

## SECTION 32 91 15 - PLANTING SOILS

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

- A. All of the Contract Documents, including GENERAL AND SUPPLEMENTARY CONDITIONS and DIVISION 01 GENERAL REQUIREMENTS, apply to the work of this Section and are hereby made a part of this Section.
- B. Examine all Drawings and other Sections of the Specifications for requirements therein affecting the work of this trade.

## 1.2 SCOPE OF WORK

- A. This Section specifies administrative and procedural requirements for manufactured planting soils (planting soils) including, but not limited, to the following:
  - 1. Subgrade preparations.
  - 2. Planting soil material acquisition.
  - 3. Testing and analysis for specification conformance.
  - 4. Layout of drainage lines and installation of drainage layer below planting soils.
  - 5. Preparation of mixes and testing for conformance.
  - 6. Mock Up.
  - 7. Installation and placement of soils.
  - 8. De-compaction and re-compaction of soils.
  - 9. Final in-place testing of soils.
  - 10. Coordination with other contractors.
  - 11. Clean-up.
- B. References to other Sections are given that would duplicate provisions in this Section.

## 1.3 RELATED WORK UNDER OTHER SECTIONS

- A. Section 32 93 00 – Plants
- B. Section 31 20 00 – Earth Moving

## 1.4 QUALITY ASSURANCE/DEFINITIONS

- A. Definitions:
  - 1. Refer to Section 32 93 00 Plants
  - 2. ASA: American Society of Agronomy.
  - 3. Soil Scientist: The project Soil Scientist shall be Pine and Swallow Environmental, 867 Boston Rd., Groton, MA 01450, 978-448-9511, [www.pineandswallow.com](http://www.pineandswallow.com)
  - 4. Subgrade: Soil material and levels resulting from the approved rough grading work.
  - 5. Drainage Layer/Drainage Blanket: A layer of specified sand/sand and gravel to facilitate drainage and control of groundwater below Horticultural soils.
  - 6. Horticultural Soils: Horticultural Soils are composed of a blend of three base components: base loam, organic material and sand. The quality of the blend depends on the quality of the original components. Locate and obtain approval of sources for base loam, organic material and sand that meet the Specification requirements. Contractor is then responsible for mixing the components. Approximate mixing ratios are provided, but may require adjustment, depending on

the final materials and with the approval of the Architect or their representative, in order to meet Specification requirements for each blend.

- B. Testing/Testing Agency
  - 1. Refer to Section 31 20 00 Earth Moving.
  - 2. Refer to Section 32 93 00 Plants
  - 3. Refer to this section, 1.5 B.
- C. Contractor is solely responsible for quality control of the Work.
- D. The installer shall be a firm having at least 5 years of successful experience of a scope similar to that required for the Work, including the preparation, mixing and installation of custom Planting Soil and planting mixes in urban locations.
  - 1. The installing Contractor shall be the same firm that is installing planting as described in Section 32 93 00 – Plants
  - 2. Installer Field Supervision: Installer to maintain an experienced full-time supervisor on Project site when any Planting Soil preparation work is in progress.
  - 3. The installer's crew shall be experienced in the installation of soil, grading and interpretation of grading plans in urban areas.
- E. Soil work shall be performed by a firm that has sufficient earthwork machinery at the job site simultaneously to amply provide for the vigorous execution of the site work without interruption or delay, except for unforeseen circumstances, such as weather. Machinery operators shall be well experienced in this type of work.
- F. Comply with applicable requirements of the laws, codes, ordinances and regulations of Federal, State and municipal authorities having jurisdiction. Obtain necessary approvals from all such authorities.
- G. Comply with all requirements for control of silt and sediment during soil installation work as indicated in the contract documents. Provide additional silt and sediment control to maintain silt and sediments within the working area as required by the progress of the work or as directed by the Landscape Architect and Soil Scientist.
- H. Pre-installation Conference: Conduct conference at project site prior to the start of any work related to Planting Soil preparation and shall meet the requirements of this Section 3.1(D).
- I. Layout and Grading:
  - 1. Permanent benchmarks shall be established by a registered land surveyor or professional civil engineer, at the Contractor's expense. The Contractor shall maintain established bounds and benchmarks and replace them, if any are destroyed or disturbed.
  - 2. The Contractor shall maintain at the site, sufficient surveying equipment to accurately excavate to the required subgrade and install soil to the required finish grade. The Contractor shall be responsible to install soil profiles at the elevations and thickness shown on the Plans.

#### 1.5 TESTING, SUBMITTALS, MOCK-UPS AND INSPECTIONS

- A. Testing for Subgrade, Planting Soil Components and Planting Soil Mixes: Testing is required at the following intervals:
  - 1. Testing of individual components (Base Loam, Sand, and Compost) for planting soil mixes prior to blending of any soils for use at the Project Site. Tests are as described in this Section.

2. After test results for components have been accepted, create sample Planting Soil Mixes of each planting soil mix and perform tests described in this Section.
  3. After the test results for each Planting Soil Mix have been accepted, and during the production of planting soils, test every 200 cubic yards of every Planting Soil Mix blended for: organic matter content, gradation, and pH. Before shipping of any Planting Soil Mix, the Contractor shall confirm that the Soil Scientist has accepted the mix. Testing applies to all soil layers of the planting profile. After three consecutive compliant tests, the Contractor may increase the interval of testing to 500 cubic yards.
  4. After horticultural tests have been approved, contractor shall submit representative samples of each soil blend to a geotechnical testing laboratory for ASTM 698 Standard Proctor tests to obtain optimum moisture content and maximum dry density values.
  5. In-place tests: Compaction tests of each type of material (soil layer) placed shall be in accordance with this Section. Infiltration tests shall be in accordance with this Section.
  6. Installation of Drainage Layer: Contractor shall notify Landscape Architect and Soil Scientist at least 5 days prior to the installation of drainage layers. Contractor shall demonstrate layout and installation of drainage lines and drainage layer. Horticultural soil shall not be installed until drainage layer is accepted.
- B. Test Reports: Submit certified reports for tests as described in this Section.
1. Mechanical gradation (sieve analysis) shall be performed for sand, silt, and clay content and compared to the USDA Soil Classification System using sieve size numbers: 10, 18, 35, 60, 140 and 270. The silt and clay (0.002 mm) content shall be determined by a Hydrometer Test (ASTM D-422-63) of soil passing the #270 sieve.
  2. Chemical analysis shall be undertaken for Phosphorus, Potassium, Calcium, Magnesium, Aluminum, Iron, Manganese, Lead, Cation Exchange Capacity, Soluble Salts, organic matter content, acidity (pH) and buffer pH.
  3. Tests shall be conducted in accordance with Recommended Soil Testing Procedures for the Northeastern United States, 2nd Edition, Northeastern Regional Publication No. 493; Agricultural Experiment Stations of Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont and West Virginia. Tests include the following:
    - a. Test for soil Organic Matter by loss of weight on ignition, as described in Northeastern Regional Publication No. 493.
    - b. Test for soil CEC by exchangeable acidity method as described in Northeastern Regional Publication No. 493.
    - c. Test for soil Soluble Salts shall be by the 1:2 (v:v) soil:water Extract Method as described in Northeastern Regional Publication No. 493.
    - d. Test for Buffer pH by the SMP method as described in Northeastern Regional Publication No. 493.
    - e. Tests for pH shall be conducted on a 1:1 soil to distilled water ratio.
  4. Certified reports on analyses from producers of composted organic materials shall be required and new test reports shall be submitted when compost sources are changed. Analyses shall include all tests for criteria specified in 2.1, K.
  5. Saturated Hydraulic Conductivity: Test procedure ASTM D5856-95 (2000).
    - a. Hydraulic Conductivity tests shall be performed on samples during QA/QC testing at the Soil Supplier's facility.

6. Testing Agencies: The following firms are acceptable testing agencies for the various components and blends.
    - a. Leaf Yard Waste Compost Comprehensive and Stability Test: Woods End Research Laboratory, P.O. Box 297, Mt. Vernon, ME, 04352, tel: 201.293.2457, fax: 201.293.2488.
    - b. Leaf Yard Waste Compost Comprehensive except Stability Test: University of Massachusetts, 203 Paige Laboratory, 161 Holdsworth Way, Amherst, MA 01003, <http://soiltest.umass.edu>, tel: 413.545.2311, fax: 413.545.1931 or approved equal.
    - c. Mechanical Gradation, Chemical Analysis and Organic Matter Content, All Soil Components and Planting Soil Mixes: University of Massachusetts, 203 Paige Laboratory, 161 Holdsworth Way, Amherst, MA 01003, <http://soiltest.umass.edu>, tel: 413.545.2311, fax: 413.545.1931 or approved equal.
  7. Laboratory Density Testing: ASTM D698 - 12 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort
    - a. Density tests shall be performed on samples collected at the Soil Supplier's facility, to obtain the optimum moisture content and maximum dry density values.
- C. In-Place Testing
1. Density Tests: ASTM D1556 Density of soil and rock in place using "Sand Cone Method" or ASTM D6938-08a Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth). ASTM D698 Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort. (Standard Proctor).
    - a. In-place density tests shall be carried out at a rate of one test per each plant bed or lawn area.
    - b. Soil density shall meet the requirements specified herein, see PART 3.
  2. As required, in-place infiltration tests shall be performed using Turf-Tec IN2-W Infiltrometer utilizing manufacturer's operating instructions. Turf-Tech IN2-W Infiltrometer as manufactured by Turf Tec International, 1471 Capital Circle NW, Suite #13, Tallahassee, FL 32303. Order Line 800-258-7477, Phone 850-580-4026, Fax 850-580-4027.
  3. At the direction of the Landscape Architect and Soil Scientist, in-place planting soil blends shall be sampled and tested by the Owner for compliance with gradation and organic matter content as specified herein. Non-compliant materials shall be removed from the site or amended as specified by the Soil Scientist.
- D. Samples: Prior to ordering the below listed materials, submit representative composite samples to the Landscape Architect and Soil Scientist for selection and approval. Representative composite samples shall be composed of at least five equal-sized subsamples mixed thoroughly and resampled for submittal. Do not order materials until Landscape Architect's, and Soil Scientist's acceptance has been obtained. Delivered materials shall closely match the approved samples.
1. Components
    - a. Compost: duplicate samples of 1 gallon.
    - b. Base Loam: duplicate samples of 1 gallon.
    - c. Medium to Coarse Sand: duplicate samples 1 gallon.

2. Test Blends
    - a. Planting Bed Soil: duplicate samples of 1 gallon.
    - b. Sand-Based Structural Soil (SBSS): duplicate samples of 1 gallon.
  3. Production Stockpiles
    - a. Planting Bed Soil: duplicate samples of 1 gallon.
    - b. Sand-Based Structural Soil: duplicate samples 1 gallon.
  4. Materials
    - a. 3/8" Crushed Stone: duplicate samples of 1 gallon.
    - b. #9 Crushed Stone: duplicate samples of 1 gallon.
    - c. Filter Fabric Mirafi 140N or equal: duplicate one square foot samples.
    - d. Perforated Aeration 4-inch pipe: duplicate one foot samples.
    - e. Nonperforated Aeration 4-inch pipe: duplicate one foot samples.
- E. Sources for Base Loam, Sand, and Compost: Submit information identifying sources for all soil components and the firm responsible for mixing of planting soil mixes.
1. Landscape Architect, Soil Scientist, and Owner shall have the right to reject any soil supplier or mixing facility.
  2. Soil mix supplier shall have a minimum of five years experience at supplying custom planting soil mixes.
  3. Submit supplier name, address, telephone and fax numbers and contact name.
  4. Submit certification that accepted supplier/ mixer is able to provide sufficient quantities and qualities of materials for the entire project.
  5. Final approval of soil supplier/ mixer shall be made after on-site review of supplier's and mixer's facility(ies) by the Soil Scientist.
- F. Subgrade Survey
1. Contractor shall submit for approval by the Landscape Architect a survey of final subgrade in all areas where planting soils will be placed. Placement of any drainage layer or planting soil shall not precede acceptance by the Landscape Architect.
- G. Mock Up and Inspection
1. At the beginning of site work, the contractor shall demonstrate, in the presence of the Soil Scientist, subgrade preparations, including de-compaction and re-compaction methods and placement of sand blanket and drain lines that achieve the requirements of this Section. All subsequent subgrade preparations shall be in accordance with approved methods.
  2. The Contractor shall not place Horticultural Subsoil, Planting Soil, Sand Based Structural Soil on prepared subgrade or drainage layer prior to inspection and approval of Landscape Architect and Soil Scientist for compliance with depth, compaction and percolation rate. The Contractor shall request inspection before proceeding at least ten working days prior to placement of soils.
  3. The Contractor shall not plant any plant material prior to inspection and approval of Landscape Architect and Soil Scientist for compliance with soil depth and compaction specifications. The Contractor shall request inspection before proceeding at least ten working days prior to placement of soils.
  4. The Contractor shall construct a Mock Up of the initial installation of Sand Based Structural Soil in the presence of the Soil Scientist. The Mock Up may be part of the permanent installation if the Soil Scientist approves it. The Mock Up shall be conducted with the same equipment that will be used for the duration of the Sand

Based Structural Soil installation. Mock Up must be conducted with material compliant with the soil moisture requirements provided in 1.6 H. A geotechnical testing agency shall be on site to conduct soil moisture and compaction/density tests for each lift installed during the Mock Up and all subsequent SBSS soil placement.

G. **Planting Soil Testing Protocol**

1. **The Appendix summarizes the process of planting soil testing, submittal, and evaluation.**

1.6 DELIVERY, STORAGE AND HANDLING

- A. Refer to Section 31 20 00 Earth Moving for overall material handling requirements.
- B. In addition, the following provision is established: Material shall not be handled or hauled, placed or compacted when it is wet as after a heavy rainfall, early spring or if frozen. Soil shall be handled only when the moisture content is compliant with Section 329115 1.6.H. The Landscape Architect, Soil Scientist and the Owner shall be consulted to determine if the soil is too wet to handle.
- C. Store and handle packaged materials in strict compliance with manufacturer's instructions and recommendations. Protect all materials from weather, damage, injury and theft.
- D. Sequence deliveries to avoid delay. On-site storage space is permissible only with written notice from Construction Manager. Deliver materials only after preparations for placement of planting soil have been completed.
- E. Prohibit vehicular and pedestrian traffic on or around stockpiled planting soil.
- F. Planting Soil that is to be stockpiled longer than two weeks, whether on or off site, shall not be placed in mounds greater than six feet high.
- G. Vehicular access to the site is restricted. Before construction, the Contractor shall submit for approval a plan showing proposed routing for deliveries and site access.
- H. Soil Moisture Content
  1. Contractor shall not move, blend or grade soil when moisture content is so great that free moisture is apparent, nor when it is so dry that dust will form in the air or that clods will not break readily, nor when it is frozen. Apply water, if necessary, or allow to dry to bring soil moisture between 60% of optimum moisture content and optimum moisture content as determined by ASTM D698 prior to compaction, grading or planting.
    - a. Sand Based Structural Soil must be tested, and be compliant for soil moisture content immediately prior to delivery or placement at the site.
  2. Field Soil Moisture Test procedure is applicable for general soil moving and placement only and shall not be considered appropriate for compaction of soils, nor is a replacement for the above testing procedure.
    - a. Form soil in palm of hand, if soil retains shape and crumbles upon touching, the soil may be worked.
    - b. If the soil will not retain shape it is too dry and should not be worked.
    - c. If the soil retains shape and will not crumble, it is too wet and should not be worked.

- d. If the soil glistens or free water is observed when the sample is patted in the palm of hand the soil is too wet and should not be worked.
- e. This field test is a guideline. Test in 1.6 H. 1. is the test for compliance.

## PART 2 - PRODUCTS

## 2.1 SOIL MATERIALS

## A. General

1. All plant mix material shall be imported and fulfill the requirements as specified and be tested to confirm the specified characteristics.
2. Samples of individual components of soil mixes in addition to blended soil mixes including mulch materials shall be submitted by the Contractor for testing and analysis to the approved testing laboratory. Comply with specific materials requirements specified.
  - a. No base component material or soil components for soil mixes shall be used until certified test reports by an approved soil testing laboratory and have been received and approved by the Landscape Architect and Soil Scientist.
  - b. As necessary, make any and all soil mix amendments and resubmit test reports indicating amendments until approved.
3. The Landscape Architect and Soil Scientist may request additional testing by Contractor for confirmation of mix quality and/or soil mix amendments at any time until completion. Changes in mix ratios may be required.

## B. Soil Testing and Soils Testing Report Submittal

1. All testing of the soil mix components shall be carried out by the Soils Testing Laboratory. Recommendations for amending and/or correcting the soil mix will be provided to the Contractor by the Soil Scientist after approval by the Landscape Architect and Soil Scientist.
2. Failure of any material by testing and/or amendment procedure to meet Specification requirements shall require the Contractor to seek another source for the failed material and the initiation of all testing procedures for the new replacement material shall immediately take place.
3. The Contractor shall be responsible for recognizing that these critical project materials warrant timely and serious attention, that the testing process to achieve Approved materials should be considered a lead time item, and that under no circumstance shall failure to comply with all specification requirements be an excuse for "staying on project construction schedule."

C. Soil Samples: Contractor is responsible for paying costs for testing. Submit 1 gallon planting soil samples in two phases. Submit samples concurrent with horticultural soil test reports in both phases. Submit as phase one, planting soil base components for approval. Only after approval of phase one components, submit as phase two, soil blend mixes / mediums for approval. All reports must be from recent analyses, less than 90 days old, and represent materials that are available for delivery to the site.

1. Phase One Submittals of Planting Soil Base Components:
  - a. Base Loam (Imported Topsoil)
  - b. Organic Amendment Materials (Compost)
  - c. Coarse Sand for Amending Soil and Drainage
  - d. Crushed Stone for Use Over Sand Based Structural Planting Soil



2. Phase Two Submittals of Planting Mediums: mixing and batching of soil mediums to be submitted in the same manner as bulk soils and will be prepared prior to delivery to site.
  - a. Sand Based Structural Planting Soil (Horticultural Subsoil)
  - b. Planting Bed Soil
3. Phase Three Submittals shall be identical to Phase Two Submittals and be conducted for each 200 cubic yards of soil material prepared for the project site.
4. Submit reports for each of the above samples: Submit sample from each proposed source for testing and approval. Deliver samples to both the testing laboratory and the project soil scientist and pay costs. Send report directly to Owner's Representative.
5. Soil Sample Submittals: Sampling shall be done by the Contractor. The size of the samples and method of sampling shall be as follows: Samples shall be representative of the material to be brought to the site. Each sample shall be a Composite Sample, which consists of 5 separate sub samples taken from a minimum of (5) different locations at each source and mixed together to make the test sample.
6. The Contractor shall schedule this testing in order to permit reasonable time for testing, evaluation, and approvals prior to scheduled installation. Allow for a minimum of 4 weeks to perform testing and obtain approvals.

D. Imported Base Loam

1. Imported Base Loam, as required for blending with sand and compost, shall be a naturally occurring A-Horizon soil formed from geologic soil forming processes without admixtures of sand or organic matter sources (composts). Base Loam, which has been contaminated by incorporation of subsoil, shall not be acceptable for use. Base Loam as required for the work shall be free of subsoil, large stones, earth clods, sticks, stumps, clay lumps, roots or other objectionable, extraneous matter or debris. Base Loam shall also be free of quack-grass rhizomes, Agropyron Repens, and the nut-like tubers of nutgrass, Cyperus Esculentus, and all other primary noxious weeds. Base Loam shall not be delivered or used for planting while in a frozen or muddy condition. Base Loam for mixing shall conform to the following grain size distribution for material passing the #10 sieve:

U.S. Sieve Size Number	Percent Passing	
	Minimum	Maximum
10	---	100
18	85	100
35	70	95
60	50	85
140	36	53
270	32	42
0.002mm	3	6

2. The ratio of the particle size for 80% passing (D<sub>80</sub>) to the particle size for 30% passing (D<sub>30</sub>) shall be 8 or less (D<sub>80</sub>/D<sub>30</sub> < 8).
3. Maximum size shall be one-inch largest dimension. The maximum retained on the #10 sieve shall be 20% by weight of the total sample. Tests shall be by combined

hydrometer and wet sieving in compliance with ASTM D422 after destruction of organic matter by ignition.

4. The organic content shall be between 4.0 and 8.0 percent by weight.
5. pH shall be between 5.8 and 7.0.
6. Chemical analysis shall be undertaken for Phosphorus, Potassium, Calcium Magnesium, Aluminum, Iron, Manganese, Lead, Cation Exchange Capacity, Soluble Salts, acidity (pH) and buffer pH.

E. Coarse Sand

1. Sand for Planting Soil Blends, protection of filter fabric and for drainage as required, shall be uniformly graded medium to coarse sand consisting of clean, inert, rounded to sub-angular grains of quartz or other durable rock free from loam or clay, mica, surface coatings and deleterious materials with the following grain size distribution for material passing the #10 sieve:

U.S. Sieve Size Number	Percent Passing	
	Minimum	Maximum
10	100	--
18	60	80
35	25	45
60	8	20
140	0	8
270	0	3
0.002mm	0	0.5

2. Maximum size shall be one-inch largest dimension. The maximum retained on the #10 sieve shall be 20% by weight of the total sample.
3. The ratio of the particle size for 70% passing (D70) to the particle size for 20% passing (D20) shall be 2.8 or less ( $D70/D20 < 2.8$ ). Tests shall be by combined hydrometer and wet sieving in compliance with ASTM D422.
4. pH shall be less than 7.2.

F. Alternate Sand Layer Drainage Material

1. Sand for Drainage shall meet the requirements of Coarse Sand above, or Alternate Sand Drainage Material may be substituted, provided it meets the Specification ranges below, and is submitted and accepted by the Soil Scientist and Landscape Architect.
2. Free-draining sand and gravel borrow shall consist of inert, hard, durable stone and coarse sand, free from loam, clay, mica, surface coatings and deleterious materials and shall conform with the following gradation:

U.S. Sieve No.	% Passing by Weight	
	Minimum	Maximum
3 inch	100	-
1/2 inch	60	-
# 4	40	100
# 50	8	28
# 200	0	5

3. Sand and gravel borrow shall be placed in lifts not more than nine inches thick before compaction. Compaction shall be by vibration to a density between 90 and 95% Standard Proctor. Saturated hydraulic conductivity of the sand and gravel shall

be not less than 20 inches per hour according to ASTM D5856-95 (2000) when compacted to a minimum of 95% Standard Proctor, ASTM 698.

G. Organic Amendment (Compost)

1. Organic Matter for amending planting soils shall be a stable, humus-like material produced from the aerobic decomposition and curing of Leaf Yard Waste Compost, composted for a minimum of one year (12 months). The leaf yard waste compost shall be free of debris such as plastics, metal, concrete or other debris. The leaf yard waste compost shall be free of stones larger than 1/2", larger branches and roots. Wood chips over 1" in length or diameter shall be removed by screening. The compost shall be a dark brown to black color and be capable of supporting plant growth with appropriate management practices in conjunction with addition of fertilizer and other amendments as applicable, with no visible free water or dust, with no unpleasant odor, and meeting the following criteria as reported by laboratory tests.
  - a. The ratio of carbon to nitrogen shall be in the range of 12:1 to 25:1.
  - b. Stability shall be assessed by the Solvita procedure. Protocols are specified by the Solvita manual (version 4.0). The compost must achieve a maturity index of 6 or more as measured by the Solvita scale. Stability tests shall be conducted by Woods End Research Laboratory, Mt. Vernon, Maine.
  - c. Organic Content shall be at least 20 percent (dry weight). One hundred percent of the material shall pass a 1/2-inch (or smaller) screen. Debris such as metal, glass, plastic, wood (other than residual chips), asphalt or masonry shall not be visible and shall not exceed one percent dry weight. Organic content shall be determined by weight loss on ignition for particles passing a number 10 sieve according to procedures performed by the West Experiment Station at the University of Massachusetts, Amherst or equal.
  - d. pH: The pH shall be between 6.5 to 7.4 as determined from a 1:1 soil-distilled water suspension using a glass electrode pH meter American Society of Agronomy Methods of Soil Analysis.
  - e. Salinity: Electrical conductivity of a one to five soil to water ratio extract shall not exceed 2.5 mmhos/cm (dS/m).
  - f. The compost shall be screened to 1/2-inch maximum particle size and shall contain not more than 3 percent material finer than 0.002mm as determined by hydrometer test on ashed material.
  - g. Nutrient content shall be determined by the University of Massachusetts Soil Testing Laboratory or equivalent laboratory and utilized to evaluate soil-required amendments for the mixed soils. Chemical analysis shall be undertaken for Nitrate Nitrogen, Ammonium Nitrogen, Phosphorus, Potassium, Calcium, Aluminum, Magnesium, Iron, Manganese, Lead, Soluble Salts, Cation Exchange Capacity, soil reaction (pH), and buffer pH.

H. Crushed Stone for use over Sand Based Structural Planting Soil

1. Crushed stone (3/4 inch) shall consist of durable crushed rock consisting of the angular fragments obtained by breaking and crushing solid or shattered rock and free from a detrimental quantity of thin, flat or elongated or other objectionable pieces. Crushed stone shall be reasonably free from clay, loam or deleterious material and shall conform to the following gradation.

U.S. Sieve No.	% Passing by Weight	
	Minimum	Maximum
1 inch	100	-
3/4inch	90	100
1/2 inch	10	50
3/8 inch	0	20
# 4 Sieve	0	5

- I. Filter Fabric shall be Mirafi 140N or approved equivalent.
- J. Perforated Aeration Pipe
  - 1. Aeration pipe shall be 4 inch ADS Perforated Single Wall Corrugated Polyethylene Pipe, manufactured by ADS Company, Columbus, OH 43221, or approved equal. Pipe shall be manufacturer's standard perforated configuration. Jointing shall be made using manufacturer's standard snap coupling type fittings.
- K. Non-perforated Pipe
  - 1. Pipe shall be 4" ADS Single Wall Corrugated Polyethylene Pipe, manufactured by ADS Company, Columbus, OH 43221, or approved equal. Pipe shall be manufacturer's standard non-perforated configuration. Jointing shall be made using manufacturer's standard snap coupling type fittings.
- L. AASHTO # 9 Crushed Stone

## 2.2 PLANTING SOIL MIXES

- A. All existing vegetation shall be removed from stockpiles prior to blending. Uniformly mix ingredients by windrowing/tilling on an approved hard surface area or by alternately processing materials through a screening plant. All soil components and Organic Amendment shall be maintained moist, not wet, during mixing. Amendments shall not be added unless approved to extent and quantity by the owner and additional tests have been conducted to verify type and quantity of amendment is acceptable. Percentages of components are approximate, and will be verified upon completion of individual test results for components of the various mixes. Due to variability of soil materials, mix ratios may require adjustment and re-submittal at the expense of the Contractor.
- B. After component percentages are determined by the Soil Scientist, each planting soil mix shall be tested for physical and chemical analysis. Component percentages may be modified at any time by the soil scientist dependent upon the results of testing of the various components or final blends.
- C. Sand Based Structural Soil
  - 1. Base Loam, Sand and Compost, each as specified above, shall be combined in an approximate mix ratio of four parts by volume Sand to one part by volume Imported Base Loam to one and one half part by volume Compost (4S:1L:1.5C) to create a uniform blend which meets the following requirements.
  - 2. Gradation for Material Passing the Number 10 Sieve:

U.S. Sieve Size Number	% Passing by Weight	
	Minimum	Maximum
10	100	-
18	68	90
35	38	63
60	18	39
140	9	18
270	8	10
0.002mm	1	2

3. Maximum size shall be one-inch largest dimension. The maximum retained on the #10 sieve shall be 15% by weight of the total sample.
4. Ratio of the particle size for 70% passing (D70) to the particle size for 20% passing (D20) shall be 3.2 or less. (D70/D20 <3.2)
5. Saturated hydraulic conductivity of the mix: not less than 6 inches per hour, according to ASTM D5856-95 (2000) when compacted to a minimum of 92% Standard Proctor, ASTM 698.
6. Organic content: between 2.5 and 3.5 percent by weight.
7. The pH shall be between 6.0 and 6.5.
8. After approval of the above horticultural testing, conduct Standard Proctor Test (ASTM 698) to obtain maximum dry density and optimum moisture content values.

D. Planting Bed Soil

1. Planting Bed Soil shall consist of a combination of approximately equal parts by volume Stripped Existing or Imported Base Loam, Coarse Sand and Organic Amendment/Compost (1L:1S:1C) to create a uniform blend which meets the following requirements.
2. Gradation for material passing a Number 10 Sieve shall be achieved in the final mix.

U.S. Sieve Size No.	Percent Passing	
	Minimum	Maximum
10	100	
18	85	95
35	60	85
60	42	65
140	21	44
270	18	24
0.002 mm	2	4

3. Maximum size shall be one half-inch largest dimension. The maximum retained on the #10 sieve shall be 10% by weight of the total sample.
4. The ratio of the particle size for 80% passing (D80) to the particle size for 30% passing (D30) shall be 6 or less (D80/D30 <6).
5. The final mix shall have an organic content between 5 and 7 percent by weight.
6. The final mix shall have a hydraulic conductivity of not less than 1.5 inches per hour according to test procedure ASTM D5856-95 (2000) when compacted to a minimum of 86 percent Standard Proctor ASTM D 698. Tests shall be by combined hydrometer and wet sieving in compliance with ASTM D422 after destruction of organic matter by ignition.
7. Chemical analysis shall be undertaken for Phosphorus, Potassium, Calcium Magnesium, Aluminum, Iron, Manganese, Lead, Cation Exchange Capacity, Soluble Salts, acidity (pH) and buffer pH.

E. Horticultural Subsoil

1. Sand Based Structural Soil shall be used as the planting medium below 12" of planting soil for use as horticultural subsoil within the soil profiles. Sand Based Structural Soil used as horticultural subsoil shall not be vibratory compacted, but shall be compressed as required in Section 3, Execution.

## PART 3 – EXECUTION

## 3.1 PRE-INSTALLATION EXAMINATION AND PREPARATION

- A. Reference Other Sections as necessary.
- B. Coordinate activities with other project contractors so that there is no soil disturbance from traffic or other construction activities subsequent to placement.
- C. Pre-Installation Examination Required: The Contractor shall examine previous work, related work, and conditions under which this work is to be performed and shall notify Landscape Architect and Soil Scientist in writing of all deficiencies and conditions detrimental to the proper completion of this work. Beginning work means Contractor accepts substrates, previous work, and conditions. The Contractor shall not place any planting soil until all work in adjacent areas is complete and approved by the Landscape Architect and Soil Scientist.
- D. Kickoff Meeting: At least 10 working days prior to the start of work, the contractor shall request a landscape construction kickoff meeting with the owners representative, landscape architect, soil scientist and any other parties involved with landscape construction. The contractor must demonstrate familiarity with this Section 329115 Planting Soils, and other relevant sections of the construction documents. The contractor shall articulate the means and methods of soil blending, subgrade preparation, soil placement and other steps outlined in the Specification.
- E. Examination of Subgrade: The subgrade shall be examined by the Contractor prior to the start of subgrade preparation, soil placement and planting. Any deficiencies shall be noted and related to the Landscape Architect and Soil Scientist in writing prior to acceptance of the subgrade by the Landscape Contractor. Deficiencies include, but shall not be limited to the following:
  - 1. Construction debris present within the planting areas.
  - 2. The subgrade is at incorrect depths for installing the designed soil profile and drainage layer.
  - 3. Incomplete irrigation and/or subsurface drainage installation.
  - 4. Incomplete lighting and exterior electrical installation.
  - 5. Conflict with underground utilities.
  - 6. Subgrade contaminated with oils, compressible material, silt or clay
  - 7. Subgrade without drainage layer must infiltrate water at the rate of at least one inch per hour.
- F. Confirm that the subgrade is at the proper elevation and compacted as required. Subgrade elevations shall slope parallel to the finished grade and/or toward the subsurface drain lines as shown on the drawings.
  - 1. Slope sides of excavations to comply with local codes and ordinances having jurisdiction. Shore and brace slopes where required and maintain sides of slopes of excavations in safe condition until completion of backfilling. Provide protection measures as required for public safety.
  - 2. All subgrade areas to be filled with Drainage layer, Lawn or Planting Soil shall be free of construction debris, refuse, vegetation, compressible or decay able materials, all stones greater than 6 inches, concrete washout or soil crusting films of

- silt or clay that reduces or stops drainage from the Lawn or Planting Soil into the subsoil; and/or standing water. Such material shall be removed from the site.
3. The subgrade must slope at a minimum of two percent towards the bottom of slopes and subdrains. Subgrade levels shall be adjusted as required to ensure that all planting and lawn areas have adequate drainage.
- G. Do not proceed with the installation of Drainage Layer, Lawn or Planting Soil, until all utility work in the area has been installed.
1. The Contractor shall identify the locations of underground utilities prior to proceeding with soil work and shall protect all utilities from damage.
- H. Planting Soil Preparation: Refer to Section 329115, 2.2 for planting soil and mixtures. Examine soil and remove foreign materials, stones and organic debris over 1/2" in size. Remove all vegetation from stockpiles prior to blending. Mix-in fertilizers and amendments as required by tests and as approved by the Landscape Architect and Soil Scientist. All preparation and mixing shall be accomplished when the soil moisture content is compliant with Section 329115, 1.6.H and at a moisture content approved by the Landscape Architect and Soil Scientist. If lime is to be added, it shall be mixed with dry soil before fertilizer is added and mixed.
- 3.2 EXCAVATION AND REMOVAL
- A. Refer to Division 31 Earthwork
- 3.3 MIXING OF PLANTING SOIL MIXES
- A. Soil blends shall be produced with equipment that blends together each component in a thorough and uniform manner. This may be accomplished by a minimum of three handling events on a hard surfaced area with earth moving equipment or by alternately passing soil components through a screener.
- B. Base components and Soil Mix stockpiles should be protected from wind and rain and shall not be permitted to be stored in standing water.
- 3.4 WORKING AROUND UTILITIES
- A. Carefully examine the civil, record, and survey drawings to become familiar with the existing underground conditions before digging.
- B. Known underground and surface utility lines are indicated on the utilities drawings – See Civil and Architect's plans. Contact the local Dig Safe organization and give them their required time to respond and mark the property. Determine location of underground utilities and perform work in a manner that will avoid possible damage. Hand excavate, as required. Maintain grade stakes set by others until parties concerned mutually agree upon removal.
- C. Perform work in a manner that will protect utilities from damage. Hand excavate as required and provide adequate means of support and protection of utilities during soil installation operations. Maintain grade stakes set by others until parties concerned mutually agree upon removal. The Contractor shall repair all utilities damaged by soil operations at the Contractor's expense.
- 3.5 SUBGRADE PREPARATION, INSPECTION AND PERCOLATION TESTING



- A. In areas without drainage blanket, after subgrade levels have been reached, the Landscape Architect or Soil Scientist shall observe de-compaction and preparation of the subgrade according to this Section and inspect soil conditions to evaluate subsurface drainage conditions.
- B. Coordinate the following scarification work to eliminate subgrade compaction when located in Horticultural areas. Maintain 12" clearance from any underground utilities during subgrade de-compaction.
  - 1. Heavy Site Subgrade Compaction Mitigation:
    - a. Heavily compacted subgrade areas such as, but not limited to, temporary parking areas, material stockpile areas, temporary roadways, construction areas and areas around structures and other similar areas.
    - b. Prior to establishing the final subgrade, these areas shall be dug up or ripped to a depth of (18) inches to break up the soil hard pan, then re-compacted with two passes of the tracks of a wide track bulldozer size D-6 or smaller, curled bucket of excavator or other approved equipment. Vibratory compaction of subgrade in planted areas is prohibited.
  - 2. General Site Subgrade Compaction Mitigation for all general Horticultural areas that are not heavily compacted and would be mitigated as specified in Item 1 above:
    - a. Immediately prior to placing drainage layer or Planting Soil, the entire subgrade shall be loosened to a minimum depth of 8-inches using the teeth of a backhoe or other suitable equipment, then re-compacted with two passes of the tracks of a wide track bulldozer size D-6 or smaller, or other approved equipment. Vibratory compaction of subgrade in planted areas is prohibited.
- C. After Subgrade has been scarified as described above, it shall be recompressed by using the tracks of a wide-tracked bulldozer, multiple passes of a skid steer loader, or the curled bucket of an excavator. In areas of subgrade with no drainage layer, verify the subgrade passes water at or greater than the minimum requirement.
- D. Remove all stones or debris greater than 6" in any dimension from the subgrade prior to placing Drainage Layer or Planting Soils.
- E. After the subgrade has been prepared, in areas with no drainage layer, Percolation Tests shall be performed according to the following test procedures.
  - 1. Utilize perforated canisters or buckets seven to ten inches in diameter and a minimum of six inches high.
  - 2. A test hole shall be hand dug at the soil horizon to be tested approximately one-inch larger than the diameter of the test canister and approximately six inches deep. The sides of the test hole shall not be smoothed.
  - 3. Place one-half inch of clean coarse sand in the bottom of the hole and place the canister firmly into the hole. The space around the canister shall then be filled with coarse sand. Tamp the coarse sand to firmly fill any void space around the test canister.
  - 4. Fill the canister with water to the soil horizon level and allow to drain until approximately one inch of water remains, or a minimum of 1 hour.
  - 5. Refill the canister to the soil horizon level. After the water level drops approximately one inch, start the test. Record time versus water level as the water level drops. The percolation rate is the length of time for the water level to drop per inch. The field scientist shall record the rate of percolation for a minimum of two hours or until

the water level has dropped a minimum of three inches after the start of measurements.

### 3.6 INSTALLATION OF DRAINAGE LAYER

#### A. Drainage Layer

1. After subgrade preparation, layout drainage lines as shown on the plans. Excavate subgrade to achieve a minimum slope of 3% toward drain lines. Drain lines must slope downward at a minimum of 0.5 percent, with 1 percent or greater preferred.
2. Use manufacturer snap type fittings for all drain line connections.
3. After layout and inspection of drain lines, place drainage sand layer over drain lines in areas and in thicknesses depicted on the plans.
4. In areas with no drainage blanket, drain piping must be surrounded by a minimum of 2 inches of sand for protection of filter fabric.
5. Notify Landscape Architect and Soil Scientist and obtain acceptance of drainage layer prior to installation of lawn or planting soil.
6. Drainage Layer shall be compacted to a minimum of 95% Standard Proctor.

### 3.7 BACKFILLING OF HORTICULTURAL SOIL LAYERS

#### A. Soil Placement Preparation:

1. Verify that the plumbing for the irrigation system has been installed and accepted.
2. Verify that the subgrade preparations have been reviewed and accepted, including de-compaction and removal of large stones.
3. Notify the Landscape Architect and Soil Scientist of soil placement operations at least seven calendar days prior to the beginning of work.
4. In areas with no drainage layer, verify that the subgrade passes the minimum water infiltration requirement.
5. Do not proceed with the installation of Horticultural Soils, until all utility work in the area has been installed.
6. The Contractor shall identify the locations of underground utilities prior to proceeding with soil work and shall protect all utilities from damage.
7. Do not begin Planting Soil installation until all drainage, irrigation main lines, lateral lines, subgrade preparations and irrigation risers shown on the drawings are viewed and approved by the Landscape Architect and Soil Scientist.
8. Protect adjacent walls, walks and utilities from damage or staining by the soil. Use plywood and/or plastic sheeting as directed to cover existing asphalt, concrete, metal and masonry work.
  - a. Clean up any soil or dirt spilled on any paved surface, including at the end of each working day.
  - b. Any damage to the paving or architectural work shall be repaired by the Contractor at the Contractor's expense.

- #### B.
- After the subgrade soils have been loosened, re-compressed and inspected, and/or Drainage Layer has been approved, or Horticultural Soil may be spread by using a wide track bulldozer size D-5 or smaller or may be dumped and spread with the bucket of a backhoe from the edge of the loosened area. No rubber-tired equipment or heavy equipment except for a small bulldozer shall pass over the subsoils (subgrade) after they have been loosened and recompressed. If the Contractor plans to utilize such areas for any use of heavy equipment, this work should be carried out prior to beginning the process of loosening soils or filling in that area.

- C. Placement of Planting Bed Soil, Sand Based Structural Soil and Horticultural Subsoil:
1. Placement of Planting Bed Soil and plant stock shall be carried out simultaneously to prevent excessive traffic over soil lifts and to maintain the integrity of the soil layers. The contractor shall install plants simultaneously with the installation of the lower soil layers. The upper soil layers shall not be installed before all plants are installed and before the acceptance by the Landscape Architect and Soil Scientist.
    - a. After subgrade preparation and approval, in areas of tree and shrub planting with rootballs 12" in diameter or greater, crate a transition layer and place and compact Horticultural Subsoil (SBSS) as described in this Section.
    - b. After inspection and approval of Horticultural Subsoil, place trees and shrubs in locations shown on the plans and at the proper elevations.
    - c. Create a transition layer as described in this Section. Place and compact Planting Bed Soil around trees and shrubs as described in this Section.
  2. Sand Based Structural Soil (SBSS) shall be substituted for horticultural subsoil for the lower layer of soil in planted areas. Sand Based Structural Soil should only be vibratory compacted at areas beneath structure. Sand Based Structural Soil for use as horticultural subsoil shall not be vibratory compacted.
  2. Planting Bed Soil, and Horticultural Subsoil shall be placed in lifts not to exceed 8 inches in thickness and compacted to meet minimum and maximum requirements as specified below:
    - a. A transition zone shall be formed between the prepared subgrade, drainage layer, Sand Based Structural Soil, and Planting Bed Soil by placing one inch of the upper-layer soil and raking into the lower soil to a two-inch thickness.
    - b. Horticultural Subsoil (SBSS) shall be compacted to between 84 and 87 percent Standard Proctor, except soils beneath the rootballs shall be compacted to between 87 and 90 percent Standard Proctor to create a firm pedestal and prevent settlement of the rootballs.
    - c. Planting Bed Soil shall be compacted to between 82 and 85 percent Standard Proctor.
    - d. Horticultural Soils shall not be compacted with vibratory equipment. Sand Based Structural Soil must be compacted with vibratory equipment provided the moisture content is compliant with Section 329115 1.6H.
  3. Sand-Based Structural Soil shall be spread in lifts not greater than eight inches and compacted with a minimum of three passes of vibratory compaction equipment to a density between 92 and 96 percent Standard Proctor Maximum Dry Density.
    - a. Prepare Mock-Up of initial Sand Based Structural Soil Installation as provided in this Specification. After approval of the Mock Up, all subsequent installation of Sand Based Structural Soil shall be placed according to approved methods.
    - b. A medium to large sized vibratory plate compactor should be used to compact Sand Based Structural Soil. Moisture content of Sand Based Structural Soil should be as close to optimum moisture content (as determined by Standard Proctor Test) as possible for best results.
    - c. Rake the surface of each accepted lift of Sand Based Structural Soil to break the surface glaze caused by the compaction equipment, prior to placing subsequent lifts.

- d. Density testing for Sand Based Structural Soil must be ASTM D6938-10 Nuclear Methods, after ASTM D698 Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort. Density testing shall be conducted at a minimum of one test for each plant bed for each lift. Geotechnical testing agency must be on-site to conduct soil moisture and density tests during installation of Sand Based Structural Soil.
  - e. Sand-Based Structural Planting Medium shall be placed in 8" lifts to a minimum depth of two feet within the areas shown on the Drawings, except as otherwise indicated. A minimum of eight inches of 3/8 inch crushed stone shall be placed over the Sand-Based Structural Soil in areas shown on the Plans.
4. In all cases, the soil being placed shall be in a dry to damp condition. No wet soils shall be placed. Soil moisture content must be compliant with Section 329115 1.6.H prior to compaction. For best results SBSS should be as close to optimum moisture content as possible. All testing of in-place density for planting materials shall be made by the soil scientist or according to ASTM D6938-10 Nuclear Methods after conducting ASTM D698 Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort.
    - a. Sand Based Structural Soil must be tested for moisture content and compaction by ASTM Methods by an approved geotechnical testing firm at the time of installation.
  5. Prevention of compacted soils can be accomplished by beginning the work in corner, against walls, or the center of isolated beds, and progressing outwards towards the borders.
  6. Lawn Soil and Planting Soils shall never be moved or worked when wet or frozen.
  7. The Contractor shall place barricades or steel plates as required to prevent any unnecessary compaction of planting soil from vehicles, equipment, or pedestrian traffic.
  8. After Planting Soil has been spread, it shall be carefully prepared by hand raking. Stones and debris over one inch in any direction shall be removed from the premises. Fine grade planting beds to a smooth even surface with loose uniformly fine texture. Remove ridges and fill depressions as required to meet finish grades. Limit fine grading to areas that can be planted immediately after grading. Maintain the finished surfaces at the grades shown and spread additional soil to correct settlement or erosion. Surface drainage shall be maintained. Soil shall be damp and free from frost during fine grading operations.

### 3.7 PROTECTION

- A. The Contractor shall protect landscape work and materials from damage due to landscape operations, operations by other Contractors or trespassers. Maintain protection during installation until acceptance. Treat, repair or replace damaged Planting Soil installation work immediately.
- B. Provide all means necessary, including fences, to protect all soil areas from compaction and contamination by trash, dust, debris, and any toxic material harmful to plants or humans after placement. Any area that becomes compacted, shall be de-compacted and tilled to the extent determined by the soil scientist and recompressed to the density ranges specified. Any uneven or settled areas shall be filled, re-graded and re-compacted to meet the requirements of this Specification. Soil that becomes contaminated shall be removed and replaced with specified soil material.

- C. Phase the installation of the planting soil blends such that equipment does not have to travel over already installed planting soil. Use of haul roads is acceptable provided that the haul road is completely re-worked to meet the requirements of this Specification.
- D. Apply filter fabric covering and planking or other engineering controls over soil to minimize compaction and collect dust and debris in any area where the Contractor must work after the installation of Planting Soil.
- E. Till compacted Planting Soil and replace Planting Soil that has become contaminated as determined by the Landscape Architect. Planting Soil shall be tilled or replaced by the Contractor at no expense to the Owner.

### 3.8 CLEAN-UP

- A. During installation, keep pavements clean and work area in an orderly condition.
- B. Keep the site free of trash and debris at all times. Immediately dispose of wrappings or waste materials associated with products necessary for the completion of the work.
- C. All trash and debris shall be kept in a central collection container. Do not bury trash and debris in back-fill.
- D. Once installation is complete, remove any excess soil from pavements or embedded in fixtures.

### 3.9 COORDINATION AND EXCESS MATERIALS

- A. Coordinate activities with other project contractors so that there is no soil disturbance from traffic or other construction activities subsequent to placement.
- B. Excess Planting Soil Mixtures and Materials: Remove the excess planting soil mixture and materials from the site at no additional cost to the Owner unless other wise requested.

### 3.10 POST-INSTALLATION TESTING

- A. In-place density testing is required in all areas. Placed planting soils must be inspected for compaction level by the soil scientist or by the following acceptable Density Test Methods: ASTM D1556 Density of soil and rock in place using Sand Cone Method, ASTM D6938-10 Nuclear Methods, ASTM D2167-08 Rubber Balloon method, after ASTM D698 Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort.
- B. Density testing for Sand Based Structural Soil must be by ASTM D1556 Density of soil and rock in place using Sand Cone Method, ASTM D6938-10 Nuclear Methods, ASTM D2167-08 Rubber Balloon Method, after ASTM D698 Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort. Density testing shall be conducted at a minimum of one test for each lift in each plant bed or a minimum of every 300 square feet.
- C. Placed Planting Soils must be capable of infiltrating water at the minimum rate provided in this Specification for each type of planting soil

END OF SECTION

**APPENDIX: PLANTING SOIL TESTING PROTOCOL**

