control program for minimizing erosion and siltation during the construction phase of the project. The Contractor shall provide additional erosion and sediment control materials and methods as required to affect the erosion and siltation control principles specified herein.

1.2 RELATED SECTIONS

A. Examine Contract Documents for requirements that affect work of this Section. Other Specification Sections that directly relate to work of this Section include, but are not limited to:

1. Section 01110 – Environmental Protection Measures

2. Section 02140 – Dewatering and Drainage

3. Section 02200 – Earthwork

1.3 SUBMITTALS

A. Proposed methods, materials to be employed, and schedule for effecting erosion and siltation control and preventing erosion damage shall be submitted for approval. Submittals shall include:

1. List of proposed materials including manufacturer's product data.

2. Perimeter (Limit of Work) Erosion Controls damaged during construction shall be replaced immediately. Schedule of any additional erosion control program indicating specific dates for implementing programs in each major area of work, including dewatering sedimentation basin(s) shall be submitted prior to installation.

B. The following samples shall be submitted:

Sample	Size
Filter Fabric	12 X 12 in. (Woven and Non-woven)

1.4 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

1. Massachusetts Department of Transportation: Construction Standards.

2. 310 CMR 10.00: Wetlands Protection Act Regulations

3. Massachusetts Department of Environmental Protection: Erosion and Sediment Control Guidelines for Urban and Suburban Areas.

1.5 EROSION CONTROL PRINCIPLES

A. Erosion Control Principles

The following erosion control principles shall apply to the land grading and construction phases:

1. Stripping of vegetation, grading, or other soil disturbance shall be done in a manner which will minimize soil erosion.

2. Whenever feasible, natural vegetation shall be retained and protected.

3. Extent of area which is exposed and free of vegetation and duration of its exposure shall be kept within practical limits.

4. Temporary seeding, mulching, or other suitable stabilization measures shall be used to protect exposed critical areas during prolonged construction or other land disturbance. Prolonged exposure of unstabilized soil shall not exceed 60 days.

5. Drainage provisions shall accommodate increased runoff resulting from modifications of soil and surface conditions during and after development or disturbance. Such provisions shall be in addition to existing requirements.

6. Sediment shall be retained on-site.

7. Truck wheel wash station shall be properly maintained during work. Dewatering sedimentation basin(s) shall be installed prior to dewatering operations.

B. Erosion Protection

Cut and fill slopes and stockpiled materials shall be protected to prevent erosion. Slopes shall be protected with permanent erosion protection when erosion exposure period is expected to be greater than or equal to two (2) months, and temporary

erosion protection when erosion exposure period is expected to be less than two (2) months.

1. Permanent erosion protection shall be accomplished by seeding with grass and covering with an erosion protection material, as appropriate for prevailing conditions.

2. Temporary erosion protection shall be accomplished by covering with an erosion protection material, as appropriate for prevailing conditions.

3. Except where specified, fill slopes shall be limited to a grade of 3:1 (horizontal: vertical); cut slopes shall be limited to a grade of 2:1.

PART 2 - PRODUCTS

2.1 FILTER SOCK

A. Filter sock for construction of erosion control devices shall be blown or placed media (mulch or compost) in twelve-inch diameter biodegradable filter sock.

B. Wooden stakes (2-inches by 2-inches by 36-inches) shall be placed 10 feet on center, driven a minimum of 12-inches into the ground.

2.2 HAY BALES

A. Hay bales for construction of erosion control devices shall be new, firm, salt marsh hay bound with biodegradable twine.

2.3 TEMPORARY SEED COVER

A. If required, seed mixture for temporary cover by hydroseeding application shall conform to the following:

Quantity per 1,000 sq. ft. Coverage	Material
27-1/2 lb.	Wood Fiber Mulch
4 lb.	Seed
½ lb.	Annual Ryegrass
22 lb.	10-6-4 Fertilizer
69 gal.	Water

B. Hydroseeding Equipment:

Hydroseeding equipment may be either portable or truck mounted, with dual agitation, a minimum working volume of 1,000 gallons and a minimum spray range of eighty (80) feet.

1. Hydroseeding equipment must be capable of uniformly applying the slurry mix including wood fiber mulch if required, at the specified rate, and at the required locations.

2. Hydromulching equipment, either trailer or truck mounted, must be capable of uniformly applying straw or hay mulch at a minimum mulching rate of eight (8) tons per hour, at a distance of not less than eighty (80) feet.

2.4 DEWATERING (SILT) BAGS

A. Silt bags shall be utilized for trench dewatering activities.

2.5 SEDIMENTATION CONTROL AT CATCH BASINS

A. Silt sacks (or approved equal) shall be utilized at each catch basin for sedimentation control.

2.6 SILT FENCE

A. Where silt fence is required, provide the following woven geotextile fabric for silt fence:

1. Mirafi 100X as manufactured by Mirafi, Pendergrass, GA.
2. GEOTEX 2130 as manufactured by Propex, Chattanooga, TN.
3. Or acceptable equivalent product.

B. Physical Properties of Minimum Average Roll of the woven geotextile fabric for silt fence shall be:

	Property	ASTM Test Method	Units	Value
1.	Grab Strength	D4632	lbs [N]	100 [450](min.)
2.	Permissivity	D4491	sec - 1	0.10 (min.)
3.	Apparent Opening Size	D4751	Sieve #	20-30
4.	Ultraviolet Stability	D4355	%	70 (min.)

PART 3 - EXECUTION

3.1 HYDROSEEDING

A. If required for long-term disturbance greater than 60 days, seed for temporary cover shall be spread by the hydroseeding method, utilizing power equipment commonly used for that purpose. Seed, fertilizer, mulch and water shall be mixed and applied to achieve application quantities specified. Material shall be applied in 2 equal applications, with the equipment during the second pass moving perpendicular to direction employed during the first pass. Hydroseeding shall not be

done when it is raining or snowing, or when wind velocity exceeds 5 mph.

B. If the results of hydroseeding application are unsatisfactory in the opinion of the Engineer, the mixture and/or application rate and methods shall be modified to achieve the required results.

C. After the grass has appeared, all areas and parts of areas which fail to show a uniform stand of grass, for any reason whatsoever, shall be reseeded and such areas and parts of areas seeded repeatedly until all areas are covered with a satisfactory growth of grass as determined by the Engineer.

3.2 MAINTENANCE AND REMOVAL OF EROSION CONTROL DEVICES

A. Wetland area, water courses, and drainage swales adjacent to construction activities shall be monitored continuously for evidence of silt intrusion and other adverse environmental impacts, which shall be corrected immediately upon discovery.

B. Culverts and drainage ditches shall be kept clean and clear of obstructions during construction period.

C. Maintenance of Erosion Control Devices

1. Sediment behind the erosion control device shall be checked at least weekly and after heavy rain. Silt shall be removed if greater than 6 inches deep.

2. Condition of erosion control devices shall be checked at least weekly and after heavy rain. Damaged and/or deteriorated items shall be replaced. Erosion control devices shall be maintained in place and in effective condition.

3. Filter socks, silts sacks, hay bales, and other erosion control devices shall be inspected at least weekly and maintained or replaced as required to maintain both their effectiveness and essentially their original condition. Underside of perimeter controls shall be kept in close contact with the earth below at all times, as required to prevent water from washing beneath controls.

4. Sediment deposits shall be properly disposed of, in a location and manner which will not cause sediment nuisance elsewhere.

D. Removal of Erosion Control Devices

1. Erosion control devices shall be maintained until all disturbed earth has been paved or vegetated, at which time they shall be removed. After removal, areas disturbed by these devices shall be regraded and seeded.

2. Erosion protection material shall be kept securely anchored until acceptance of the entire Project.

END OF SECTION 02020

SECTION 02101

SITE INVESTIGATION

PART 1 – GENERAL

1.1 SITE CONDITIONS

A. The Contractor acknowledges that he/she has satisfied him/herself as to the nature and location of the work, the general and local conditions, particularly those bearing upon transportation, disposal, handling, and storage of materials, availability of labor, water, electric power, roads and uncertainties of weather, groundwater table or similar physical conditions at the site, the conformation of subsurface materials to be encountered, the character of equipment and facilities needed prior to and during the prosecution of the work and all other matters which can in any way affect the work or the cost thereof under this Contract. Any failure by the Contractor to acquaint him/herself with all available information concerning these conditions will not relieve him/her from responsibility for estimating properly the difficulty or cost of successfully performing the work.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION 02101

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SECTION 02140

DEWATERING AND DRAINAGE

PART 1 – GENERAL

1.1 SCOPE OF WORK

A. Furnish, install, operate, monitor, maintain, and remove temporary dewatering and drainage systems as necessary to lower and maintain groundwater levels below subgrades of excavations and prevent surface water runoff from entering or accumulating in excavations, to permit construction in the dry.

B. Collect and properly dispose of all discharge water from dewatering and drainage systems in accordance with local requirements and permits.

C. Repair any damage caused by dewatering and drainage system operations.

D. Remove temporary dewatering and drainage systems when no longer needed, and restore all disturbed areas.

1.2 RELATED WORK

A. Section 01110 – Environmental Protection Measure

B. Section 02020 – Erosion and Sediment Control

C. Section 02200 – Earthwork

1.3 SUBMITTALS

A. Submit the proposed temporary dewatering and drainage system designs. Contractor shall remain responsible for adequacy and safety of construction means, methods, and techniques.

1.4 DEFINITIONS

A. Where the phrase "in-the-dry" is used in these specifications, it shall be defined as soil conditions that are no more than two percentage points above the optimum moisture content for that soil.

1.5 QUALITY ASSURANCE

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

B. Employ the services of a dewatering specialist or firm having the following

qualifications:

1. Have completed at least five (5) successful dewatering projects of equal size and complexity and with equal systems within the last five (5) years.
2. Retain the services of a Registered Professional Engineer (in the state where the project is located) having a minimum of five (5) years' experience in the design of well points, deep wells, recharge systems, or equal systems.
3. Retain the services of a field representative having a minimum of 5 years' experience in installation of well points, deep wells, recharge systems, or equal systems.

B. If subgrade soils are disturbed or become unstable due to dewatering operation or an inadequate dewatering system, notify the Engineer, stabilize the subgrade, and modify system to perform as specified at no additional cost to the Owner.

C. Notify the Engineer immediately if any settlement or movement is detected on structures. If the settlement or movement is deemed by the Engineer to be related to the dewatering, take actions to protect the adjacent structures and submit a modified dewatering plan to the Engineer within 24 hours. Implement the modified plan and repair any damage incurred to the adjacent structures at no additional cost to the Owner.

D. If oil and/or other hazardous materials are encountered after dewatering begins, immediately notify the Engineer.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Piping, pumping equipment and all other materials required to dewater excavations shall be suitable for the intended purpose. Standby pumping units shall be maintained at the site to be used in case of failure of the normal pumping units. Do not excavate until the dewatering system is operational

B. Provide and store auxiliary dewatering equipment, consisting of pumps and hoses on the site in the event of breakdown, a minimum of one (1) working auxiliary pump is required, and an additional one (1) pump for every five (5) used.

C. Provide and maintain erosion/sedimentation control devices as indicated or specified and in accordance with the dewatering plan.

D. Provide temporary pipes, hoses, flumes, or channels for the transport of discharge water to the discharge location.

E. Provide cement grout having a water cement ratio of 1 to 1 by volume.

PART 3 – EXECUTION

3.1 GENERAL

A. Surface water and groundwater shall be controlled such that excavation to final grade is made in-the-dry, the bearing soils are maintained undisturbed and softening or instability of, or disturbance to, the subgrade due to the presence or seepage of water does not occur.

B. All work shall be protected from flotation.

C. The impact of anticipated subsurface soil/water conditions shall be factored into the selection of methods of excavation and proposed dewatering and drainage systems. Where groundwater levels are above the proposed bottoms of excavations, it is expected that some type of pumped dewatering system will be required for pre-drainage of the soils prior to excavation to final grade and for maintaining the lowered groundwater level until construction has been completed to such an extent that the foundation, structure, pipe, conduit, or fill will not be floated or otherwise damaged. It is further expected that the type of system, spacing of dewatering units, and other details of the work will vary depending on soil/water conditions at a particular location.

3.2 SURFACE WATER CONTROL

A. Surface water control measures shall be constructed to prevent flow of surface waters into excavations. Such measures may include dikes, ditches, and sumps.

3.3 EXCAVATION DEWATERING

A. Provide and maintain adequate equipment and facilities to remove promptly and dispose of properly all water entering excavations. Excavations shall be kept in-the-dry, so as to maintain an undisturbed subgrade condition throughout construction below grade, including backfill and fill placement.

B. Water entering excavations from precipitation or surface runoff shall be collected in shallow ditches around the perimeter of the excavation, drained to sump, and pumped from the excavation to maintain in-the-dry conditions.

C. Pipe and conduit shall not be laid in water or allowed to be submerged prior to backfilling. Pipe and conduit which becomes submerged shall be removed and the excavation dewatered and restored to proper conditions prior to reinstalling the pipe and conduit.

D. Excavations for foundations and structures shall be maintained in-the-dry for a minimum of four days after concrete placement. In no event shall water be allowed to enter an excavation and rise to cause unbalanced pressure on foundations and structures until the concrete or mortar has set at least 24 hours.

E. Dewatering and drainage operations shall at all times be conducted in such a manner as to preserve the natural undisturbed bearing capacity of the subgrade at the bottom of the excavation. If the subgrade becomes disturbed for any reason, the unsuitable subgrade material shall be removed and replaced with concrete, compacted granular fill, or other approved material to restore the bearing capacity of the subgrade to its natural undisturbed condition.

F. Dewatering and drainage operations shall be conducted in a manner which does not cause loss of ground or disturbance to the pipe bedding or soil which supports overlying or adjacent structures.

3.4 DISPOSAL OF DRAINAGE

A. All water discharged from temporary dewatering and drainage systems shall be disposed of in accordance with approved sedimentation and control plans and methods. Sanitary sewer systems or private on-site septic systems shall not be used to dispose of drainage.

END OF SECTION 02140

SECTION 02160

TEMPORARY EXCAVATION SUPPORT SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the following:

1. Design, furnish and install temporary excavation support systems as required to maintain lateral support, prevent loss of ground, limit soil movements to acceptable limits and protect from damage existing and proposed improvements including, but not limited to, pipelines, utilities, structures, roadways, and other facilities.

2. Common types of excavation support system include, but are not limited to: singular or multiple stages comprised of cantilevered or internally braced soldier piles and lagging, steel sheetpile wall, timber sheetpile wall, trench box, or combinations thereof. Trench box temporary excavation support system is only acceptable for pipe or utility trench excavations. Temporary unsupported open cut excavation with stable sloping sides is allowed where applicable.

3. Wherever the word "sheeting" is used in this section or on the contract drawings, it shall be in reference to any type of excavation support system specified except trench box.

4. Construction of the temporary excavation support systems shall not disturb the existing structures or the completed proposed structures. Damage to such structures shall be repaired by the Contractor at no additional cost to the Owner.

5. The Contractor shall bear the entire cost and responsibility of correcting any failure, damages, subsidence, upheaval or cave-ins as a result of improper installation, maintenance or design of the temporary excavation support systems. The Contractor shall pay for all claims, costs and damages that arise as a result of the work performed at no additional cost to the Owner.

1.2 RELATED SECTIONS

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

1. Section 02140 – Dewatering and Drainage

2. Section 02200 – Earthwork

3. Section 03300 – Cast-in-Place Concrete

1.3 SUBMITTALS

A. Shop Drawing: Submit the following in accordance with Section 01300 - SUBMITTALS:

1. Submit the following qualifications four (4) weeks prior to the construction:

a. Qualifications of Contractor's temporary excavation support system designer as specified in Paragraph 1.4 D.

b. Qualifications of Contractor's temporary excavation support system installer as specified in Paragraph 1.4 E.

c. Qualifications of Contractor's independent tieback testing laboratory as specified in Paragraph 1.4 F, if a tieback system is utilized.

d. Qualifications of Contractor's temporary excavation support system installation supervisor as specified in Paragraph 1.4 G.

2. Submit a temporary excavation support plan stamped and signed by a Massachusetts Registered Professional Engineer at least two weeks prior to start of the construction. Do not submit design calculations. The review will be only for the information of the Owner and third parties for an overall understanding of the project relating to access, maintenance of existing facilities and proper utilization of the site. The Contractor shall remain responsible for the adequacy and safety of the means, methods and sequencing of construction. The plan shall include the following items as a minimum:

a. Proposed temporary excavation support system(s), details, location, layout, depths, extent of different types of support relative to existing features and the permanent structures to be constructed, and methods and sequence of installation and removal.

b. If utilizing a tieback system, include tieback installation procedures and criteria for acceptance of tiebacks for performance and proof tests. Submit the tieback testing results to the Engineer for information only.

c. Requirements of dewatering during the construction, per Section 02140.

d. Minimum lateral distance from the edge of the excavation support system for use for vehicles, construction equipment, and stockpiled construction and excavated materials.

e. List of equipment used for installing the excavation support systems.

3. Submit a Construction Contingency Plan specifying the methods and procedures to maintain temporary excavation support system stability if the allowable movement of the adjacent ground and adjacent structures is exceeded.

4. For excavation support systems left in place, submit the following as-built information prior to backfilling and covering the excavation support systems:

a. Survey locations of the temporary excavation support systems, including coordinates of the ends and points of change in direction.

b. Type of the temporary excavation support system.

c. Elevations of top and bottom of the excavation support systems left in place.

1.4 QUALITY ASSURANCE

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

B. Conform to the requirements of the OSHA Standards and Interpretations: "Part 1926 Subpart P - Excavation, Trenching, and Shoring", and all other applicable laws, regulations, rules, and codes.

C. All welding shall be performed in accordance with AWS D1.1.

D. Prepare design, including calculations and drawings, under the direction of a Professional Engineer registered in Massachusetts and having the following qualifications:

1. Not less than ten (10) years' experience in the design of specific temporary excavation support systems to be used.

2. Completed not less than five (5) successful temporary excavation support system projects of equal type, size, and complexity within the last five (5) years.

E. Temporary Excavation Support System Installer's Qualifications:

1. Not less than three (3) years' experience in the installation of similar types and equal complexity as the proposed system.

2. Completed not less than three (3) successful excavation support systems of similar type and equal complexity as the proposed system.

F. If utilizing a tieback system, employ an independent testing laboratory to test the tieback system with the following qualifications:

1. Be accredited by the American Association of State Highway and Transportation Officials (AASHTO) Accreditation Program.

2. Employ personnel conducting testing who are trained in the methods and procedures to test and monitor tieback systems of similar type and equal complexity, as the proposed system.

3. Have not less than five (5) years' experience in testing of tieback systems of similar type and equal complexity as the proposed system.

4. Have successfully tested at least three (3) tieback systems of similar type and equal complexity as the proposed system.

G. Install all temporary excavation support systems under the supervision of a supervisor having the following qualifications:

1. Not less than five (5) years' experience in installation of systems of similar type and equal complexity as the proposed system.

2. Completed at least five (5) successful temporary excavation support systems of similar type and equal complexity as the proposed system.

1.5 DESIGN CRITERIA

A. Design of temporary excavation support systems shall meet the following minimum requirements:

1. Support systems shall be designed for earth pressures, hydrostatic pressure, equipment, temporary stockpiles, construction loads, and other surcharge loads.

2. Design a bracing system to provide sufficient reaction to maintain stability.

3. Limit movement of ground adjacent to the excavation support system to be within the allowable ground deformation as specified.

4. Design the embedment depth below bottom of excavation to minimize lateral and vertical earth movements and provide bottom stability. Toe of braced temporary excavation support systems shall not be less than 5 feet below the bottom of the excavation.

5. Design temporary excavation support systems to withstand an additional 2 feet of excavation below proposed bottom of excavation without redesign except for the addition of lagging and/or bracing.

6. Maximum width of pipe trench excavation shall be as indicated on the drawings.

7. Do not cast permanent structure walls directly against excavation support walls.

1.6 DELIVERY, STORAGE AND HANDLING

A. Store sheeting and bracing materials to prevent sagging which would produce permanent deformation. Keep concentrated loads which occur during stacking or lifting below the level which would produce permanent deformation of the material.

1.7 PROJECT/SITE CONDITIONS

A. Subsurface Conditions: Refer to the Contract Document for available information.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Structural Steel: All soldier piles, wales, rakers, struts, wedges, plates, waterstop and accessory steel shapes shall conform to ASTM A36.

B. Steel Sheet Piling: ASTM A328, continuous interlocking Z-type. Steel sheet shall be ASTM A572 Grade 60.

C. Timber Lagging Left in Place: Pressured treated per appropriate AWPA standards.

D. Tieback Tendons: Tieback tendons shall be high strength steel wire strand cables conforming to ASTM A416, or bars conforming to ASTM A722. Splicing of individual cables shall not be permitted.

E. Raker Ties: ASTM A615 Grade 60.

F. Cement Grout Materials and Admixtures for Tieback Anchorages: Grout cube strength shall be a minimum 3500 psi at 7 days and 5000 psi at 28 days.

G. Concrete: Refer to Section 03300.

H. Tamping tools adapted for backfilling voids after removal of the excavation support system.

I. Provide specific trench box sizes for each pipe and utility excavation with structural capacity of retaining soil types as described in OSHA's 29 CFR Part 1926 Subpart P.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation of the temporary excavation support systems shall not commence until the related earth excavation and dewatering submittals have been reviewed by the Engineer with all Engineer’s comments satisfactorily addressed.

B. Install excavation support systems in accordance with the temporary excavation support plan.

C. If utilizing a tieback system, all performance and proof tests shall be conducted in the presence of the Engineer. Testing performed without the Engineer present will not be accepted. Repeat testing in the Engineer's presence at no additional cost to the Owner.

D. Do not drive sheeting within 100 feet of concrete less than seven (7) days old.

E. Carry out program of temporary excavation support in such a manner as to prevent undermining or disturbing foundations of existing structures of work ongoing or previously completed.

F. Bottom of the trench box excavation support system shall be above the pipe invert prior to installing the pipe.

G. Install and survey geotechnical instrumentation in accordance with the temporary excavation support plan. Notify the Engineer immediately if any geotechnical instrumentation is damaged. Repair or replace damaged geotechnical instrumentation at the sole option of the Engineer and at no additional cost to the Owner.

H. Continuously monitor movements of the ground adjacent to excavation support systems and adjacent structures. In event of the measured movements approaching or exceeding the allowable movements, take immediate steps to arrest further movement by revising procedures such as providing supplementary bracing, filling voids behind the trench box, supporting utilities or other measures (Construction

Contingency Plan) as required.

I. Notify utility owners if existing utilities interfere with the temporary excavation support system. Modify the existing utility with the utility owner's permission or have the utility owner make the modifications at no additional cost to Owner.

3.2 GROUND DEFORMATION ADJACENT TO EXCAVATION SUPPORT SYSTEMS

A. Criteria for "threshold" and "limiting" movements of wall elements of excavation support system have been established as follows:

1. "Threshold" Horizontal Movement:

Dx = No greater than 1.25 inch where no buildings are present within 25 ft. of support system

Dx = No greater than 0.5 inch where buildings are present within 25 ft. of support system.

Where
Dx = measured horizontal wall movement at any level.

2. "Limiting" Horizontal Movement:

Dx = No greater than 2.0 inches where no buildings are present within 25 ft. of support system

Dx = No greater than 0.75 inch where buildings are present within 25 ft. of support system.

B. The Contractor shall notify the Engineer and shall take immediate steps to control further movement by revising his procedures, providing supplemental bracing or other measures (working 24 hours per day or temporarily terminating work in the area of movement if necessary) as required if any of the following occur:

1. Field measurements indicate that any of the "threshold" movement criteria are reached or exceeded.

2. Field measurements or observations indicate that significant or sustained wall movements are occurring (total movement may be less than the "Limiting" movement criteria).

3. Movements of adjacent structures, utilities or other facilities are detected.

C. If "Limiting" movements are being approached or reached, the Engineer, based on his judgment and review of the movement monitoring data, may require the Contractor to temporarily terminate the work in the area where such movement is

occurring and implement all necessary mitigation measures which are satisfactory to the Engineer, to arrest the movements, at no cost to the Owner.

D. Horizontal or vertical movement of any point on adjacent structures shall not exceed 0.5 inches. The Contractor shall establish and monitor survey points on the adjacent structures. The Contractor shall take all necessary measures to prevent greater settlements, at no additional cost to the Owner.

E. These criteria are intended to establish a minimum basis for the Contractor's design and procedures and in no way relieve the Contractor of his sole responsibility for preventing detrimental movements and damage to adjacent structures, utilities or other work.

F. Monitoring personnel shall use a procedure for reading and recording geotechnical instrumentation data which compares the current reading to the last reading during data collection to eliminate spurious readings.

G. Plot the observed ground deformation readings versus time. Annotate the plots with construction loading and excavation events having an impact on the readings. Evaluate plots by means of secondary rate-of-change plots to provide early warning of accelerating ground movements.

H. Implement Construction Contingency Plan under direction of the temporary excavation support system designer, installation supervisor and the Engineer.

3.3 REMOVAL OF EARTH RETENTION SYSTEM

A. Sheeting shall not be left in place unless otherwise indicated or approved in writing by the Engineer.

B. When indicated or approved by the Engineer, remove the temporary excavation support system without endangering the constructed or adjacent structures, utilities, or property. Immediately backfill all voids left or caused by withdrawal of temporary excavation support systems with bank-run gravel, screened gravel or select borrow by tamping with tools specifically adapted for that purpose.

C. When tiebacks are used, release tension in tiebacks as the excavation is backfilled. Do not leave tensioned tieback in place at the completion of the work.

D. The excavation support system left-in-place shall be cut-off a minimum of 2 feet below the bottom of the next higher foundation level or a minimum of 5 feet below finished grade.

E. Conduct survey of the locations and final cut-off elevations of the excavation support systems left in place.

F. Submit as-built information, prior to backfilling.

3.4 CONTRACT CLOSEOUT

A. Provide in accordance with Section 01700.

END OF SECTION 02160

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SECTION 02200

EARTHWORK

PART 1 – GENERAL

1.1 SUMMARY

A. This Section includes excavations of normal depth in earth for trenches and structures; backfilling such excavations to the extent required; filling; rough grading; miscellaneous earth excavation; temporary excavation support; the removal, hauling and stockpiling of suitable excavated material for subsequent use in the work; all rehandling, hauling and placing of stockpiled materials for use in refilling, filling, backfilling, grading and such other operations; the removal and satisfactory disposal off the site of unsuitable material; compaction; and appurtenant work, complete, in accordance with the Drawings and Specifications, and as directed.

B. Related Sections includes the following:

1. Section 02140 – Dewatering and Drainage

2. Section 02160 – Temporary Excavation Support Systems

3. Section 02212 – Rock Excavation

4. Section 02576 – Pavement Repair and Resurfacing

1.2 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

B. Backfill Materials: If requested by the Engineer, the Contractor shall pay for and submit a grain size analysis and curve performed in accordance with ASTM D422 for each proposed source of backfill for review by the Engineer. The grain size analysis shall indicate that the backfill material conforms to the gradation requirements specified.

C. If requested by the Engineer, submit a controlled density fill (CDF) mix design showing the proportions and gradations of all materials.

D. If requested by the Engineer, submit a moisture-density curve indicating the maximum dry-density and optimum moisture content as determined by ASTM D1557 for each proposed source of backfill for review by the Engineer.

E. Submit the qualifications of the independent geotechnical testing laboratory performing soil testing and inspection services during earthwork operations. The

geotechnical testing laboratory must demonstrate to the Engineer's satisfaction, based on evaluation of laboratory submitted criteria conforming to ASTM D3740, that it has the experience and capability to conduct required field and laboratory geotechnical testing. In addition, the laboratory shall be supervised by a Registered Professional Engineer in the State of Massachusetts.

F. Submit an excavation, backfilling, and filling plan at least one week prior to start of any earth moving activities. The review will be only for the information of the Owner and third parties for an overall understanding of the project relating to access, maintenance of existing facilities and proper utilization of the site. The Contractor shall remain responsible for the adequacy and safety of the means, methods and sequencing of construction. The plan shall include, but not be limited to the following items:

1. Detailed sequence of work.

2. General description of construction methods.

3. Numbers, types, and sizes of equipment proposed to perform excavation and compaction.

4. Details of dust control measures.

5. Proposed locations of stockpiled excavation and/or backfill materials.

6. Proposed surplus excavated material off-site disposal areas and required permits.

1.3 EXCAVATION CLASSIFICATIONS

A. Earth Excavation or "Excavation" consists of removal of materials encountered to the subgrade elevations indicated and subsequent reuse or disposal of the materials removed. All excavation is classified as earth excavation unless it otherwise meets the classifications provided below for exploratory excavation, unauthorized excavation, additional excavation, or rock excavation.

B. Exploratory Excavation, also referred to as test pits, shall consist of the removal of materials for the purpose of locating underground utilities or structures as an aid in establishing the precise location of new work. Exploratory excavation shall be performed as shown on the plans and as directed by the Engineer. Exploratory excavation shall be paid for under the unit cost pay item. Exploratory excavation not directed or approved by the Engineer shall be at the Contractor’s expense.

C. Unauthorized Excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction of the Engineer. Unauthorized excavation, as well as remedial work directed by the Engineer, shall be at Contractor's expense.

D. Additional Excavation:

1. When excavation has reached required subgrade elevations, notify the Engineer who will review subgrade conditions.

2. If unsuitable bearing materials are encountered at required subgrade elevations, carry excavations deeper and replace excavated material as directed by the Engineer.

3. Removal of unsuitable material and its replacement as directed will be paid on the basis of contract conditions relative to changes in work or as provided for under the unit rates for this classification.

E. Rock Excavation:

1. Determination of rock excavation classification will be made by the Engineer as specified in Section 02212 – Rock Excavation.

1.4 EXCAVATION

A. The Contractor shall perform all excavations of every description and of whatever substances encountered, in a manner as required to allow for placing of temporary earth support, forms, installation of pipe and other work, and to permit access to the Engineer for the purpose of observing the work. Excavations shall be to such widths as will give suitable space for the required work. Bottoms of trenches and excavations shall be protected from frost and shall be firm, dry and in an acceptable condition to receive the work; work shall not be placed on frozen surfaces nor shall work be placed on wet or unstable surfaces.

B. All excavations made in open cut will be controlled by the conditions existing at the various locations and shall always be confined to the limits as designated by the Engineer. In no case shall earth be excavated or disturbed by machinery so near to the finished subgrade for structures and pipelines as to result in the disturbance of the earth below the subgrade. The final excavation to subgrade should be accomplished with a smooth faced bucket or by hand if directed by the Engineer.

C. The Contractor shall satisfy all dewatering requirements specified in Section 02140 – Dewatering and Drainage, before performing trench excavations.

1.5 TEMPORARY EARTH SUPPORT

A. The Contractor shall furnish, place and maintain such sheeting, shoring, and bracing at locations necessary to support the sides of excavations and to prevent danger to persons or damage to pavements, facilities, utilities, or structures, and to prevent injurious caving or erosion or the loss of ground, and to maintain pedestrian and vehicular traffic as directed and required in accordance with Section 02160 - Temporary Excavation Support Systems.

PART 2 – PRODUCTS

2.1 BACKFILL MATERIALS

A. Common Fill. Common fill (structural fill, gravel borrow, or backfill) shall consist of inert material that is hard, durable stone and coarse sand free from frost, frozen lumps, loam and clay, surface coatings, and deleterious materials.

Graduation requirements for gravel shall be determined by AASHTO-T11 and T27 and shall conform to the following:

Sieve Designation	Percent Passing
1/2 in.	50-85
No. 4	40-75
No. 50	8-28
No. 200	0-10

Maximum size of stone in gravel shall be 6 inches largest dimension

B. Select Fill:

1. Processed Gravel for pavement sub-base shall conform to the Massachusetts Highway Department Standard Specifications, Section M1.03.1 “Processed Gravel for Sub-Base” and shall be hard, durable stone of proper size and gradation and coarse sand, unfrozen and substantially free from vegetation, roots, loam and other organic matter, clay, snow, frozen particles and other fine or harmful substances.

Processed gravel shall be graded within the following limits:

Sieve Designation	Percentage Passing
3-in	100
1-1/2-in	70 to 100
1/4-in	50 to 85
No. 4	30 to 60
No. 200	0 to 10

2. Screened Gravel. Screened gravel shall consist of hard, durable, particles of proper size and gradation, free from sand, loam, clay, excess fines and deleterious materials. The size of the particles shall be uniformly graded gravel such that not less than 95 percent of the particles will pass a 1/2-in sieve, 40 to 70 percent will pass the 3/8-in sieve, and not more than 5 percent will pass a No. 4 sieve.

3. Crushed stone. Crushed stone shall consist of sound, durable stone, free of any foreign material, angular in shape, free from structural defects and comparatively free of chemical decay. The stone shall be maximum size of 1-1/2-in and a minimum size of 1/2-in. Crushed stone shall be used as ordered by the Engineer.

4. ¾-inch Crushed Stone: Durable, clean angular rock fragments obtained by breaking and crushing rock material. Sieve analysis by weight:

Sieve Size	% Passing by Weight
1"	100
3/4"	95-100
1/2"	35- 70
3/8"	0- 25

5. Sand: Sand shall conform to MassDOT Specification M4.02.02.

C. Topsoil: Friable loam, typical of fertile local topsoil; free from pure clay, weeds, noxious weed seeds, sod, clods and stones larger than 1 inch, toxic substances, litter, or other deleterious material; having a mildly alkaline to medium acid pH between 6.0 and 7.5. Soluble salts shall not exceed 4 milli-mhos per centimeter.

Soil Texture: 20 to 40% fines (silt and clay fraction passing the 200 sieve) and 60 to 80% Sand and gravel. The maximum particle size shall be 1-inch.

Organic Content: 5 to 10%

Additives: As required by soil analysis of Topsoil for lawn areas.

D. Controlled Density Fill (CDF) or "Flowable Fill": Controlled density fill shall consist of a flowable, self-consolidating, rigid setting, low density mixture meeting performance standards as specified in Massachusetts Highway Department 1995 Standard Specifications for Highway and Bridges, Type 1E. CDF is to be batched at a ready mix plant and is to be used at a high or very high slump of approximately 10 to 12 inches. It shall be flowable, require no vibration and after it has been placed can be excavatable by hand tool and/or small machines. The ingredients shall comply with the following:

- Portland Cement – AASHTO M 85
- Fly Ash – AASHTO M 295 Class F
- Sand – M4.02.02 (Massachusetts Highway Specification)
- Controlled Density Fill shall be used as ordered by the Engineer and as shown on the Drawings as backfill for trenches within the State Highway Layout.

2.2 DUST CONTROL

A. Calcium chloride shall conform to AASHTO M144, Type I or Type II.

PART 3 – EXECUTION

3.1 EXCAVATION

A. Cut pavement with a saw or pneumatic tools to prevent damage to remaining pavement without extra compensation. Where pavement is removed in large pieces, dispose of pieces before proceeding with excavation.

B. Do not remove excavation materials from the site of the work or dispose of except as directed or permitted by the Engineer.

C. Provide suitable and safe bridges and other crossings where required for accommodation of travel, and to provide access to private property during construction, and remove said structures thereafter.

D. Trenches shall be excavated to sufficient depths and to sufficient widths for installing new pipe/components where required, placing and removing of decking, sheeting and bracing, and for pumping and drainage facilities. The bottom of the excavations shall be firm and dry and in all respects acceptable to the Engineer. Trench width and depth shall be a practical minimum, as needed for proper execution for the work.

E. While excavating and backfilling is in progress, traffic shall be maintained, and all utilities and other property protected as provided in the General Conditions and General Requirements.

F. Excavation and dewatering shall be accomplished by methods which preserve the undisturbed state of subgrade soils. The trench may be excavated by machinery to, or just below the designated subgrade, provided that material remaining in the bottom of the trench is no more than slightly disturbed. Subgrade soils which become soft, loose, "quick", or otherwise unsatisfactory as a result of inadequate excavation, dewatering or other construction methods shall be removed and replaced by gravel borrow as required by the Engineer at the Contractor's expense.

G. Clay and organic silt soils are particularly susceptible to disturbance due to construction operations. When excavation is to end in such soils, the Contractor shall use a smooth-edge bucket to excavate the last one foot of depth.

H. Where pipe is to be laid in screened gravel, the trench may be excavated by machinery to the normal depth of the pipe plus the depth of the stone, provided that the material remaining in the bottom of the trench is no more than slightly disturbed.

I. Where pipe is to be laid directly on the trench bottom, final excavation at the bottom of the trench shall be performed manually, providing a flat-bottom true to grade upon undisturbed material. Bell holes shall be made as required.

J. Excavate trenches to depths so as to permit pipe to be laid at elevations, slopes, or depths of cover indicated on drawings, and at uniform slopes between indicated elevations.

K. Make pipe trenches as narrow as practicable and do not widen by scraping or loosening materials from the sides. Make every effort to maintain sides of trenches firm and undisturbed until backfilling has been placed and compacted.

L. Excavate trenches with approximately vertical sides for entire depth of trench.

3.2 STOCKPILING OF SURPLUS EXCAVATED MATERIALS

A. The Contractor shall strip and stockpile excavated trench materials. Any bushes that are removed shall be protected and replanted in the same location. Removed curbing shall be stockpiled in a safe manner. Where grassed areas are disturbed by stockpiled materials, the Contractor shall rake out the area and loam and re-seed at his expense.

B. Stockpiling of materials shall be included in the pay items for excavating and no allowances shall be made for any stripping and stockpiling requirements.

C. Should conditions make it impracticable or unsafe to stack material adjacent to the trench, the material shall be hauled and stored at a location provided by the Contractor. When required, it shall be re-handled and used in backfilling the trench.

3.3 PROTECTION OF EXISTING STRUCTURES

A. Carefully support and protect from damage, existing pipes, poles, wires, fences, curbings, property line markers, and other structures, which the Engineer determines must be preserved in place without being temporarily or permanently relocated. Should such items be damaged, restore without compensation therefore, to at least as good condition as that in which they were found immediately before the work was begun. Contractor shall hand dig around existing utilities.

B. Curbing, fencing, sign posts, utility poles, mailboxes, etc. in the vicinity of the Contractor's operations shall be adequately protected, and if necessary removed and restored after backfilling. All items which are damaged during construction shall be replaced with material fully equal to that existing prior to construction.

C. Enclose uncut tree trunks adjacent to work in wooden boxes of such height as may be necessary for protection from injury from piled material, equipment, operations, or otherwise due to work. Operate excavating machinery and cranes of suitable type with care to prevent injury to trees not to be cut and particularly to overhanging branches and limbs.

D. Cut all branches, limbs, and roots smoothly and neatly without splitting or crushing. Neatly trim, cut the injured portions and cover with an application of

grafting wax or tree healing paint as directed.

E. Protect cultivated hedges, shrubs, and plants which might be injured by the Contractor's operations by suitable means or dig up and temporarily replant and maintain. After construction operations have been substantially completed, replant in original positions and care for until growth is reestablished. If cultivated hedges, shrubs, and plants are injured to such a degree as to affect their growth or diminish in their beauty or usefulness, replace by items of equal kind and quality existing at the start of the work.

F. Do not use or operate tractors, bulldozers, or other power-operated equipment on paved surfaces when their treads or wheels of which are so shaped as to cut or otherwise damage such surfaces.

G. Restore surfaces damaged by the Contractor's operations to a condition at least equal to that in which they were found immediately before work commenced. Use suitable materials and methods for such restoration.

3.4 RELOCATION AND REPLACEMENT OF EXISTING STRUCTURES

A. Whenever certain existing structures, as described below, are encountered, and the Engineer so directs, change the location, remove and later restore, or replace such structures, or assist the Owner in doing so. Such work to be paid for under applicable items of work, otherwise as Extra Work.

B. In removing existing pipes or other structures, include for payment only those new materials which are necessary to replace those unavoidably damaged as determined by the Engineer.

C. The preceding two paragraphs apply to pipes, wires, and other structures which meet the following: (a) are not indicated on the drawings or otherwise provided for, (b) encroach upon or are encountered near and substantially parallel to the edge of the excavation, and (c) in the opinion of the Engineer, will impede progress to such an extent that satisfactory construction cannot proceed until they have been changed in location, removed (to be later restored), or replaced.

3.5 EXCAVATION SUPPORT SYSTEM

A. Furnish, put in place and maintain sheeting and bracing required by Federal, State or local safety requirements to support the sides of the excavation and prevent loss of ground which could endanger personnel, damage or delay the work or endanger adjacent structures. If the Engineer is of the opinion that at any point sufficient or proper supports have not been provided, he/she may order additional supports placed at the expense of the Contractor. Compliance with such order shall not relieve the Contractor from his/her responsibility for the sufficiency of such supports. Care shall be taken to prevent voids outside of the sheeting, but if voids are formed, they shall be immediately filled and rammed.

B. When moveable trench bracing such as trench boxes, manhole boxes, moveable sheeting, shoring or plates are used to support the sides of the trench, care shall be taken in placing and moving the boxes or supporting bracing to prevent movement of the pipe, or disturbance of the pipe bedding and the screened gravel backfill.

C. When installing pipe; trench boxes, moveable sheeting, shoring or plates shall not be allowed to extend below mid-diameter of the pipe. As trench boxes, moveable sheeting, shoring or plates are moved, screened gravel shall be placed to fill any voids created and the screened gravel and backfill shall be recompacted to provide uniform side support for the pipe.

D. The Contractor will be permitted to use steel sheeting in lieu of wood sheeting for the entire job wherever the use of sheeting is necessary. The cost for use of sheeting will be included in the bid items for pipe and shall include full compensation for driving, bracing and later removal of sheeting.

E. All sheeting and bracing shall be carefully removed in such manner as not to endanger the construction of other structures, utilities, or property, whether public or private. All voids left after withdrawal of sheeting shall be immediately refilled with sand by ramming with tools especially adapted to that purpose, by watering or otherwise as directed.

F. The Contractor shall receive no payment, for sheeting, bracing, etc., during the progress of the work. The Contractor shall receive no payment for sheeting which has actually been left in the trench for the convenience of the Contractor.

G. Sheeting driven below mid-diameter of any pipe shall remain in place from the driven elevation to at least 1-ft above the top of the pipe.

3.6 BACKFILLING

A. As soon as practicable after the pipe has been laid and jointed and inspected by the Engineer, backfilling shall begin and thereafter be prosecuted expeditiously. Screened gravel shall be placed by hand shovel in 6-inch thick lifts up to the springline of the pipe. This area of backfill is considered the zone around the pipe and shall be thoroughly compacted before the remainder of the trench is backfilled.

B. Where the pipes are laid in streets, the remainder of the trench up to a depth of 12-inches below the bottom of the specified permanent paving shall be backfilled with gravel borrow material in layers not to exceed 6-inches and thoroughly compacted. The sub-base layer shall be 12-inches of processed gravel thoroughly compacted.

C. To prevent longitudinal movement of the pipe, dumping backfill material into the trench and then spreading will not be permitted until selected material or screened gravel has been placed and compacted to a level 12-inches over the pipe.

D. Unfavorable Conditions:

1. In no case shall fill be placed over material that is frozen. No fill material shall be placed, spread or rolled during unfavorable weather conditions. When work is interrupted by heavy rains, fill operations shall not be resumed until the moisture content and the density of the previously placed fill are as specified.

2. In freezing weather, a layer of fill shall not be left in an uncompacted state at the close of the day's operations. Prior to terminating work for the day, the final layer of compacted fill shall be rolled with a smooth wheeled roller to eliminate ridges of soil left by compaction equipment.

E. An impervious dam or bulkhead cutoff of clay or other impervious material shall be constructed in the trench as directed, to interrupt the unnatural flow of groundwater after construction is completed. The dam shall be effectively keyed into the trench bottom and sidewalls. Provide at least one clay or other impervious material dam in the pipe bedding between each manhole where directed or every 300 feet, whichever is less.

F. Backfilling and filling operation shall be suspended in areas where tests are being made until tests are completed and the testing laboratory has advised the Engineer that adequate densities are obtained.

G. Subject to the approval of the Engineer, fragments of ledge and boulders smaller than 6-in may be used in trench backfill providing that the quantity in the opinion of the Engineer, is not excessive. Rock fragments shall not be placed until the pipe has at least 2-ft of earth cover. Small stones and rocks shall be placed in thin layers alternating with earth to insure that all voids are completely filled. Fill shall not be dropped into the trench in a manner to endanger the pipe.

H. Bituminous paving shall not be placed in backfilling unless specifically permitted, in which case it shall be broken up as directed. Frozen material shall not be used under any circumstances.

I. All road surfaces shall be broomed and hose-cleaned immediately after backfilling. Dust control measures shall be employed at all times.

J. Exploratory excavation shall be backfilled as soon as the desired information has been obtained. The backfilled surface shall be maintained in a satisfactory condition for travel until resurfaced as specified.

3.7 COMPACTION

A. Compaction Requirements: The degree of compaction is expressed as a percentage of the maximum dry density at optimum moisture content as determined by ASTM Test D1557, Method C. The compaction requirements are as follows:

Area	ASTM Density Degree of
Pavement sub-base	95%
General fill below pavement sub-base	92%

B. Moisture Control:

1. Fill that is too wet for proper compaction shall be dried to a proper moisture content to allow compaction to the required density. If fill cannot be dried within 24 hours of placement, it shall be removed and replaced with drier fill.

2. Fill that is too dry for proper compaction shall receive water uniformly applied over the surface of the loose layer. Sufficient water shall be added to allow compaction to the required density.

C. Compaction Control:

1. In-place density tests shall be made in accordance with ASTM D1556, D2922 or D2167 as the work progresses, to determine the degree of compaction being attained by the Contractor. Any corrective work required as a result of such tests, such as additional compaction, or a decrease in the thickness of layers, shall be performed by the Contractor at no additional expense to the Owner. In-place density tests will be made by a geotechnical engineer selected by the Engineer or the Contractor's independent testing laboratory at the Contractor’s expense.

2. The Engineer's duties do not include supervision or direction of the actual work by the Contractor, his employees or agents. Neither the presence of the Engineer nor any observation and testing performed by him shall excuse the Contractor from defects discovered in his work at that time or subsequent to the testing.

D. Material Testing Frequency: The following testing frequencies are minimum required for all structural and non-structural fill, grading and embankment.

1. Field In-Place Density and Moisture Content - Screened gravel and crushed stone shall be compacted as specified and indicated. For other backfill and fill materials, minimum test frequency shall be as follows, and no less than one test per lift:

   a. Trenches under structures foundation preparation or roadways sub-base: Every 100 lin. ft. per lift.
   b. Trenches in areas without structures or roadways: Every 250 lin. ft. per alternate lift.
   c. Paved Roadways: Every 100 lin. ft. per lift.
   d. Paved Areas: 2,000 sq. ft. per lift.

e. Under Structure: 1,000 sq. ft. per lift.
f. Around Structures: 1,500 sq. ft. per lift.
g. Embankment Fills: 5,000 sq. ft. per lift.

2. Moisture Density - One per source, except for screened gravel and crushed stone. Repeat the moisture density test for every 1,000 cubic yard of material use, and whenever visual inspection indicates a change in material gradation as determined by the Engineer.

3. Gradation Analysis - A minimum of one per source and for each moisture density test and whenever visual inspection indicates a change in material gradation.

4. Liquid Limit, Plastic Limit and Plasticity Index - Minimum of one test per 500 cubic yards [382 cubic meters] of soil for use as fill material and whenever classification of material is in doubt as determined by the Engineer.

E. Compaction Methodology:

1. Each layer of backfill material shall be thoroughly compacted by rolling, tamping, or vibrating with mechanical compacting equipment or hand tamping. If rolling is employed, it shall be by use of a suitable roller or tractor, being careful to compact the fill throughout the full width of the trench.

2. Backfilling operations shall be such that material is compacted in 6 inch lifts, including the trench around the barrel of the pipe. Compaction of each lift up to a minimum of 12-inches above the pipe shall be done by use of power-driven tampers weighing at least 20 pounds or by vibratory compactors. Care shall be taken as to not place excessive pressure on the new pipe.

3. Vibratory mechanical compaction is the preferred method for compaction. Should jetting be proposed by the Contractor, its viability to achieve the required degree of compaction shall be proven on a test section of trench, prior to allowing its use on a widespread basis. Compaction testing shall be used to determine the effectiveness of the jetting operation. Jetting shall be accomplished using a rigid pipe, long enough to reach deep into the trench. Large volumes of water under high pressure equivalent to that available from a fire hydrant, are necessary for jetting. The Contractor is made aware that municipal water may not be available due to limited supply. The Contractor shall provide water for jetting operations at his own expense. Jetting locations shall be frequent enough to achieve required compaction.

4. Where other methods are not practicable, compaction shall be by use of hand or pneumatic ramming with tools weighing at least 20 lbs. The material being spread and compacted in layers not over 6-in thick. If

necessary, sprinkling shall be employed in conjunction with rolling or ramming.

5. In backfilling trenches, each layer of backfill material shall be moistened and compacted to a density at least equal to that of the surrounding undisturbed earth, and in such a manner as to permit the rolling and compaction of the filled trench or excavation with the adjoining earth to provide the required bearing value, so that paving of the excavated and disturbed areas, where required, can proceed immediately after backfilling is completed.

3.8 FINE GRADING

A. Before surface or sub-base is spread, the subgrade shall be shaped to a true surface conforming to the Drawings. All depressions and high spots shall be filled with suitable material or removed and such areas again compacted until the surface is smooth and properly compacted. A tolerance of 1/2-inch above or below the finished subgrade will be allowed provided that this 1/2-inch above or below grade is not maintained for a distance longer than 50 feet and that the required crown is maintained in the subgrade. Any portion which is not accessible to a roller shall be thoroughly compacted by other mechanical methods.

B. Construction Tolerances:

1. Construct finished surfaces to plus or minus 1 inch of the elevations indicated.

2. Grade cut and fill areas to plus or minus 0.20 foot of the grades indicated.

3. Complete embankment edges to plus or minus 6 inches of the slope lines indicated.

4. Provide the Engineer with adequate survey information to verify compliance with above tolerances.

3.9 DUST CONTROL

A. Calcium chloride shall be applied when ordered by the Engineer and only in areas which will not be adversely affected by the application.

B. Calcium chloride shall be uniformly applied at a rate of 1-1/2 pounds per square yard or at any other rate as directed by the Engineer. Application shall be by means of a mechanical spreader, or other approved method. The number and frequency of applications shall be determined by the Engineer.

3.10 PLACING TOPSOIL

A. Scarify compacted subgrade to a 2-inch depth to bond topsoil to subsoil. Place topsoil to a minimum depth of 4 inches for areas disturbed by Contractor's construction operations and as shown on the Drawings. Spread evenly and grade to elevations and slopes shown. Hand rake areas inaccessible to machine grading.

END OF SECTION 02200

SECTION 02212

ROCK EXCAVATION

PART 1 – GENERAL

1.1 SUMMARY

A. Rock excavation may be required where boulders, monolithic concrete, reinforced concrete or stone structures measuring in excess of one cubic yards solid in volume or larger are encountered or solid ledge which, in the opinion of the Engineer, requires drilling, wedging, sledging, cutting, barring, or hydraulically fracturing for removal, is encountered.

B. The following do not constitute rock excavation: hardpan; soft or disintegrated rock; concrete which can be removed with a pick; previously blasted rock or broken stone less than the above mentioned one cubic yard; stone walls; rocks or sections of blasted ledge that may fall into or be jarred loose from the sides of the trench beyond the maximum limits of excavation approved by the Engineer.

C. Blasting is not allowed.

1.2 SCOPE OF WORK

A. Furnish all labor, materials, equipment, and incidentals required to excavate and dispose of rock and boulders as shown on the Drawings and as specified herein.

1.3 RELATED WORK

A. Section 01110 – Environmental Protection Measures

B. Section 02200 – Earthwork

1.4 DELIVERY, STORAGE, AND HANDLING

A. The delivery, storage, and handling of explosives shall be performed only by qualified persons licensed in Massachusetts, and shall be in full conformance with all laws, regulations, ordinances, and practices. Extreme care shall be taken to avoid injury or damage to persons or property.

1.5 DEFINITIONS

A. Typical of materials classified as rock are boulders 1.0 cu. yd. or more in volume, solid rock, rock in ledges, and rock-hard cementitious aggregate deposits. Intermittent drilling or ripping performed to increase production and not necessary to permit excavation of material encountered will be classified as earth excavation.

Do not perform rock excavation work until material to be excavated has been cross-sectioned and classified by Engineer. If the area to be excavated is predrilled prior to the excavation of overburden soils, the Engineer shall be notified at least two days in advance to allow observation of the drilling by the Engineer in order to classify the excavation. Visual observation of the completed excavation may be made by the Engineer to modify the excavation classifications. Removal of rock excavation prior to classification by the Engineer shall be considered as earth excavation unless accepted by the Engineer in writing. Such excavation will be paid on the basis of contract unit rates for this classification.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Gravel borrow shall be as specified in Section 02200 under Common Fill.

PART 3 – EXECUTION

3.1 DISPOSAL OF ROCK AND BOULDERS

A. Fragmented rock with dimensions not exceeding six (6) inches in any direction may be mixed with common fill, providing compaction requirements will not be compromised.

B. Rock and boulders may be crushed and screened for reuse in the Work, provided that the resultant materials meet the requirements for gravel borrow, processed gravel, or crushed stone as specified in Section 02200.

C. Unused rock and boulders shall be removed and disposed of off-site.

END OF SECTION 02212

SECTION 02435

WET WELL EPOXY LINING

PART 1 - GENERAL

1.1 WORK INCLUDED:

A. This Section covers the epoxy lining of the rehabilitated sewer wet well at the Clapboardtree Street Pump Station as called for herein and as shown on the Contract Drawings. It is the intent of this specification to govern all work, materials, and equipment required for the purpose of providing corrosion protection for the rehabilitated sewer wet well at the Clapboardtree Street Pump Station as a result of applying an epoxy lining to the interior of the existing concrete structure.

B. This Section includes procedures for cleaning, preparation, application and testing. The applicator, approved and trained by the manufacturer, shall furnish all labor, equipment and materials for applying an epoxy lining to form a monolithic liner. All aspects of the installations shall be in accordance with the manufacturer's recommendation and per the following specifications which includes:

1. The removal of any loose and unsound material

2. Pressure washing and cleaning of the area to be coated.

3. The elimination of active infiltration prior to liner application.

4. The repair and filling of voids

5. The application of a cementitious liner to provide structural enhancement

6. The application of a 100% solids epoxy primer

7. The spray application of an epoxy liner to provide corrosion protection.

C. The Contractor shall furnish all equipment, material and labor required to perform all epoxy lining work as described in this specification.

D. External grouting of inverts, bench, walls, corbel, and pipe connections shall be performed prior to application of liner system.

1.2 RELATED WORK:

A Drawings and general provisions of Division 0 and Division 1 Specification Sections, apply to this section.

B. Examine all Contract Documents and all other Sections of the Specifications for requirements therein affecting the work of this trade.

1. Section 02538 – Temporary By-Pass Sewage Pumping

2. Section 02570 – Sewers, Manholes and Appurtenances

3. Section 03700 – Modifications to Existing Concrete

1.3 QUALITY ASSURANCE:

A. The Work described herein shall be performed by a company with not less than five (5) years of experience in providing the required services, employing experienced workers and experienced supervisory personnel. Supervisory personnel shall have not less than three (3) years of experience in providing the required services and shall be present at the jobsite during all work related to the required services.

1.4 REFERENCES:

A. The following standards form a part of this specification as referenced:

The National Association of Sewer Service Companies (NASSCO) Recommended Specifications for Sewer Collection System Rehabilitation (Current Edition).

ASTM F2551	Standard Practice for Installing a Protective Cementitious Liner System in Sanitary Sewer Manholes
ASTM C94	Ready-Mix Concrete
ASTM C109	Comprehensive Strength
ASTM C234	Standard Test Method for Comparing Concretes on the Basis of the Bond Developed with Reinforcing Steel
ASTM C267	Chemical Resistance
ASTM C490	Standard Practice for Use of Apparatus for the Determination of Length Change of Hardened Cement Paste, Mortar, and Concrete
ASTM C596	Shrinkage
ASTM C666, Method A	Freeze/Thaw Resistance
ASTM D4414	Standard Practice for Measurement of Wet Film Thickness for Organic Coatings
ASTM 543	Resistance of Plastics to Chemical Reagents
ASTM 638	Tensile Properties of Plastic
ASTM 695	Comprehensive Properties of Rigid Plastics
ASTM C882	Standard Test Method for Bond Strength of Epoxy-Resin Systems Used With Concrete By Slant Shear
ASTM D790	Flexural Properties of Unreinforced and Reinforced Plastics

1.5 LINING SYSTEM DESCRIPTION:

A. Unless otherwise indicated herein, sewer wet well sealing shall be carried out in accordance with the current edition of PERFORMANCE SPECIFICATION GUIDELINE FOR MANHOLE REHABILITATION**,** of NASSCO Recommended Specifications for Sewer Collection System Rehabilitation.

B. The Contractor may propose alternative processes and/or products for review and approval by the Engineer.

C. The location of the sewer wet well scheduled to be epoxy lined is shown on the Drawings.

1.6 SUBMITTALS:

A. Prior to beginning the work, submit the following information:

1. Qualifications of the firm/personnel who will perform the Work.

2. Provide at least five (5) references of different projects in which at least 50 manholes have been epoxy lined by the firm within the past three (3) years.

3. Description of the system, equipment and material with MSDS proposed for sewer wet well epoxy lining.

4. Manufacturer's warranty.

B. Prior to applying epoxy liner, Contractor shall submit a report to the Engineer certifying that the concrete has been prepped in accordance with the specification requirements and in accordance with the manufacturer's recommendations.

1.7 WARRANTY:

A. The wet well lining work performed shall be warrantied against infiltration and faulty workmanship and materials for a period of one (1) year after the project is accepted by the Owner.

PART 2 - PRODUCTS

2.1 REHABILITATION MATERIALS:

All products used for lining, sealing, patching, and cleaning shall be environmentally safe. The contractor shall submit MSDS Data Sheets for all materials used.

2.2 SEALING OF INVERT, STOPPING ACTIVE LEAKS AND EXTERIOR CHEMICAL SEALING:

The contractor shall use a chemical grout that is environmentally safe for the sealing of sewers. The chemical grout shall be in accordance with CHEMICAL SEALING (GROUTING) MATERIALS of the NASSCO Standard Specifications.

2.3 PATCHING MIX:

A quick-setting cementitious material shall be used as a patching mix and is to be mixed and applied according to the manufacturer's recommendation and shall have the following minimum requirements.

Compressive Strength	ASTM C-109	6 hr 1,400 psi
Bond		>1,600 psi, 28 days
Calcium Aluminate Cement		Sulfate resistant
Applied Density		105 pcf +/- 5 lbs
Shrinkage	ASTM C-490	0% AT 90% Relative Humidity
Placement Time		5-10 minutes
Set Time		15-30 minutes

2.4 INFILTRATION CONTROL MIX:

A rapid-setting cementitious product specifically for leak control shall be used to stop water infiltration and shall be mixed and applied according to the manufacturer's recommendations and shall have the following minimum requirements.

Compressive Strength	ASTM C-109	1 hr >400 psi 24 hr 1,000 psi
Sulfate Resistance	ASTM C-267	No weight loss after 15 cycles @ 2,000 ppm
Freeze/Thaw	ASTM C-666 Method A	100 cycles
Pull Out Strength	ASTM C-234	14,000 lbs
Placement Time		<1.0 minute

2.5 CEMENTITIOUS LINER MIX:

The cementitious liner mix shall be used to form a structural enhancing monolithic liner covering all interior concrete surfaces and shall have the following minimum requirements at 28 days:

Compressive Strength	ASTM C-109	6,000 psi

Shrinkage	ASTM C-596	0%, 90% humidity
Freeze/Thaw Resistance cycles	ASTM C-666	No visible damage after 100

The liner mix shall be applied in one monolithic layer.

2.6 CORROSION PROTECTIVE COATING (EPOXY PRIMER AND LINER)

The corrosion protective coating shall be a 100% solids, solvent-free two-component epoxy resin system thixotropic in nature and filled with select fillers to minimize permeability and provide sag resistance acceptable to the following specifications:

Volatile Organic Compounds (vol %)	ASTM D2584	0%
Flexural Strength	ASTM D790	13,000 psi
Compressive Strength	ASTM D695	18,000 psi
Tensile Strength	ASTM D638	7,600 psi
Tensile Elongation	ASTM D638	1.50 %
Hardness, Type D	ASTM D2240	88
Adhesion	ASTM D4541	>Tensile Strength of Concrete (substrate failure)
Chemical Resistance	(ASTM D543)	Sulfuric Acid, 10% Immersion Service

2.6 BRICK MATERIALS:

A. Brick shall be sound, hard, and uniformly burned brick, regular and uniform in shape and size, of compact texture, and satisfactory to the Engineer. Bricks shall comply with ASTM C32. Grade SS shall be used for inverts and shelves, and Grade MS shall be used for applications other than inverts and shelves. Rejected brick shall be immediately removed from the work and brick satisfactory to the Engineer substituted.

B. Concrete Masonry Units: Concrete masonry units shall be made from hydraulic cement, water, and suitable mineral aggregates, and conform to ASTM C139.

C. Mortar shall be composed of Portland cement, hydrated lime, and sand in which the volume of sand shall not exceed three times the sum of the volumes of cement and lime. Mortar for Grade SS Brick shall be mixed in the volume proportions of 1:1/2:4-1/2; Portland cement to hydrated lime to sand.

D. Cement shall be Type II Portland cement as specified for concrete masonry.

E. Hydrated lime shall be Type S conforming to ASTM C207.

F. Sand shall comply with ASTM C144 specifications for "Fine Aggregate," except that all of the sand shall pass a No. 8 sieve.

2.7 CONCRETE:

A. Cement shall be domestic Portland Cement conforming to ASTM C150, Type II.

B. Fine aggregate shall be washed natural sand conforming to ASTM C33.

C. Coarse aggregate shall be well graded crushed stone conforming to ASTM C33, size No. 67.

D. No admixtures shall be used unless approved by the Engineer in writing.

2.8 WATER:

A. Water used in mixing shall be potable.

2.9 DELIVERY, STORAGE, AND HANDLING:

A. Materials shall be delivered to the site in the Manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.

B. All materials shall be stored properly and in accordance with Manufacturer's instructions.

PART 3 - EXECUTION

3.1 SAMPLING AND TESTING OF LINER:

A. The Owner reserves the right to test all materials.

B. Products that fail to meet the requirements of these specifications shall not be incorporated in the work.

3.2 SURFACE PROTECTION:

A. During progress of work, where appearance is important, adjacent areas or grounds which may be permanently discolored, stained, or otherwise damaged by dust and rebound, shall be adequately protected and, if contacted, shall be cleaned by early scraping, brushing or washing, as the surroundings permit.

B. No street markings shall be removed or covered throughout the progress of work.

3.3 EXISTING FLOWS:

A. The Contractor shall divert flows as required for the work in accordance with the requirements in Section 02538 – Temporary By-Pass Sewage Pumping.

3.4 CEMENTITIOUS LINING:

A. PREPARATION

1. Remove all foreign material from the wet well wall and bench using a high-pressure water spray (minimum 5,000 psi). Loose and protruding brick, mortar, and concrete shall be removed using a mason's hammer and chisel and/or scraper. Fill any large voids with quick-setting patching mix. Surfaces to be repaired shall be clean and free of loose materials. Additional surface preparation shall be as recommended by the manufacturer of the materials to be applied.

2. Leaks shall be stopped using a chemical grout, which shall be applied as per the manufacturer's recommendations. Leaks may require weep holes drilled at the wet well base to localize the infiltration during the application, after which the weep holes shall be sealed with a chemical grout and plugged with the quick-setting infiltration control mix prior to the final liner application. Areas with evidence of previous leakage (e.g., mineral deposits) shall also be grouted.

B. INVERT SEALING

1. The Contractor shall carry out all work as described in SEWER MANHOLE SEALING 3 (3.1) of the NASSCO Standard Specifications using sealing materials and procedures accepted by the Engineer. Grout ports shall be located in the invert and base of the wet well. The Contractor shall also ensure that sealing material is injected at the wet well/pipe connections. A quick setting patch mix shall be troweled uniformly not to exceed ½-inch, onto the damaged invert extended out onto the base of the wet well sufficiently to tie into the structurally enhanced monolithic liner to be applied. The finished inverts shall create a smooth transition between the wet well invert and cured-in-place liner. Application of the quick setting patch mix will not be required in the wet well that will have a cured-in-place liner through the invert. The locations are as indicated on the plans.

C. INTERIOR SEALING

1. Interior lining of the wet well shall be conducted only after all wet well demolition work and existing concrete repair work has been completed.

2. Unless otherwise indicated herein, the Contractor shall carry out all work as described in SEWER MANHOLE REHABILITATION, CEMENTITIOUS LINER, of the NASSCO Standard Specifications using lining materials and

procedures accepted by the Engineer.

3. Preparation, as described in the above referenced NASSCO specification, shall be completed prior to the placement of the cementitious liner.

4. Sealant shall not be placed on a frozen surface or during freezing weather. Sealant shall not be placed when it is anticipated that the temperature during the following 24 hours will drop below 32 degrees, Fahrenheit.

5. Pipes and/or service connections shall be temporarily plugged prior to the application of the cementitious wet well interior liner. A flash coat of the liner material shall be applied three (3) inches into each service connection. Temporary plugs shall be removed once the liner has cured sufficiently to prevent erosion of the new liner.

6. Thickness shall be verified with a wet gauge at random points of the new interior surfaces as required by the Engineer. Minimum thickness of one-half (½) inch is required.

7. Application shall be with low velocity, continuous flow equipment to prevent the adverse effects of rebound. A smooth trowel finish shall be applied.

8. The Contractor shall prohibit debris from entering the invert by either covering the invert or plugging during application.

D. DIGITAL PHOTOGRAPHS

1. The Contractor shall take a digital photograph of the interior of the wet well, before and after lining, in JPEG format. Filenames shall contain wet well designations. Digital photographs shall have a minimum resolution of ten (10) megapixels.

3.5 CORROSION PROTECTIVE COATING

A. Installation of the corrosion protective coating shall not commence until the cementitious liner material has properly cured and been prepared in accordance with manufacturer recommendations.

B. The specified corrosion protective coating shall be applied utilizing manufacturer approved heated plural component spray equipment. The protective coating shall be applied in two coats to achieve 125-250 mil average thickness. The second coat of the protective coating should occur as soon as the basecoat becomes tack free, ideally within 12 hours but no later than the recoat window for the specified product. Additional surface preparation procedures are required if this recoat window is exceeded.

3.6 REPAIR WET WELL CORBEL, INVERT AND BENCH:

A. Existing wet well bench and invert (including debris, brick, block, and mortar) shall be removed and disposed of.

B. Bricks shall be moistened by suitable means, as directed, until they are neither so dry as to absorb water from the mortar nor so wet as to be slippery when laid.

C. Each brick shall be laid as a header in a full bed and joint of mortar without requiring subsequent grouting, flushing or filling, and shall be thoroughly bonded as required.

D. Channels and shelves shall be constructed of brick and concrete as shown on the Drawings. The brick lined channels shall correspond in shape with the lower half of the pipe. The top of the shelf shall be set at the elevation of the crown of the highest pipe and shall be sloped 1 inch per foot to drain toward the flow through channel. Brick surfaces exposed to sewage flow shall be constructed with a nominal 2-inch by 8-inch face exposed (i.e. bricks on edge).

3.7 WET WELL GROUTING TO STOP LEAKS:

A. The Contractor shall drill grout ports at all leaks. Chemical sealing material shall be pumped through the grout ports to seal the exterior of the wet well. Areas with evidence of previous leakage (e.g., mineral deposits) shall also be grouted. Grout ports shall be plugged with the quick-setting infiltration control mix following completing of grout installation.

B. The Contractor shall prohibit debris from entering the invert by either covering the invert.

C. The chemical sealing material used shall be as described in chemical sealing (grouting) materials of the NASSCO Standards Specification.

D. The Contractor shall be aware of the potentially close proximity of grout ports to underdrain piping. The Contractor shall take care in making sure grout is not pumped into the underdrain during this process.

3.8 FIELD TESTING/INSPECTION:

A. Material Testing: One 2 x 2 inch sample cube shall be taken for every 50 bags of cementitious lining material used. Samples shall be sprayed from the nozzle of the application equipment, identified and sent to an independent test laboratory for compression strength testing as described in ASTM C109.

B. Thickness Testing: During application of the corrosion protective coating a wet film thickness gage, such as those available through Paul N. Gardner Company, Inc. meeting ASTM D4414 - Standard Practice for Measurement of Wet Film Thickness of Organic Coatings by Notched Gages, shall be used to ensure a monolithic coating

and uniform thickness during application.

C. Holiday Testing: After the protective coating has set hard to the touch it shall be inspected with high-voltage holiday detection equipment. Surfaces shall first be dried, an induced holiday shall then be made on to the coated concrete surface and shall serve to determine the minimum/maximum voltage to be used to test the coating for holidays at that particular area. The spark tester shall be initially set at 100 volts per 1 mil (25 microns) of film thickness applied but may be adjusted as necessary to detect the induced holiday (refer to NACE RPO188-99). All detected holidays shall be marked and repaired by abrading the coating surface with grit disk paper or other hand tooling method. After abrading and cleaning, additional protective coating material can be hand applied to the repair area. All touch-up/repair procedures shall follow the protective coating manufacturer's recommendations.

D. Bond Strength: Measurement of bond strength of the protective coating to the substrate shall be made at regular intervals and along different sections of the structure. Bond strength shall be measured in accordance with ASTM D4541. Any areas detected to have inadequate bond strength shall be evaluated by the Project Engineer. Further bond tests may be performed in that area to determine the extent of potentially deficient bonded area and repairs shall be made by Applicator in strict accordance with manufacturer's recommendations.

E. Prior to the expiration of the warranty period, the Contractor shall inspect the sewer wet well rehabilitated during this project in accordance with SEWER MANHOLE SEALING of the NASSCO Standard Specifications at a time where groundwater is sufficiently high as determined by the Engineer. The Contractor shall repair any defects found, there shall be no leaks and no evidence of previous leakage.

F. All inspecting, testing, and reworking within the warranty period shall be provided at no additional cost to the Owner.

END OF SECTION 02435

SECTION 02538

TEMPORARY BY-PASS SEWAGE PUMPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions - BIDDING AND CONTRACT REQUIREMENTS and other DIVISION 1 Specification Sections, apply to this section.

1.2 SUMMARY

A. Furnish, install, field test, and operate temporary by-pass pumping systems for the purpose of diverting sewage flow around work areas for the duration of the project. The pumping system shall protect against surcharging of the existing sewer system upstream of the work area by installing adequate temporary by-pass pumping to handle dry weather and wet weather flows. Provide all labor, tools, materials, and equipment necessary to by-pass flow around the work areas.

B. The design, installation, and operation of temporary by-pass pumping systems shall be the Contractor's responsibility. The Contractor shall provide the services of a professional bypass company who can demonstrate to the Owner and Engineer that the company specializes in the design and operation of temporary bypass pumping systems. The by-pass system shall meet the requirements of all codes and regulatory agencies having jurisdiction.

C. By-pass operations shall be continuously monitored by the Contractor, regardless of duration or timing of by-passing. By-pass should be coordinated with low-flow times, to the extent feasible.

D. Maintain temporary by-pass pumping systems so that they are completely functional throughout the required period of service.

E. Provide all maintenance including manufacturer recommended preventative maintenance and on-call repair services. Contractor shall provide repair services and/or replacement equipment 24 hours per day, 7 days per week within 4 hours of being notified.

F. The Contractor shall not allow sewage flow to discharge to any salt or fresh water body by means of overflow, by-pass pumping, or any other method that may contaminate these water areas.

A. Except as specifically permitted, the installation of the by-pass pipelines is prohibited in all saltmarsh/wetland areas. The pipeline must be located off streets and sidewalks and on shoulders of the roads. When the by-pass pipeline crosses local streets and private driveways, the Contactor must place the by-pass pipelines in a portable hose ramp, or place temporary bituminous pavement, cold patch, or other approved material to

form a ramp on each side of the pipe to the satisfaction of the Engineer or by depressing the pipe as directed by the Engineer.

G. The ramp shall be high load bearing capacity. Upon completion of the by-pass pumping operations, the Contractor shall remove all piping, restore all property to pre-construction condition, and restore all pavement. The Contractor is responsible for obtaining any approvals from the Owner for placement of the temporary pipeline within public ways.

1.3 SUBMITTALS

A. Submit the following in accordance with the Conditions of Contract and Division 1 Specification Sections and as specified herein:

1. A detailed description of the proposed pumping systems, project approach, and requirements here within stamped by a Professional Engineer in the State of Massachusetts.

2. A detailed description of the proposed temporary by-pass pumping system including pumps, pump drives, piping, hoses, valves, fittings, controls, wiring, and other ancillary accessories required to provide a complete operating system.

3. Complete list of system components to be provided.

4. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.

5. Performance data for each type of equipment that will show compliance with specification requirements stated herein.

6. Detailed plans and sections showing the proposed pumping system layout. Plan shall include but not limited to the following:

   a. Staging area and access requirements for all pumps.
   b. Number, size, material, location, and method of installation of suction piping.
   c. Number, size, material, location, and method of installation of discharge piping.
   d. Sewer plugging method and types of plugs.
   e. Pump size, capacity, number of units, fuel tank capacity, fuel consumption requirements, and method of refueling.
   f. Calculations of static lift, pipe size selection, friction losses, flow velocity, and pump selection.
   g. Provide pump performance curves showing they meet calculated requirements for head, capacity, and NPSH.

   h. Proposed method of noise control for each pump with external Dba value.

i. Temporary pipe supports, anchorage, cover material, and other accessories as required to stabilize the piping system..
j. Proposed pump controls and alarm panel and system for remote transmittal of alarms.

7. Emergency response plan describing the intended means of handling but not limited to the following:

a. Break or failure of by-pass piping.
b. Failure of by-pass pump.
c. Overflows.
d. Backup into dwelling or onto private property.
e. Operations during inclement weather including snow storms.

8. Contact phone number and pager number for 24-hour service.

9. Recommend spare parts to be stored on-site for emergency maintenance.

10. Procedures for start-up and testing of the bypass pumping system to demonstrate compliance with specified automatic operation and maintenance requirements.

11. Field inspection reports

1.4 QUALITY ASSURANCE

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

B. The Contractor shall employ the services of a professional bypass pumping company who can demonstrate five years of recent and continuous specialization in the design, installation, operation, and removal of temporary bypass pumping systems in wastewater applications. The complete system shall be furnished from a single vendor who shall be capable of providing service staff, repair parts and replacement of any deficient system component within 1 hour of a service call, twenty-four hours per day, and seven days per week.

C. The by-pass pumping system shall be standard equipment and totally suited for the application as detailed herein. The equipment to be furnished shall be satisfactory and safely designed, in accordance with the design parameters as detailed in these contract documents. It shall be constructed for continuous, automatic operation, for extended periods of time.

D. All items shall be designed and constructed in full accordance with all applicable state and local codes and regulations. Labor, materials, and costs required to meet state codes shall be the responsibility of the Contractor and the professional by-pass pumping company.

E. Provide services of factory-trained professional bypass pumping company representative, specifically trained on type of equipment specified:

a. 1 day per pumping system set-up

1.5 FLOW DATA

A. The project area consists of active sanitary sewers; therefore, flows and flow data are variable depending on location and conditions. It is the responsibility of the Contractor to maintain flows in accordance with this specification under all flow conditions. The bypass system shall be capable of pumping at the existing pump station capacity.

B. The Contractor shall use the following flow information for the design of the temporary by-pass pumping system for the pump station:

1. Average Daily Flow = 10 gpm
2. Peak Hourly Flow = 35 gpm

C. A by-pass pumping plan will be required for the pump station bypass. The by-pass pumping plan shall be stamped by a Massachusetts Registered Professional Engineer in accordance with Paragraph 1.3.

1.6 REPORTING

A. The Contractor shall be responsible for notifying MassDEP about any sanitary sewer overflow (SSO) events that may occur during the course of construction activities. Notification to MassDEP shall be made as soon as possible and no later than 24 hours after discovery of the event.

PART 2 - MATERIALS

2.1 PUMPING EQUIPMENT

A. Each temporary by-pass pumping system shall be complete including pumps, drives, piping, piping headers, valves, flow meter, controls, and appurtenances as required for a complete system.

B. The pumps, drives, and controls shall be designed and built for 24-hour continuous service at any and all points within the required range of operation, without overheating, without cavitation, and without excessive vibration or strain. All parts shall be so designed and proportioned as to have the strength, stability, and stiffness and be constructed to meet the specified requirements. Methods shall be provided for inspection, repairs, and adjustment.

C. All equipment shall be suitable for outdoor operation under adverse weather conditions. Provide protection from freezing as required to maintain system operation.

D. Each pump shall be able to pass typical municipal sewage.

E. All pumps shall be centrifugal, end suction, fully automatic self-priming units that do not require the use of foot-valves, vacuum pumps, diaphragm pumps, or isolation valves or float apparatus in the priming system. Pump seals shall be high pressure, mechanical self-adjusting type with solid carbide faces capable of withstanding suction pressures to 100 psi without the pump running. The mechanical seal shall be cooled and lubricated in an oil bath reservoir, requiring no maintenance or adjustment. The oil bath reservoir shall not come in contact with or leak into the pumped water. Each pump shall be capable of running dry, with no damage for extended periods of time. All pump seal metal parts shall be stainless steel. All elastomers shall be Viton.

F. Each pump shall be driven by an electrical engine.

G. Provide automatic start/stop controls for the pumping system to automatically maintain system flow. Controls shall be contained in a local NEMA 4X rated control panel with provision to manually operate each pump, provide indication of pump operation, and indicate the total flow being pumped. The pump control panel shall include high/low water level alarms and remote auto-dialer to send alarms to a minimum of four telephone numbers.

H. Pumps shall be provided with noise protective acoustically-silenced enclosures that meet MA DEP, and all local construction noise requirements and as a minimum: 80 dBA at seven feet; 65 dBA at thirty feet; 60 dBA at nearest residence; and less than 10 dBA raised above background levels; and no pure tone condition. Contractor shall be responsible for all materials, labor, and equipment to show compliance with the above requirements.

I. Pumps shall be provided with secondary containment for diesel operated pumps.

2.2 ADDITIONAL EQUIPMENT

A. Provide all required suction and discharge pipe and fittings, discharge manifold pipe and fittings, discharge shutoff valves and check valves for each pump, pressure regulating valves, insulation, freeze protection, and all accessories to meet the specifications.

B. All pipe and fittings shall be steel with flanged or quick connect coupling connections, or high density polyethylene pipe with fused joints or approved equal. Joints shall be Victaulic or equal. Suction piping shall be rated for 25-in Hg vacuum. Discharge piping, fittings, connections, valves, and other discharge piping accessories shall be rated for a minimum working pressure of 150 psi.

C. Lay flat hose shall be extra heavy duty, highly abrasive resistant and fitted with gasketed couplings. Hose shall be rated for a minimum working pressure of 150 psi.

D. Aluminum “irrigation” type piping or glued PVC pipe will not be allowed.

PART 3 - EXECUTION

3.1 GENERAL

A. The Contractor shall have adequate standby equipment available and ready for immediate operation and use in the event of an emergency or equipment breakdown. One stand-by pump for each size pump utilized shall be installed and piped into the suction and discharge manifold at the bypass pump, ready for automatic start and use in the event of primary pump failure.

B. The Contractor shall adequately handle all flow, even instantaneous peak flows, without damage or overflow. The Contractor shall make himself aware of potential large instantaneous flow contributors connected to the sewer.

C. Plugging or blocking of sewage flows shall incorporate primary and secondary plugging devices. When plugging or blocking is no longer needed for performance and acceptance or Work, it is to be removed in a manner that permits the sewage flow to slowly return to normal without surge, to prevent surcharging or causing other major disturbances downstream.

D. The by-pass pumping system shall not require excavation to reduce the suction lift without approval of the Engineer. Pumps may not be benched down to make the suction lift unless approved by the Engineer.

E. The Contractor shall exercise caution and comply with OSHA requirements when working in the presence of gases, combustible or oxygen-deficient atmospheres, and confined spaces.

3.2 DELIVERY, STORAGE AND HANDLING

A. Provide in accordance with Section 01610 - Delivery, Storage, and Handling and as specified herein. Ship equipment, materials and spare parts complete except where partial disassembly is required by transportation regulations or for protection of components.

B. Pack spare parts in containers bearing labels clearly designating contents and pieces of equipment for which intended.

C. Deliver spare parts at same time as pertaining equipment.

D. Store and safeguard equipment, material, and spare parts.

3.3 INSTALLATION

A. Install pumping units on a firm level surface.

B. Equipment failing to meet specific conditions shall be removed and replaced at no additional cost to the Owner.

3.4 FIELD TEST AND QUALITY CONTROL

A. The piping system must provide adequate water tightness. The Engineer may require the Contractor to perform a leakage test with clean water if in the Engineer's sole opinion the piping system appears as though it may leak.

B. Any such testing shall be to the Engineer's satisfaction and shall be at the Contractor's expense.

C. In the event that a unit fails to pass a test, make all modifications required to place the unit in proper working order.

D. In the event that a unit fails a test a second time, remove the unit and replace with a satisfactory one, at no cost to the Owner.

E. The Contractor shall provide all necessary instrumentation, equipment, devices, and appurtenances, as well as temporary wiring or piping, required to perform field tests.

3.5 SYSTEM OPERATION

A. Perform all required maintenance on the equipment to maintain the system integrity and capacity as specified.

B. Provide clean-up and disposal of contaminated material and reporting for all product spills.

C. At the completion of the period of service, disconnect all temporary piping and remove all system components from the site. Restore the work site to its original condition

3.6 CONTRACT CLOSEOUT

A. Provide in accordance with Section 01700 - Contract Closeout.

END OF SECTION 02538

SECTION 02570

SEWERS, STRUCTURES AND APPURTENANCES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section specifies requirements for the proposed sewer manholes, gravity sewer piping, sewer force main bypass piping, fittings and valves, and associated items.

B. The work includes furnishing and installing sewer pipes, fittings, structures, and other appurtenances required and in accordance with the Drawings and Specifications.

1.2 RELATED WORK

A. Section 02200 – Earthwork

B. Section 02616 – Ductile Iron Pipe and Fittings for Buried Sewer Force Main

C. Section 02640 – Valves and Appurtenances

1.3 SUBMITTALS

A. List of materials proposed and manufacturers' specifications and installation instructions.

B. Shop drawings for all material and structures prior to ordering materials, including pipe materials, connections, fittings and valves, precast concrete sewer manholes and frames and covers, and component construction, features, configuration, and dimensions.

1.4 INSPECTION

A. All pipe may be inspected at the plant for compliance with these specifications by an independent testing laboratory selected and paid for by the Owner. The Contractor shall require the manufacturer's cooperation in these inspections.

B. Inspection of the pipe may also be made after delivery. The Contractor shall furnish all labor to assist the Engineer in inspecting the pipe. The pipe shall be subject to rejection at any time on account of failure to meet any of the specification requirements, even though pipe samples may have been accepted as satisfactory at the place of manufacture. Pipe rejected after delivery shall be marked for identification and shall be removed from the site at once.

C. Imperfections in materials may be repaired, subject to approval of the Engineer, after demonstration by the manufacturer that strong and permanent repairs result. Repairs shall be carefully inspected before final approval.

1.5 DELIVERY, STORAGE & HANDLING

A. All materials shall be adequately protected from damage during transit. Pipes shall not be dropped.

B. All pipe and other appurtenances shall be inspected before placement in the work and any found to be defective from any cause, including damage caused by handling, and determined by the Engineer to be unrepairable, shall be replaced at no cost to the Owner.

C. Storage and handling of pipes, manholes and other sewer system appurtenances shall be in accordance with the manufacturer's recommendations, subject to the approval of the Engineer.

D. Only nylon-protected slings shall be used for handling the pipe. No hooks or bare cables will be permitted.

E. Pipe shall be stored above ground at a height no greater than 5 feet, and with even support for the pipe barrel.

PART 2 - PRODUCTS

2.1 POLYVINYLCHLORIDE (PVC) PIPE (GRAVITY)

A. Gravity Pipe: Gravity pipe shall be push-on joint SDR 35 PVC meeting the requirements of ASTM D3034 for sizes 3-inch to 15-inch. Locations of SDR 35 PVC shall be as indicated on the Contract Drawings. For sizes greater than 15-inch, pipe shall comply with ASTM F679, latest record. Pipe color shall be in accordance with Uniform Color Code as established by the American Public Works Association Utility Location and Coordination Council (adopted September 2000).

B. Gravity Fittings: Fittings, couplings and adaptors shall be manufactured by Romac Industries Inc., or approved equal.

C. Joints: PVC pipe shall have an integral wall bell and spigot push-on joint with elastomeric gaskets secured in place in the bell of the pipe. The bell shall consist of an integral wall section with a solid cross section elastomeric gasket, factory assembled, securely locked in place to prevent displacement during assembly. Elastomeric gaskets shall conform to ASTM D3212. Where petroleum contamination is known or suspected to be in the soil and/or groundwater, nitrile gaskets shall be required.

D. Spigot Pipe Ends: Spigot pipe ends shall be supplied with bevels from the manufacturer to ensure proper insertion. Each spigot end shall have an "assembly stripe" imprinted thereon to which the bell end of the mated pipe will extend upon proper joining of the two pipes.

E. Insulation: Extruded closed-cell rigid formed polystyrene, equal to "Styrofoam: HI-60" by Dow Chemical. Size is 2-inch thick by 4 feet wide.

2.2 POLYVINYLCHLORIDE (PVC) PIPE (FORCE MAIN)

A. Force Main Pipe: PVC Force Main pipe shall be push-on joint, bell and spigot type with pressure rating of 200 psi. For sizes 1-1/2-inch to 12-inch diameter, force main pipe shall be SDR 21 PVC meeting the requirements of ASTM D-2241, with material per ASTM D-1784, Grade 1, Type 1. Joints to meet ASTM F477 and shall be tested to ASTM D-3139 standard.

B. Joints:

1. All joints are to be made water-tight.

2. Pipe shall be jointed in strict accordance with the pipe manufacturer's instruction. Jointing of all pipe shall be done entirely in the trench.

3. Lubricant for jointing of ball and spigot PVC pipe shall be applied as specified by the pipe manufacturer. Use only lubricant supplied by the pipe manufacturer.

4. Ball and spigot PVC pipe shall be pushed home by hand or use of bar and clock. The use of power equipment such as a backhoe bucket is not recommended and shall only be used at the direction of the manufacturer.

5. To join field-cut pipe, pipe shall be cut square. The cut end of the pipe surface shall be properly beveled to the size and shape of a factory-finished beveled end. All sharp edges shall be rounded off.

C. Insulation: Extruded closed-cell rigid formed polystyrene, equal to "Styrofoam: HI-60" by Dow Chemical. Size is 2-inch thick by 4 feet wide.

2.3 DUCTILE IRON (DI) PIPE (FORCE MAIN)

A. Force Main Pipe and Fittings:

1. Ductile iron force main pipe size 3 to 12 inches diameter shall be push-on joint, pressure Class 350, ANSI/AWWA C150/A21.50, inside epoxy coating per manufacturer standard.

2. Fittings, size 3 to 12 inches diameter, shall be pressure Class 350, ANSI/AWWA C153/A21.53, push-on joints per ANSI/AWWA C111/A21.11.

3. Gaskets shall conform to ANSI/AWWA C111/A21.11. Restrained joints shall be provided by a field lock gasket supplied by the manufacturer of the pipe for that purpose. (U.S. Pipe – "FIELDLOK", Clow –"SUPER-LOCK," or U.S. Pipe – "TRFLEX").

4. Pipe and fittings to have an outside coating of asphaltic material per ANSI/AWWA C153/A21.53 and ANSI/AWWA C110/A21.10.

5. Valves and fittings to have an inside coating of epoxy lining applied in accordance with AWWA C550.

B. Flanged Ductile Iron Pipe and Fittings:

1. Flanged ductile iron pipe force main pipe size 3 inches to 24 inches, shall be pressure Class 250 psi, per ANSI/AWWA C115 A21.15 with asphaltic coating outside and epoxy coated inside.

2. Flange bolt circle and holes per ANSI/AWWA/C115/A21.15.

3. Gaskets per ANSI/AWWA C111/A21.11.

4. Flange adapters to push-on joint pipe sections shall be supplied by the manufacturer of the pipe.

C. Couplings and Connectors:

1. Sleeve Type, Buried

a. Cast iron or epoxy coated steel, middle rings, ASTM A513
b. Reducer type where required
c. Followers, two steel rings epoxy coated
d. Bolts ANSI 21.11/AWWA C111, galvanized
e. Two wedge section compressible gaskets
f. Dresser Manufacturing Co. – Style 38, 162, or 128 as appropriate

2. Sleeve Type, Exposed:

a. Steel middle ring, shop prime.
b. Reducer type for different pipe sizes.
c. Two steel follower rings.
d. Two wedge section compressible gaskets.
e. Steel bolts.
f. Dresser Manufacturing Co., Style 38.

3. Flexible Connectors:

a. Do not use rubber or elastomeric PVC type flexible couplings to connect pressure sewers.
b. Material shall be compatible with pipes being joined.
c. Maximum allowable deflection per joint shall be 15 degrees or per manufacturer's recommendation, whichever is less.
d. Stainless steel metal retaining rings.
e. Use suitable retaining control rods.
f. Pressure rating shall be equal to or greater than the pipe pressure rating.

2.4 SEWER MANHOLES

A. Precast Units:

1. Structure: All precast concrete manholes shall conform to ASTM D478. Four foot (4') inside diameter precast units (4,000 psi minimum compressive strength) with eccentric cone section tapering to thirty inch (30") diameter (minimum), or flat top as required, and one pour monolithic base section conforming to ASTM C478. All units shall be designed for HS-20 loading. Manhole wall thickness shall be 5 inches, minimum.

2. Precast Unit Joint Seals: Butyl Rubber section joint confirming to ASTM C443.

3. The date of manufacture, trademark and name of the manufacturer shall be clearly marked on the inside of each precast section.

B. Masonry:

1. Brick for construction of minor grade adjustments shall be Grade MS conforming to ASTM C32. Grade MS shall be used for manhole structures and applications other than inverts and shelves. Manhole frame shall be flush with a minimum of 2 and a maximum of 5 brick courses. Precast concrete grade rings are acceptable for elevation adjustments greater than 6 inches.

2. Brick for construction of shelves and inverts shall be Grade SS conforming to ASTM C32. Red clay sewer brick inverts shall be smoothly rounded to the direction of flow. Inverts shall be constructed with 4,000 psi concrete in void areas and with sewer brick. All sewer inverts are to be constructed once the manhole is installed. Manhole inverts built above ground will not be accepted.

3. Mortar shall be in conformance with ASTM C270, Type M. The mortar shall be composed of one part Type I or Type II Portland cement, 3.5 parts sand, well graded with no grain larger than will pass a Number 8 sieve, and 0.25 parts hydrated lime.

4. Cement shall be Type I or II Portland cement conforming to ASTM C150, Standard Specification for Portland cement. Where masonry is exposed to salt water, Type II shall be used.

5. Hydrated lime shall be Type S conforming to ASTM D207.

6. Sand for masonry mortar shall conform to the gradation requirements of ASTM C144.

C. Manhole Frame and Cover: Provide heavy duty cast iron frame and cover, minimum Class 25 conforming to ASTM "Standard Specification for Gray Iron Castings," designation A48. The words "WESTWOOD" shall be embossed on the cover in 2" lettering. The words "SEWER" shall be embossed on cover in three inch lettering.

Frame shall have a clear opening dimension of 24 inches and the frame shall a minimum of 8 inches in height. All frame and cover sets shall be manufactured by East Jordan Iron Works, or equal. The frame and cover shall be watertight up to 15 psig external pressure.

D. Pipe Connections: Connections to precast concrete manholes shall be made by one of the methods as follows:

1. LOCK JOINT Flexible Manhole Sleeve cast into the manhole base. Stainless steel strap and exposed sleeve shall be protected with bitumastic coating.

2. PRESS WEDGE II gasket cast into the manhole base. The rubber wedge shall be driven into the V slot from the manhole exterior.

3. RES-SEAL compression ring with exposed metal protected by bitumastic coating.

4. KOR-N-SEAL neoprene boot cast into manhole base. Stainless steel clamp shall be protected by bitumastic coating.

E. Dampproofing Bitumastic Coating: The entire exterior surface of all masonry and concrete (whether precast or cast-in-place) structures associated with sewerage systems, such as: manholes, pump stations, valve pits, etc., shall receive two coats of waterproofing such as Carboline Bitumastic 300M as manufactured by SOMAY Products, Inc., Miami, FL; Sonnoshield HLM 5000 as manufactured by Sonneborn, Shakopee, MN or approved equal at a minimum thickness of 7 mils per coat and a total thickness of 14 mils; however, in no case shall the thickness per coat be less than that recommended by the manufacturer.

2.5 FORCE MAIN BYPASS CONNECTION HANDHOLE

A. Precast Units:

4. Bypass Connection Handhole: 4,000 psi minimum compressive strength. All units shall be designed for HS-20 loading.

5. The date of manufacture, trademark and name of the manufacturer shall be clearly marked on the inside of each precast section.

B. Masonry:

1. Brick for construction of inverts and adjusting manholes to grade shall be Grade SS conforming to ASTM C32. Red clay sewer brick shall be used and the inverts shall be smoothly rounded to the direction of flow.

2. Mortar shall be in conformance with ASTM C270, Type M. The mortar shall be composed of Portland Cement hydrated lime, and sand, in the proportions of 1 part cement to ¼ part hydrated limit to 3-1/2 parts sand, by volume.

3. Cement shall be Type I or II Portland cement conforming to ASTM C150, Standard Specification for Portland Cement. Where masonry is exposed to salt water, Type II shall be used.

4. Hydrated lime shall be Type S conforming to ASTM D207.

5. Sand for masonry mortar shall conform to the gradation requirements of ASTM C144.

C. Manhole Frame and Cover:

1. Provide heavy duty cast iron frame and cover, minimum Class 25 conforming to ASTM "Standard Specification for Gray Iron Castings," designation A48. The words "SEWER" shall be embossed on cover. Letter size shall be three inches. Frame shall have a clear opening dimension of 24 inches and the frame shall a minimum of 6 inches in height. The frame and cover shall be watertight up to 15 psig external pressure.

D. Pipe Connections: Pipe penetrations shall be sealed using non-shrink grout. Refer to Section 03300 for non-shrink grout specifications.

2.6 BURIED UTILITY WARNING AND IDENTIFICATION TAPE

A. Provide detectable aluminum foil plastic backed tape or detectable magnetic plastic tape manufactured specifically for warning and identification of buried piping. Tape shall be detectable by an electronic detection instrument. Provide tape in rolls, 3 inches minimum width, color coded for the utility involved with warning and identification imprinted in bold black letters continuously and repeatedly over entire tape length. Warning and identification shall be CAUTION BURIED SEWER PIPING BELOW or similar. Use permanent code and letter coloring unaffected by moisture and other substances contained in trench backfill material. Bury tape with the printed side up at a depth of 12 inches below the top surface of earth or the top surface of the subgrade under pavements.

PART 3 - EXECUTION

3.1 EXCAVATION AND BACKFILLING

A. The type of materials to be used in bedding and backfilling and the method of placement shall conform to the requirements of Section 02200 – Earthwork, and the details shown on the Drawings.

3.2 PIPE INSTALLATION

A. All sewer piping shall be laid accurately to the lines and grades shown in the Drawings and in conformance with pipe manufacturer's recommended procedures.

B. Laying Pipe:

1. Each length of pipe shall be laid with firm, full and even bearing throughout its entire length, in a prepared trench. Pipe shall be laid with bells upgrade unless otherwise approved by the Engineer.

2. Every length of pipe shall be inspected and cleaned of all dirt and debris before being laid. The interior of the pipe and the jointing seal shall be free from sand, dirt and trash. Extreme care shall be taken to keep the bells of the pipe free from dirt and rocks so that joints may be properly lubricated and assembled.

3. No length of pipe shall be laid until the proceeding lengths of pipe have been thoroughly embedded in place, to prevent movement or disturbance of the pipe alignment.

4. Lay accurately to lines and grades indicated or required. Provide accurate alignment, both horizontally and vertically.

C. Pipe Extension: Where an existing pipe is to be extended, the same type of pipe shall be used, unless otherwise approved by the Engineer.

D. Protection During Construction: The Contractor shall protect the installation at all times during construction, and movement of construction equipment. Vehicles and loads over and adjacent to any pipe shall be performed at the Contractor's risk and in accordance with all applicable federal, state and local safety regulations.

At all times when pipe laying is not in progress, all open ends of pipes shall be closed by approved temporary water-tight plugs. If water is in the trench when work is resumed, the plug shall not be removed until the trench has been properly dewatered and all danger of water entering the pipe eliminated. The Contractor is responsible for proper dewatering to ensure a stable pipe foundation. Proper dewatering to two feet (minimum) below the pipe invert to ensure joining of the pipe in a dry condition.

E. Water Pipe – Sewer Pipe Separation: When a sewer pipe crosses above or below a water pipe, the following procedures shall be utilized. The Contractor shall comply with these following procedures.

1. Relation to Water Mains

a. Horizontal Separation: Whenever possible sewers shall be laid at a minimum at least ten feet (10'), horizontally from any existing or proposed water main. Should local conditions prevent a lateral separation of 10 feet to a water main, if:

i. It is laid in a separate trench, or if
ii. It is laid in the same trench with the water mains located at one side on a bench of undistributed earth, and if
iii. In either case the elevation of the top (crown) of the sewer is at least 18 inches below the bottom (invert) of the water main.

b. Vertical Separation: Whenever sewers must cross under water, sewer is at least eighteen inches (18”) below the bottom of the water main. When the elevation of the sewer cannot be varied to meet the above requirements, the water main shall be relocated to provide this separation or reconstructed with mechanical-joint pipe for a distance of ten feet (10’) on each side of the sewer. One full length of water main should be centered over the sewer so that both joints will be as far from the sewer as possible.

c. When it is impossible to obtain horizontal and/or vertical separation as stipulated above, both the water main and sewer shall be constructed of mechanical-joint cement lined ductile iron pipe or other equivalent based on water tightness and structural soundness. Both pipes shall be pressure tested by an approved method to assure water tightness or both pipes shall be encased in concrete.

3.3 LAYING DUCTILE IRON PIPE AND FITTINGS

A. The Contractor will be responsible for transporting materials to the job site as needed. Care shall be taken in loading, transporting and unloading to prevent injury to the pipe, lining or coatings. Pipe or fittings shall not be dropped. The engineer shall examine all pipes and fittings prior to installation. Any pipe or fittings found defective shall not be installed and immediately removed from the site. Any damage to pipe linings or coatings may be repaired as directed by the Engineer, or removed from the site. Handling and installation of pipe and fittings shall be in accordance with the manufacturer's instruction and as specified herein. Any materials damaged during loading, transporting or unloading shall be replaced at the Contractor's expense.

B. Jointing of ductile iron pipe and fittings shall be done in accordance with the printed recommendations of the manufacturer and as specified. All pipe and fittings shall be thoroughly cleaned before laying; shall be kept clean until they are used in the work; and when installed, shall conform to the lines and grades required. Special care is required in cleaning the ends of the pipe; wipe the outside of the spigot end with a clean rag prior to applying lubricant; brush clean the inside of the bell end, paying special attention to the rubber joint area, prior to installing the gasket and lubricant; and check inside the pipe for overall cleanliness.

C. Ductile iron pipe and fittings shall be installed in accordance with requirements of AWWA C600, latest edition, except as otherwise provided herein. The joint surfaces and the gasket shall be painted with a lubricant just prior to making up the joint. The spigot end shall then be gently pushed home into the bell. The position of the gasket shall be checked to insure that the joint has been properly made and is watertight. Care shall be taken not to exceed the manufacturer's recommended maximum deflection allowed for each joint. A firm, even bearing throughout the length of the pipe shall be constructed by tamping selected common fill along the sides of the pipe forming a cradle under the pipe. Tamping shall continue until the fill is 1-foot over the top of the pipe. A 4.5-foot minimum cover shall be maintained over the top of the pipe. If any defective pipe is discovered after it has been installed, it shall be removed and

replaced with a sound pipe in a satisfactory manner by the Contractor, at their own expense.

D. All pipe shall be sound and clean before laying. During pipe installation, care should be taken to protect the open end of the pipe. When installation is not in progress, including lunch time, the open ends of the pipe shall be closed with watertight plugs or other approved means. Good alignment shall be preserved during installation. Fittings, in addition to those shown on the Drawings, shall be provided, when required, for crossing utilities which are encountered during trench excavation. Solid sleeves shall be used only where approved by the Engineer.

E. When pipe cutting is required, cutting shall be done by machine, leaving a smooth cut at right angles to the axis of the pipe. Cut ends of pipe to be jointed with a bell shall be beveled to conform to the manufactured spigot end. Ceramic epoxy lining shall remain undamaged.

F. Existing Utilities: To the extent possible, the Contractor shall maintain a minimum 10 ft. lateral separation between the new water mains and existing sanitary sewers, unless otherwise directed by the Engineer.

G. The Contractor shall maintain an 18-inch clearance between the bottom of the water main and crown of the sanitary sewer. The engineer may direct this full length of main to be concrete encased when the 18-inch clearance is not possible, or when the water main is placed below the sanitary sewer.

H. Ductile iron pipe installed within 3 feet of gas lines shall be fully encased with polyethylene material.

I. Ductile iron pipe shall be wrapped in polyethylene encasement where pipe depth is at or below normal ground/tide water level, in accordance with the Drawings.

3.4 DUCTILE IRON PIPE JOINTS

A. All joints shall be made watertight.

B. Pipe shall be jointed in strict accordance with the pipe manufacturer’s instruction. Jointing of all pipes shall be done entirely in the trench.

C. Push-on Joints: Push-on joints shall be made in accordance with the manufacturer's instructions. Pipe shall be laid with bell ends looking ahead. A rubber gasket shall be inserted in the groove of the bell end of the pipe, and the joint surfaces cleaned and lubricated. Apply thin film of nontoxic gasket lubricant over inner surface of gasket in contact with spigot end. The plain end of the pipe being installed shall be aligned and inserted into the bell end of the pipe previously installed. It can then be pushed home with a jack or by other means. After joining the pipe, a metal feeler shall be used to make certain that the rubber gasket is correctly located.

D. Mechanical Joints: Mechanical joints shall be made in accordance with Appendix A of AWWA C111 and the manufacturer's instructions. Wire brush surfaces to be in contact with the gasket and thoroughly clean and lubricate the joint surfaces and

rubber gasket with soapy water before assembly. Check that the gasket has been seated in fitting before placing flange against gasket. With bolts inserted and nuts finger-tight, tighten diametrically opposite nuts progressively and uniformly around joint with a torque wrench. Bolts shall all be tightened to the specified torque. When using pneumatic or electric impact wrenches to make up fittings, complete tightening using a torque wrench to the specified torque. Under no conditions shall extension wrenches or pipe over handle of ordinary ratchet wrench be used to secure greater leverage.

E. Restrained Joints: Mechanical joint restraints shall be installed in full accordance with the manufacturer's instructions. All bolt heads on Megalug restraints shall be tightened sufficiently so that they shear off to indicate the proper tightening torque was achieved. Push-on joint restraints shall be installed in full accordance with the manufacturer's instructions where directed by the Engineer.

3.5 CONNECTIONS TO EXISTING FACILITIES

A. General Requirements: The Contractor shall make all required connections of the proposed sewer into existing sewer system, where and as shown on the Drawings and as required by the Engineer.

B. Compliance with Requirements of Owner of Facility: Connections into existing sewer facilities shall be performed in accordance with the requirements of the Owner of the facility. The Contractor shall comply with all such requirements, including securing of all required permits, paying the costs thereof, and providing twenty-four (24) hour notice prior to beginning the work.

3.6 PRESSURE TESTING OF SEWER FORCE MAIN

A. Hydrostatic and leakage test shall be conducted in accordance with AWWA Standard C600, and in the presence of the Engineer. Testing shall be conducted by a certified independent water testing company.

B. Conduct pipe tests after concrete thrust blocks have cured to the required 3000 psi strength. Fill pipe 24 hours prior to testing, and apply test pressure to stabilize system. Use only potable water.

C. Prior to pressure testing, the entire pipe section shall be flushed to remove any rocks or debris, which may have inadvertently entered the pipe during construction.

D. Once the pipe section has been filled at normal pressure and all entrapped air removed, the Contractor shall raise the pressure to 150 psi or two times the operation pressure (whichever is greater) by a special pressure pump, taking water from a small tank of proper dimensions for satisfactorily measuring the rate of pumpage into the pipe. This pressure shall be maintained for a minimum of 2 hours, during which time the line shall be checked for leaks. Measured rate of water leakage shall not exceed the allowable leakage listed below:

Bypass piping shall have zero leakage.

Should leakage exceed this rate, the Contractor shall immediately locate the leak or leaks and repair them. Pipe will be accepted only when leakage is zero, or less than the allowable amount. Approval does not absolve the Contractor from responsibility if leaks develop later within the warranty period.

3.7 CLEANING AND REPAIR

A. The Contractor shall clean the entire system of all debris and obstructions. This shall include, removal of all formwork from structures, concrete and mortar droppings, construction debris and dirt. The system shall be thoroughly flushed clean and the Contractor shall furnish all necessary hose, pumps, pipe and other equipment that may be required for this purpose. No debris shall be flushed into existing sewers, storm drains or streams. All work of cleaning and repair shall be performed at no additional cost to the Owner.

3.8 FINAL INSPECTION

A. Upon Completion of the work, and before final acceptance by the Engineer, the entire system shall be subjected to a final inspection in the presence of the Engineer. The work shall not be considered as complete until all requirements for line, grade, cleanliness, leakage tests and other requirements have been met.

END OF SECTION 02570

SECTION 02576

PAVEMENT REPAIRS AND RESURFACING

PART 1 – GENERAL

1.1 SCOPE OF WORK

A. This section includes the removal and replacement of existing bituminous pavement and sub-base; installation of temporary pavement; milling and installation of permanent pavement overlay; removal and replacement of curb and gutter (as required); removal and resetting of curbing (as required); raising and adjusting castings and valve boxes; and installation of pavement markings.

1.2 RELATED WORK

A. Section 02200 – Earthwork

1.3 REFERENCE STANDARDS

A. Except as otherwise specified herein, the current Standard Specifications for Highways and Bridges, including all addenda and supplemental information, issued by the Commonwealth of Massachusetts Department of Transportation, shall apply to materials and workmanship required for the work of this Section.

B. American Association of State Highways and Transportation Officials (AASHTO) AASHTO M144 - Standard Specification for Calcium Chloride.

C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.4 SUBMITTALS

A. Shop Drawings: Submit the following in accordance with Section 01300 - Submittals.

1. Product Data: Submit complete data on materials to be used in construction, including gradation tests for granular base.

2. Design Data: Submit design mix for bituminous base and top (wearing) course.

3. Material Certificates: Provide copies of materials' certificates signed by material producer and Contractor, certifying that each material item complies with, or exceeds, specified requirements.

1.5 QUALITY ASSURANCE

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

B. Laboratory Testing Required:

1. The bituminous mixture shall be compacted to at least 95% of the density achieved on the laboratory testing of the design mix for the project. The density of the Bituminous Concrete Pavement will be determined by using either the following tests; Nuclear Density Gauge Method ASTM D2950 or the Bulk Specific Gravity Method AASHTO-T166.

C. Thickness: Test in-place asphalt concrete courses for compliance with requirements for thickness. Repair or remove and replace unacceptable paving as directed by Engineer. In-place compacted thickness will not be accepted if exceeding the following allowable variation from required thickness:

1. Base Course: ¼-inch, plus no minus

2. Top Course: ¼-inch, plus no minus

1.6 PROJECT SITE CONDITIONS

A. Environmental Requirements:

1. Do not place materials when underlying surface is muddy, frozen, or has frost, snow, or water thereon.

2. Do not place concrete when air temperature at time of placement, or anticipated temperature for following 24 hours, is lower than 40°F or higher than 90°F.

3. Apply prime and tack coats when ambient temperature is above 50°F and when temperature has not been below 35°F for 12 hours immediately prior to application.

4. Binder Course may be placed when air temperature is above 30°F and rising.

5. Grade Control: Establish and maintain required lines and elevations.

B. Existing Conditions:

1. Drawings show approximate locations of paving areas.

2. Drawings show approximate location of existing structures along pipeline route.

1.7 GUARANTEE

A. All final pavement placed shall be warranted by the Contractor for a period of one year. During this period all areas which have settled or are unsatisfactory for traffic shall be removed and replaced at no cost to the Town, including the cost of Traffic Police. Settlement in excess of one (1) inch shall be considered significant, and shall be repaired.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Calcium chloride shall conform to AASHTO M144, Type I or Type II.

B. Bituminous concrete shall conform to Class I Bituminous Concrete Pavement, Type I- 1, of Section 460 of the Massachusetts Highway Department Standard Specifications.

C. Binder Course and Modified Top Course shall conform to the Massachusetts Highway Department Standard Specifications, Section M3.11.00, Class I, bituminous concrete.

D. Tack coat shall be emulsified asphalt, grade RS-1 and conform to the Massachusetts Highway Department Standard Specifications, Section M3.03.0.

E. Cutback asphalt shall conform to the Massachusetts Highway Department Standard Specifications, Section M3.02.0.

F. Sub-base material shall be new processed gravel conforming to the Massachusetts Highway Department Standard Specifications, Section M1.03.1 “Processed Gravel for Sub-Base”.

G. Pavement markings shall conform to the Massachusetts Highway Department Standard Specifications, Section M7.01.23 - White Traffic Paint and M7.01.24 - Yellow Traffic Paint.

PART 3 – EXECUTION

3.1 GENERAL

A. After completion of the backfilling and 12-inch cutback, final pavement shall be placed unless otherwise directed in writing by the Engineer.

B. Materials for pavement shall be mixed, delivered, placed, compacted, and tested in accordance with the referenced specification, Sections M3.11 and 460 and as specified herein.

C. Whenever the sub-base becomes dry enough to cause dust problems, spread calcium chloride uniformly over the gravel surface in sufficient quantity to eliminate the dust.

D. No vehicular traffic or loads shall be permitted on the newly completed pavement until adequate stability has been attained and the material has cooled sufficiently to prevent distortion or loss of fines. If the climatic or other conditions warrant it, the period of time before opening to traffic may be extended at the discretion of the Engineer.

E. Pavement Construction Period. No pavement shall be constructed during the period from November 15 to March 31 without approval in writing from the Engineer.

3.2 PREPARATION

A. Protection of existing Roadways:

1. Saw cut existing pavement to required width and depth to avoid damage to adjacent pavement, curbs, gutters, or other structures and as indicated on the drawings.

B. Sub-Surface Preparation:

1. Pavement Sub-base:

a. Pavement sub-base material shall be as specified in Section 02200, and as shown on the Drawings.
b. The sub-base to be placed under pavement shall be a minimum of 12- inches thick after compaction. Sub-base shall be evenly spread and thoroughly compacted in accordance with the Contract Documents. The sub-base shall be spread in layers not more than 8 - inches thick except the last layer of gravel shall be 4-inches thick, compacted measure. All layers shall be compacted to not less than 95 percent of the maximum dry density of the material as determined by ASTM D1557 Method C at optimum moisture content.
c. Complete sub-base preparation, including dynamic compaction, for full width before placing surfacing materials.

2. Subgrade:

a. Prepare subgrade in accordance with Section 02200.
b. Complete subgrade preparation, including dynamic compaction, for full width before placing surface materials.
c. Stabilize subgrades in accordance with Section 02200 so that

loaded construction vehicles do not cause rutting or displacement when depositing materials.

3.3 INSTALLATION

A. General

1. Pavement depths shall be as shown on Drawings or as specified herein.

2. Place bituminous concrete mixture on prepared surface, spread, and strike-off. Spread mixture at minimum temperature of 225 °F (107 °C). Place inaccessible and small areas by hand. Place each course to required grade, cross-section, and compacted thickness. Protect all adjacent construction from staining with mix or damage by mechanical equipment. Clean, repair, or replace any construction stained or damaged at no additional cost to the Owner.

B. Permanent trench pavement:

1. For areas with temporary pavement, permanent trench pavement shall be placed after the 90-day settling period. The temporary trench pavement and sub-base shall be excavated, graded, and compacted to a depth below the existing pavement (see Drawings for depths).

2. For areas not receiving temporary pavement, permanent trench pavement shall be placed wherever existing pavement has been removed or disturbed as soon as practical after backfilling is completed.

3. Depth of permanent trench pavement is indicated on the Drawings.

4. The existing pavement shall be saw-cut, removed and properly disposed of one foot beyond the limits of temporary trench pavement to create an offset subbase joint. All pavement edges shall be square and straight. Irregular, jagged edges will not be allowed.

5. Hose clean with water all road surfaces adjacent to the area to be paved. No paving is to be placed until sub-base surface is dry.

6. The permanent trench pavement layer shall be a hot mixed binder course placed and compacted to a thickness identified on the Drawings by steel-wheeled rollers of sufficient weight to thoroughly compact the bituminous concrete without damaging the existing pavement.

7. The top course shall be placed and compacted to a thickness identified on the Drawings. The new pavement shall be rolled smooth and even with the existing pavement.

8. The binder course shall be placed by normal construction practices. The top course shall be machine laid utilizing a sidewalk box spreader or equal; no hand work is allowed. Prior to top course all seams shall be sealed with an approved emulsified liquid asphalt and sand. The top course of the permanent trench paving shall be placed to a grade that shall not overlap the existing pavement.

9. The finished surface of the top course mixture, after compaction, shall be true to the established line and grade of the existing pavement.

D. Pavement Placement

1. Unless otherwise permitted by the Engineer for particular conditions, only machine methods of placing shall be used. Methods other than machine methods may be used, at no additional cost to the Owner. The equipment for spreading and finishing shall be mechanical, self-powered pavers, capable of spreading and finishing the mixture true to line, grade, width, and crown. The mixtures shall be placed and compacted only at such times as to permit proper inspection and checking by the Engineer.

2. After the paving mixtures have been properly spread, initial and immediate compaction shall be obtained by the use of steel rollers having a weight of not less than 240 pounds per inch width tread. Begin rolling when mixture will bear roller weight without excessive displacement. Compact mixture with hot tampers or vibrating plate compactors in areas inaccessible to rollers. Accomplish breakdown rolling and repair displaced areas by loosening and filling, if required, with hot material. Follow breakdown rolling as soon as possible, while mixture is hot. Continue second rolling until mixture has been thoroughly compacted.

3. Final rolling of the pavement shall be performed by a steel wheel roller weighing not less than 285 pounds per inch width of tread at a mix temperature and time sufficient to allow for final smoothing of the surface and thorough compaction. Continue rolling until roller marks are eliminated and course has attained maximum density.

4. Patching: Remove and replace paving areas mixed with foreign materials and defective areas. Cut-out such areas and fill with fresh, hot bituminous concrete. Compact by rolling to match surrounding surface density and smoothness.

5. Immediately after placement of new pavement, make joints between existing and new pavements, or between successive days' work, to ensure continuous bond between adjoining work. Construct joints to have same texture, density, and smoothness as other section of bituminous concrete course. Clean contact surfaces and apply tack coat. All joints between the existing and new pavements shall be keyed on an angle (4' x 10') or as approved by

the Owner, and shall be sealed with bitumen RS-1 and sanded.

6. The Contractor shall furnish and install paving to provide transition or aprons for driveways and walkways impacted by new pavement installation.

E. Pavement Markings:

1. The Contractor shall replace all reflectorized pavement markings removed or covered-over in carrying out the work, and as directed by the Engineer, no sooner than 48 hours after completion of final pavement. Markings shall conform to the latest standards of the municipality or agency having jurisdiction over the roadway. The markings shall be painted markings, 4-inches wide, white or yellow, single or double lines as required. Materials shall conform to MassDOT Standard Specifications for Highway and Bridges, latest edition, M.7.01.23 and M.7.01.24.

2. The Contractor shall provide temporary markings on the temporary pavements where existing markings are removed at no additional cost to the Owner.

G. Curb and Gutter Replacement:

1. Replace curb and gutter with same material to pre-construction lines and curb sections. Reset granite curb to pre-construction line and grade.

2. Removal and replacement of curbing shall be done in accordance with Sections 501 and 580, as applicable of the MHD Specifications for Highways and Bridges.

3. Provide expansion joints at each intersection with existing curb sections.

4. Use expansion joints one inch wide. Fill with expansion joint material and cut to shape of curb section.

H. Sidewalk and Driveway Replacement:

1. Gravel sidewalks:

a. Gravel sidewalks shall be restored to a condition at least equal to that existing immediately before the work was started.

2. Bituminous concrete sidewalks and driveways:

a. Construct in accordance with MHD Section 701, Sidewalks, Wheelchair Ramps and Driveways.

b. The subgrade shall be shaped parallel to the proposed surface of the sidewalk or driveway and shall be thoroughly rolled and tamped.

All depressions occurring shall be filled with suitable material and again rolled or tamped until the surface is smooth and hard in order for a gravel foundation to be placed upon it.

c. The sidewalk or driveway shall be a minimum of 3 inches compacted inches thick, laid in two equal courses.

d. Sidewalk cross slopes shall not exceed 2 percent as required by the Americans with Disabilities Act (ADA). The Contractor shall merge new sidewalk slopes into existing sidewalk slopes as required by ADA.

3. Cement concrete sidewalks:

a. Construct in accordance with MHD Section 701, Sidewalks, Wheelchair Ramps and Driveways.

b. Use 6 x 6, W10 x W10 welded wire reinforcement.

c. Concrete sidewalks shall be 4-inches thick and concrete driveways shall be 6-inches thick.

d. The subgrade for the walk or driveway shall be shaped to a true surface conforming to the proposed slope of the walk, thoroughly rolled at optimum moisture content, and tamped with a power roller weighing not less than one ton and not more than 5 tons. All depressions occurring shall be filled with suitable material and again rolled or tamped until the surface is smooth and hard.

e. After the subgrade has been prepared, a sub-base of gravel at optimum moisture content shall be placed, thoroughly rolled by a power roller, and tamped. The gravel shall be a minimum of 8 inches in thickness.

f. The forms shall be smooth, free from warp, strong enough to resist springing out of shape, and deep enough to conform to the thickness of the proposed walk or driveway. All mortar or dirt shall be completely removed from forms that have been previously used. The forms shall be well staked, thoroughly braced, and set to the established lines with their upper edge conforming to the grade of the finished walk or driveway.

g. The finished surface shall have sufficient pitch from the outside edge to provide for surface drainage. This pitch shall be 1/4 of an inch per foot unless otherwise directed by the Engineer. Before the concrete is placed, the sub-base for sidewalks shall be thoroughly dampened until it is moist throughout but without puddles of water.

4. General:

a. Valve boxes, manhole frames, and all other castings shall be carefully set to the proposed finished grades.

I. Berms and Waterways

1. Bituminous curbing shall be replaced as required. Curbing shall be machine laid and conform to grade of roadway and adjacent curb areas.

2. Bituminous berms shall be replaced as required. Berms shall be machine laid and conform to the grade of the roadways. Berms shall be placed in accordance with MHD Specification 470.20.

3. Bituminous waterways which have been disturbed by construction operations shall be repaired or replaced. The waterways shall be repaired and constructed in accordance with the applicable requirements of Section 280 of the MHD Specifications. Waterways shall be placed in two 1-1/2-inch thick courses on a prepared gravel base. Material shall be compacted by tamping or rolling.

3.4 PROTECTION

A. Protect replacement work with barricades or other devices as approved by Engineer so that no damage occurs as a result of subsequent construction operations.

1. After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

2. Repair damages or other irregularities to satisfaction of Engineer, at no additional cost to the Owner, before final acceptance by the Engineer.

3.5 CONTRACT CLOSEOUT

A. Provide in accordance with Section 01700.

END OF SECTION 02576

SECTION 02640

VALVES AND APPURTENANCES

PART 1 – GENERAL

1.1 SCOPE OF WORK

A. The work covered under this section includes the furnishing of all plant, labor, equipment, appurtenances, and materials, and in performing all operations in connection with installing and testing of the buried valves and appurtenances, at the locations indicated and/or as directed, complete in place in accordance with the drawings and specifications.

B. Where existing gate boxes and valves are to be removed, the contractor is responsible for disposal.

1.2 RELATED WORK

A. Section 02570 – Sewers, Structures and Appurtenances

1.3 SUBMITTALS

A. Shop Drawings:

1. Submit shop drawings and descriptive literature, showing valve dimensions and other details for each type and class of valve to be furnished.

1.4 REFERENCE STANDARDS

A. American Water Works Association (AWWA)

1. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

2. AWWA C517 – Resilient Seated Cast-Iron Eccentric Plug Valves

B. Underwriters Laboratory (UL)

C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Plug valves for force mains shall be ductile iron made in accordance with AWWA Specification C-517. Valves to be rated for 125 psi working pressure. Valve body and

bonnet to be coated inside and out with fusion bonded epoxy. All interior coatings shall be suitable for wastewater.

B. Valves are to have chevron-style v-ring seals and a non-rising stem. Valves shall have a 2-inch operating nut and be Open Left (counter-clockwise to open). An arrow indicating the opening position shall be cast into the operating nut.

C. The single piece plug/stem shall be designed for a quick lift camming motion to provide both low torque and reduced wear of the plug face elastomer.

D. Valve boxes shall be cast iron, asphalt coated, sliding type, adjustable, together with cast iron covers with the word "SEWER" plainly cast in relief on the top surface. A minimum 6-inch overlap is required between sliding sections. The inside diameter of the bottom section shall be at least 5-1/4-inches and shall have a belled base. The top section shall be at least 6-1/8-inches and have top flanges. The bottom section shall be at least 36-inches in length. The top section shall be at least 26-inches in length and have a plain bottom.

PART 3 – EXECUTION

3.1 INSPECTION AND PREPARATION

A. All valves and appurtenances shall be installed in the location shown on the drawings or where directed by the Engineer. Valves shall be true to alignment and rigidly supported. Any damaged items shall be replaced before they are installed.

B. During installation of all valves and appurtenances, the Contractor shall verify that all the items are clean, free from defects in materials and workmanship and functioning properly. Valves and other equipment which do not operate easily, or are otherwise defective, shall be repaired or replaced.

C. All valves shall be closed and kept closed until otherwise directed by the Engineer.

D. Care shall be taken to avoid freezing of water in valves.

3.3 MANUFACTURER'S SERVICE

A. The Contractor shall coordinate the services of a qualified representative of the tapping equipment and/or tapping valve supplier to provide on-site support and assistance during wet tapping operations of existing force mains.

3.4 SHOP PAINTING VALVES AND APPURTENANCES

A. Interior and exterior surfaces of all valves which are not factory epoxy coated shall be given two coats of shop finish of an asphalt varnish conforming to the latest edition of AWWA C504 for Varnish Asphalt. The pipe connection openings shall be capped to prevent the entry of foreign matter prior to application.

3.5 THRUST BLOCKS

A. Concrete thrust blocks shall be placed between the bottom of tees and/or wyes and undisturbed soil at the bottom of the trench. Minimum bearing area shall be 36 square inches. Felt roofing paper shall be placed around the tee before placing concrete.

3.6 FIELD TESTS AND ADJUSTMENTS

A. Conduct a functional field test of each valve, including actuators and valve control equipment, if any, in the presence of the Engineer to demonstrate that each part and all components together function correctly. The Contractor shall provide all testing equipment.

3.7 INSTALLATION OF BURIED VALVES AND VALVE BOXES

A. The Contractor shall furnish all necessary labor and equipment to excavate and expose the force main sufficiently to install valves and/or tapping valves as required by the Engineer.

B. Valves shall be cleaned and manually operated before installation. Valves shall be set on a firm foundation and supported by tamping pipe-bedding material under the sides of the valve. The valve box shall be supported during backfilling and maintained in vertical alignment with the top flush with the finished grade. Buried valves and valve boxes shall be set with the stem vertically aligned in the center of the valve box. The valve box shall be set so as not to transmit loads to the valve.

C. Before backfilling, all exposed portions of any bolts shall be coated with two coats of bituminous paint comparable to Bitumastic No. 50 by Koppers Co., Inc. or equal.

END OF SECTION 02640

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SECTION 02901

MISCELLANEOUS WORK AND CLEANUP

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required to do the miscellaneous work not specified in other sections but obviously necessary for the proper completion of the work as shown on the Drawings.

B. When applicable the Contractor shall perform the work in accordance with other sections of this Specification. When no applicable specification exists, the Contractor shall perform the work in accordance with the best modern practice and/or as directed by the Engineer.

C. The work of this Section includes, but is not limited to, the following:

1. Installing and maintaining construction warning and funding agency signs;

2. Crossing and relocating existing utilities;

3. Restoring of driveways and sidewalks;

4. Cleaning up;

5. Incidental work;

6. Job photographs, if required;

7. Protection and/or removal and reinstallation of existing signs, lampposts, fence posts, fencing and mailboxes;

8. Protection and bracing of utility poles;

9. Restoration and replacement of curbing; and

10. Raking and re-seeding of grassed areas disturbed during construction and/or dewatering activities, including silt basin/dewatering activity areas.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Materials required for this Section shall be the same quality of materials that are to be restored. Where possible, the Contractor may re-use existing materials that are removed.

PART 3 – EXECUTION

3.1 INSTALLING AND MAINTAINING CONSTRUCTION WARNING SIGNS

A. Construction work zone traffic control shall be the contractor's responsibility. Generally, conformance with Part VI of the Manual of Uniform Traffic Control Devices (MUTCD), latest edition, "Standards and Guides for Traffic Controls for Street and Highway Construction, Maintenance, Utility, and Incident Management Operations", will be considered to meet this requirement.

3.2 CROSSING AND RELOCATING EXISTING UTILITIES

A. In locations where existing utilities; including but not limited to culverts, water courses, including brooks and drainage ditches, storm drains, gas mains, water mains, electric, telephone, gas and water services and other utilities; cannot be crossed without interfering with the construction of the work as shown on the Drawings, the Contractor shall remove and relocate the utility as directed by the Engineer or cooperate with the Utility Companies concerned if they relocate their own utility.

B. Notification of Utility Companies shall be required prior to work being done, as specified in Section 01046 – Control of Work.

C. At pipe crossings and where designated by the Engineer, the Contractor shall furnish and place screened gravel bedding so that the existing utility or pipe is firmly supported for its entire exposed length. The bedding shall extend to the mid-diameter of the pipe crossed.

3.3 RESTORING OF DRIVEWAYS AND SIDEWALKS

A. Existing public and private driveways disturbed by the construction shall be replaced. Paved drives shall be repaved to the limits and thickness existing prior to construction. Gravel drives shall be replaced and regraded.

B. Existing public and private sidewalks disturbed by the construction shall be replaced with sidewalks of equal quality and dimension.

3.4 CLEANING UP

A. The Contractor shall remove all construction material, excess excavation, buildings, equipment and other debris remaining on the job as a result of construction operations and shall restore the site of the work to a neat and orderly condition.

B. All loose and extraneous material, including but not limited to water, sand, concrete, and general debris, in manholes and catch basins shall be removed.

C. Haybales and silt fences and any silt and debris retained by same shall be removed.

D. Sweep clean all interior spaces.

3.5 INCIDENTAL WORK

A. Do all incidental work not otherwise specified, but obviously necessary to the proper completion of the Contract as specified and as shown on the Drawings.

3.6 PHOTOGRAPHS OF PROJECT

A. Prior to the excavation in any street or cross country area, the Contractor may document existing conditions using construction photographs. Photographs for this purpose shall be at the Contractor's expense.

3.6 RESTORATION AND REPLACEMENT OF SIGNS, LAMPPOSTS, FENCE POSTS, FENCING AND MAILBOXES

A. Existing signs, lamp posts, fence posts, fencing and mailboxes which may be damaged by the Contractor or removed by the Contractor during the course of construction shall be reinstalled in a vertical position at the same location from which they were removed. Damaged items shall be replaced with an item equal to or better than the damaged items. A concrete anchor shall be provided as necessary, at no additional cost, to ensure a rigid alignment. Care shall be exercised in the reinstallation of all items to prevent damage to the new construction.

3.7 PROTECTION AND BRACING OF UTILITY POLES

A. The Contractor shall be responsible for making all arrangements with the proper utility companies for the bracing and protection of all utility poles that may be damaged or endangered by the Contractors operations. Work under this item shall include the related removal and reinstallation of guy wires, or support poles whether shown on the Drawings or not.

3.8 RESTORATION AND REPLACEMENT OF CURBING

A. Existing concrete, bituminous timber or granite curbing shall be protected. If

necessary, curbing shall be removed and replaced after backfilling. Curbing which is damaged during construction shall be replaced with curbing of equal quality and dimension at the Contractor's expense. Granite curbing removed and reset shall conform to Section 580 of the Massachusetts Highway Department Standard Specifications. Joints between sections shall be pointed as required after resetting. Bituminous berms shall conform to Section 501 of the Massachusetts Highway Department Standard Specifications.

3.8 RAKING AND RE-SEEDING

A. Grass and landscaped areas disturbed by the Contractor shall be raked and replenished with loam if required. Place topsoil to a depth in accordance with Section 02920 – Topsoil for areas disturbed by Contractor's construction operations. Spread evenly and grade to existing elevations and slopes. Hand rake areas inaccessible to machine grading. Use all available on-site stockpiled topsoil and supplement with off-site topsoil as required.

B. Areas shall be re-seeded as directed by the Engineer. Seed mixture shall be in accordance with Section 02945 – Turf.

END OF SECTION 02901

SECTION 02920

TOPSOIL

PART 1 - GENERAL

1.1 SUMMARY

A. The work of this section consists of manufacturing, delivering, and placing 6” of topsoil on prepared subgrade areas disturbed by construction. Topsoil, as available, may be stripped, screened, stockpiled and tested for reuse. Topsoil requirements in excess of available on-site will be imported. Both sources will be placed in compliance with this section.

1.2 RELATED SECTIONS

A. Drawings and general provisions of DIVISION 0 - BIDDING AND CONTRACT REQUIREMENTS and other DIVISION 1 Specification Sections, apply to this section. Related Sections include the following:

1. Section 02200 – Earthwork

2. Section 02945 – Turf

1.3 SUBMITTALS

A. In accordance with Section 01300 – Submittals: Submit soil analysis report for imported topsoil from the State University Agricultural Extension Service or other approved soil testing laboratory. Report shall cover soil textural classification (percentages of sand, silt, and clay) and include additive recommendations for lawn areas. Field methods of analysis are acceptable, but laboratory report is preferred.

1.4 PRODUCT HANDLING

A. Do not deliver topsoil in frozen, wet, or muddy condition.

PART 2 - MATERIALS

2.1 IMPORTED TOPSOIL

A. Friable loam, typical of fertile local topsoil; free-from pure clay, weeds, noxious weed seeds, sod, clods and stones larger than 1 inch, toxic substances, litter, or other deleterious material; having a mildly alkaline to medium acid pH between 6.0 and 7.5. Soluble salts shall not exceed 4 milli-mhos per centimeter.

B. Soil Texture: 20 to 40% fines (silt and clay fraction passing the 200 sieve) and 60 to 80% sand and gravel. The maximum particle size shall be 1-inch.

C. Organic Content: 5 to 10%

D. Additives: As required by soil analysis of Topsoil for lawn areas.

PART 3 - EXECUTION

3.1 PLACING TOPSOIL

A. Scarify compacted subgrade to a 2-inch depth to bond topsoil to subsoil. Place topsoil to a minimum depth of 6 inches for outside disturbed areas. Spread evenly and grade to existing elevations and slopes. Hand rake areas inaccessible to machine grading. Use all available on-site stockpiled topsoil and supplement with off-site topsoil as required, including amendments.

END OF SECTION 02920

SECTION

02945 TURF

PART 1 - GENERAL

1.1 SUMMARY

A. The work of this Section consists of providing all labor, equipment, materials, incidental work, and construction methods necessary to perform all lawn installation and fine grading work and related items as indicated on the Contract Documents and/or as specified in this Section and includes, but is not necessarily limited to, the following:

1. Seeding

2. Maintenance and protection

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of DIVISION 0 - BIDDING AND CONTRACT REQUIREMENTS and other DIVISION 1 Specification Sections, apply to this section.

B. Examine all Contract Documents and all other Sections of the Specifications for requirements therein affecting the work of this trade.

C. The following items of related work are specified and included in other Sections of the Specifications:

1. Section 02920 – Topsoil

1.3 SUBMITTALS

A. At least 90 days prior to the first day of the seeding season described in this Section, submit to the Engineer proof of certification of Foreman or Crew Leader as Massachusetts Certified Landscape Professional or Massachusetts Certified Horticulturist in accordance with QUALITY ASSURANCE paragraph of this Section.

B. Submit proof of landscape contractor's experience to the Engineer in accordance with QUALITY ASSURANCE paragraph of this Section.

C. At least 30 days prior to intended use, the Contractor shall provide the following samples and submittals for approval. Do not order materials until Engineer's approval of samples, certifications or test results has been obtained. Delivered

materials shall closely match the approved samples. Acceptance shall not constitute final acceptance. The Engineer reserves the right to reject on or after delivery any material that does not meet these Specifications.

1. Material Sampling and Testing of Loam Borrow from On-Site or Off-Site Sources shall be as specified in Section 2920 – TOPSOIL (Outside Disturbed Areas).

2. Fertilizer:

   a. Submit product literature of seeding fertilizer and certificates showing composition and analysis.
   b. Submit the purchasing receipt showing the total quantity purchased for the project prior to installation.

3. Seed: Submit a manufacturer's Certificate of Compliance to the Specifications with each shipment of each type of seed. These certificates shall include the guaranteed percentages of purity, weed content and germination of the seed, and also the net weight and date of shipment. No seed may be sown until the Contractor has submitted the certificates.

4. Hydroseeding: Prior to the start of hydroseeding, submit a certified statement for approval as to the number of pounds of materials to be used per 100 gallons of water.

5. Wood Cellulose Fiber Mulch: Submit 4 copies of manufacturer's literature and one material sample.

6. Limestone: Submit supplier's certification that the limestone being supplied conforms to these Specifications.

7. All additives needed to amend a specific soil in order to meet these specifications.

D. Maintenance Instructions: At the time of Acceptance, the Contractor shall submit complete maintenance instructions for turf care for the Owner's use. The instructions shall be reviewed for approval by the Engineer as a pre-condition for Acceptance.

1.4 EXAMINATION OF CONDITIONS

A. All areas to be improved shall be inspected by the Contractor before starting work and any defects such as incorrect grading, or drainage problems shall be reported to the Engineer prior to beginning this work. The commencement of work by the Contractor shall indicate his acceptance of the areas to be improved, and he shall assume full responsibility for the work of this Section.

B. The Contractor shall be solely responsible for judging the full extent of work requirements involved.

1.5 QUALITY ASSURANCE

A. Qualification of Landscape Contractor: The work shall be performed by a landscape contracting firm which has successfully installed work of a similar quality, schedule requirement, and construction detailing with a minimum of five years' experience. Proof of this experience shall be submitted per SUBMITTALS.

B. Qualification of Foreman or Crew Leader: All work of seeding shall be supervised by a foreman or crew leader who is a certified landscape professional or a certified horticulturist.

1. Landscape professional shall be a Massachusetts Certified Landscape Professional certified by the Associated Landscape Contractors of Massachusetts.

2. Horticulturist shall be a Massachusetts Certified Horticulturist as certified by the Massachusetts Nursery and Landscape Association.

3. Certification shall be current. Proof of certification shall be submitted per SUBMITTALS.

C. The ratio of laborers to certified landscape professionals or certified horticulturist shall not exceed twelve to one. Certified Landscape Professional or Certified Horticulturist shall be on the project site throughout the day to day performance of the work described in this Section.

PART 2 - PRODUCTS

2.1 LOAM

A. As specified in Section 02920 – Topsoil.

2.2 SOIL ADDITIVES

A. As specified in Section 02920 – Topsoil, except for additional applications of fertilizer that shall be specified under this Section based upon recommendations from soil analysis and testing as specified.

2.3 SEED

A. Seed mixture shall be fresh, clean, new crop seed. Grass shall be of the previous year's crop and in no case shall the weed seed content exceed 0.25% by weight. The seed shall be furnished and delivered in the proportion specified below in new,

clean, sealed and properly labeled containers. All seed shall comply with State and Federal seed laws. Submit manufacturer's Certificates of Compliance. Seed that has become wet, moldy or otherwise damaged shall not be acceptable. Tall fescue and rygrass shall contain Acromonium endophytes. Seed containing endophyte must be kept cool and dry at all times; do not stockpile in the sun.

1. Seed Mixture Composition for disturbed areas:

Common Name	Proportion By Weight	Germination Minimum	Purity Minimu
Tall Fescue (3 varieties minimum)	80%	85%	95%
Kentucky Bluegrass	10%	85%	95%
Perennial Rye	10%	90%	95%

a. All grass varieties shall be within the top 50 percent of varieties tested in National Turfgrass Evaluation Program, or currently recommended as low maintenance varieties by University of Massachusetts or the University of Rhode Island.
b. Seeding rate shall be 6 pounds per 1,000 square feet.

B. Seed may be mixed by an approved method on the site or may be mixed by a dealer. If the seed is mixed on the site, each variety shall be delivered in the original containers that shall bear the dealer's guaranteed analysis. If seed is mixed by a dealer then the Contractor shall furnish the Engineer the dealer's guaranteed statement of the composition of the mixture.

2.4 JUTE MESH

A. Jute mesh shall be a uniform, open, plain weave cloth of undyed and unbleached single jute yarn. The yarn shall be of a loosely twisted construction and it shall not vary in thickness more than one-half its normal diameter. Jute mesh shall be furnished in rolled strips and shall meet the following requirements:

1. Width - 48 inches, plus or minus one inch 78 warp - ends per width of cloth (minimum) 41 weft - ends per yard (minimum) Weight shall average 1.22 pounds per linear yard with a tolerance of plus or minus 5%.

B. Staples shall be U-shaped and shall be approximately six inches long and one inch wide. Machine made staples shall be of No. 11 gauge or heavier steel wire. Handmade staples shall be made from 12-inch lengths of No. 9 gauge or heavier steel wire.

C. Jute mesh shall be placed within 48 hours after finish grading or topsoiling of an

area is completed. If seeding is specified, within 24 hours after seeding of an area is completed. The jute mesh shall be placed in a manner that will minimize disturbance of the underlying soil. All equipment and application processes shall be approved by the ENGINEER prior to use.

D. The surface shall be smoothed and all gullies and potholes backfilled prior to applying jute mesh. All rocks or clods larger than two inches in size and all sticks and other foreign material that will prevent contact of the jute mesh with the surface shall be removed. If the surface is extremely dry, the Engineer may require watering prior to placement.

E. Jute mesh shall be placed uniformly, in contact with the underlying soil, at the locations shown on the Drawings or directed by the Engineer. The top edge of each strip shall be anchored by placing a tight fold of mesh vertically in a six inch deep slot or trench in the soil and tamping and stapling in place. Edges of adjacent strips shall be lapped six inches with a row of staples at a maximum interval of three feet in the lapped area. Bottom edges shall be lapped 12 inches over the next lower strip, if applicable, or buried as specified for top edges.

F. Check slots shall consist of separate four foot strips of jute mesh placed at right angles to the direction of water flow immediately prior to placing the general covering of jute mesh. Check slots shall be anchored by burying the top edge of the strip as described above.

G. Check slots shall be spaced so that one check slot, or junction slot of the jute mesh occurs every 75 feet on gradients of less than 4% and every 50 feet on gradients of more than four percent. On slope drains, a check slot or an end slot shall occur every 25 feet unless otherwise specified.

H. Edges of jute mesh shall be buried around the edges of catch basins and other structures.

I. Jute mesh shall be held in place by wire staples driven vertically into the soil. The mesh shall be fastened at intervals not more than three feet apart in three rows for each strip of mesh, with one row along each edge and one row alternately spaced in the middle. All ends of the mesh and check slots shall be fastened at six inch intervals across their width.

J. The Contractor shall maintain the areas covered by jute mesh until final acceptance of the project. Prior to final acceptance, any damaged areas shall be reshaped as necessary, reseeded, if applicable; and the jute mesh satisfactorily repaired or replaced.

2.5 FERTILIZERS

A. Fertilizer shall be a commercial product complying with the State and United States fertilizer laws. Deliver to the site in the original unopened containers that

shall bear the manufacturer's certificate of compliance covering analysis. Fertilizer shall contain not less than the percentages of weight of ingredients as recommended by the soil analysis specified in Section 02920 – TOPSOIL.

2.6 LIMESTONE

A. Ground limestone for adjustment of loam borrow pH shall contain not less than 85 percent of total carbonates and shall be ground to such fineness that 40 percent will pass through 100 mesh sieve and 95 percent will pass through a 20 mesh sieve. The Contractor shall be aware of loam borrow pH and the amount of lime needed to adjust pH to specification in accordance with testing lab recommendations.

2.7 WOOD CELLULOSE FIBER MULCH

A. Mulch to cover hydroseeded areas with slopes less than 3 to 1 shall be fiber processed from whole wood chips and clean recycled newsprint in a 1:1 proportion manufactured specifically for standard hydraulic mulching equipment. Fiber shall not be produced from recycled material such as sawdust, paper, or cardboard.

B. Moisture content shall not exceed 10 percent, plus or minus 3 percent as defined by the pulp and paper industry standards. Fiber shall have a water holding capacity of not less than 900 grams water per 100 grams fiber.

C. The mulch shall be of such character that the fiber will be dispersed into a uniform slurry when mixed with water. It shall be nontoxic to plant life or animal life.

D. The mulch shall contain a non-petroleum based organic tackifier and a green dye to allow for easy visual metering during application but shall be non-injurious to plant growth.

2.8 HERBICIDES, CHEMICALS AND INSECTICIDES

A. Provide chemicals and insecticides as needed for fungus or pest control. All chemicals and insecticides shall be approved by the Massachusetts Department of Food and Agriculture for the intended uses and application rates.

B. Provide post-emergent crab grass control throughout the maintenance period to ensure a germinated and mown lawn free of crab grass.

2.9 WATER

A. The Contractor may use water provided by the Town upon request and approval of the DPW, if available. The Contractor shall responsible to furnish his own supply of water to the site at no additional cost to the Owner. If Town water is not available, the Contractor shall be responsible to furnish adequate supplies at his own cost. All work injured or damaged due to the lack of water or use of too much water, shall be the Contractor’s responsibility to correct. Water shall be free from

impurities injurious to vegetation. The Contractor's use of Owner's water shall be at his own risk.

PART 3 - EXECUTION

3.1 FILLING AND COMPACTION

A. As specified in Section 02920 – TOPSOIL.

3.2 FINE GRADING

A. As specified in Section 02220 – EARTHWORK.

3.3 SEEDING

A. Contractor shall obtain Engineer's written approval of fine grading and bed preparation before doing any seeding.

B. Limit of proposed grading shall be limit of seeding unless otherwise indicated on the Contract Documents. All lawn areas disturbed outside the limit of seeding shall be prepared and seeded as specified herein at no additional cost.

C. The season for seeding shall be from April 1 to May 31 and from August 15 to September 30. The actual planting of seed shall be done, however, only during periods within this season which are normal for such work as determined by weather conditions and by accepted practice in this locality. To prevent loss of soil via water and wind erosion and to prevent the flow of sediment, fertilizer, and pesticides onto roadways, sidewalks, and into catch basins, seed loam areas within 5 Days of spreading the loam.

D. Seed only when the bed is in a friable condition, not muddy or hard.

E. Seeding of Disturbed areas shall be by Hydroseeding Method specified as follows:

1. Prior to the start of work, furnish a certified statement as to the number of pounds of materials to be used per 100 gallons of water. This statement shall also specify the number of square feet of hydroseeding that can be covered with the quantity of solution in the hydroseeder.

2. Hydroseed with wood cellulose fiber mulch at a rate as designated above in Part 2 – PRODUCTS.

3. For the hydroseeding process, a mobile tank with a capacity of at least 500 gallons shall be filled with water and the mixture noted above in the specified proportions. The resulting slurry shall be thoroughly mixed by means of positive agitation in the tank. Apply the slurry by a centrifugal

pump using the hose application techniques from the mobile tank. Only hose application shall be permitted. At no time shall the mobile tank or tank truck be allowed onto the prepared hydroseed beds. The hose shall be equipped with a nozzle of a proper design to ensure even distribution of the hydroseeding slurry over the area to be hydroseeded and shall be operated by a person thoroughly familiar with this type of seeding operation.

4. Contractor shall obtain Engineer's written approval of fine grading and bed preparation before doing any hydroseeding.

5. Limit of work shall be limit of hydroseeding unless otherwise indicated on the Contract Documents. All lawn areas disturbed outside the limit of hydroseeding shall be hydroseeded.

6. Seed only when the bed is in a friable condition, not muddy or hard. Construction methods shall conform to hydraulic method requirements specified in the Standard Specification.

7. Hydroseeding shall be a two-step process.

   a. Step one shall consist of spreading 100 percent of the required seed uniformly over the prepared loam bed so that the seed comes into direct contact with the soil. To mark the progress of the hydroseeding operation the Contractor may add 10 percent of the wood cellulose fiber mulch to the slurry.
   b. Step two shall consist of a separate application of wood cellulose fiber mulch immediately following the first step of hydroseeding noted above. Apply the wood cellulose fiber mulch at a rate of 2,000 pounds per acre.

3.4 TURF MAINTENANCE

A. Maintenance shall begin immediately after any area is seeded or sodded and shall continue for a 60 day active growing period for seeded areas or until Final Acceptance, whichever is longer following the completion of all lawn construction work, and until final acceptance of the project. In the event that seeding operations are completed too late in autumn for adequate germination and growth of grass, then maintenance shall continue into the following spring for the minimum 60 Day period and including the One (1) Year Maintenance Period.

B. Maintenance shall include re-seeding, two (2) mowings, watering, weeding, fertilizing a minimum of two times in addition to the fertilizer incorporated by harrowing into the spread loam, and resetting and straightening of protective barriers. Lawn work maintenance shall also include chemical treatments as required for fungus and/or pest control.

C. During the maintenance period, any decline in the condition of turf areas shall

require immediate action to identify potential problems and to undertake corrective measures.

D. Watering shall be done in a manner that will provide uniform coverage, prevent erosion due to application of excessive quantities over small areas, and prevent damage to the finished surface by the watering equipment.

1. The Contractor shall provide all labor and arrange for all watering necessary to establish an acceptable lawn. In the absence of adequate rainfall, watering shall be performed daily or as often as necessary to maintain moist soil to a depth of at least two (2) inches for seeded areas and four (4) inches for sodded areas. At no time shall a tank truck be allowed on the reseeded/re-sodded beds.

2. Watering shall be done in a manner that will provide uniform coverage, prevent erosion due to application of excessive quantities over small areas, and prevent damage to the finished surface by the watering equipment. The Contractor shall furnish sufficient watering equipment to apply water to the required soil depths each 8-hour period.

E. After the grass in seeded areas has germinated, reseed all areas and parts of areas that fail to show a uniform stand of grass. Reseed such areas and parts of areas repeatedly until all areas are covered with a satisfactory growth of grass with no less than 20 grass shoots per square inch and 2,880 grass shoots per square foot. Reseeding together with necessary grading, fertilizing, and trimming shall be done at the Contractor's expense.

F. Mowing and Edging:

1. The Contractor shall keep lawn areas mowed until Acceptance of the contract by cutting to a height of two (2) inches when growth reaches three (3) inches or as directed by the Engineer.

2. At each mowing, all edges of walks, drives, plant beds and other border conditions shall be edge trimmed by hand or machine to produce straight and uniform edge conditions.

3. Remove and discard from paved areas only clippings and debris generated by each mowing and edging operation legally off-site. Engineer, if practical and aesthetic, may allow sweeping (not blowing) clippings back into grass. Mowers shall be equipped with mulching blades. Do not remove from grass areas any clippings that have been generated by mowing operations. Do not mow grass when wet.

G. Fertilizing for seeded lawns: The first application of fertilizer is as specified in Section 02920 – Topsoil. A second application of fertilizer shall be applied to seeded areas at the time of the first mowing and shall be performed as specified

herein. This second application shall be applied at a rate that ensures that one-half pound of nitrogen is applied per 1,000 square feet. Phosphorus and potassium shall be applied proportionally in accordance with the recommendations of the soil tests and the quantities previously integrated into the soil during the first application. A third application of nitrogen fertilizer shall be applied to seeded areas approximately two months after the second application. This third application shall correspond to the following application rates dependent upon the month of application.

1. May 1-15: Apply 1.0 pound of nitrogen per 1,000 square feet.

2. June 15-30: Apply 1.0 pound of nitrogen per 1,000 square feet.

3. August 15 through September 15: Apply 1.0 pound of nitrogen per 1,000 square feet.

4. November 1-15: Apply 1.5 pounds of nitrogen per 1,000 square feet.

**Nitrogen fertilizer shall be composed of 50 percent slowly soluble or slow release nitrogen fertilizer.

3.5 APPLYING LIMESTONE

A. The Contractor shall return to the site at the beginning of the next seeding season as specified above and spread limestone across all lawn areas installed under this Contract. Limestone shall be spread at rates determined by the soil tests specified.

3.6 ACCEPTANCE

A. Following the minimum required maintenance periods for lawn construction, the Contractor shall request the Engineer in writing for a formal inspection of the completed work. Request for inspection shall be received by the Engineer at least 10 Days before anticipated date of inspection.

B. Acceptance Requirements:

1. At the end of the maintenance period, seeded areas shall have a close stand of grass as defined above with no weeds present and no bare spots greater than 3 inches in diameter over greater than 5 percent of the overall seeded area. At least 90 percent of the grass established shall be permanent grass species. If seeded areas are deficient, the Contractor's responsibility for maintenance of all seeded areas shall be extended until deficiencies are corrected.

C. Furnish full and complete written instructions for maintenance of the lawns to the Owner at the time of acceptance in conformance with Submittals requirements.

D. Engineer's inspection shall determine whether maintenance shall continue in any part.

3.7 CLEAN UP

A. Absolutely no debris may be left on the site. Excavated material shall be removed as directed. Repair any damage to site or structures to restore them to their original condition, as directed by the Engineer, at no cost to the Owner.

END OF SECTION 02945

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