32 91 13 – Soil Preparation

1. Introduction

   A. This Construction & Design standard covers planting guidelines to be used in conjunction with other related sections listed below:

31 25 00	Erosion and Sedimentation Controls
32 01 90	Operation and Maintenance of Planting
32 01 90	Operation and Maintenance of Planting (Grasses)
32 01 90.13	Fertilizing
32 01 90.23	Pruning
32 01 90.26	Watering
32 90 00	Planting
32 91 00	Planting Preparation
32 91 13.26	Mulch
32 92 19	Seeding
32 92 23	Sodding
32 93 00	Plants
32 93 13	Groundcovers
32 93 43	Trees

   B. Designers should coordinate with Duke University Landscape Services (LS) to coordinate selection and execution requirements for Soil Preparation.

2. References

   A. ASTM: American Society of Testing Materials cited section numbers.

   B. U.S. Department of Agriculture, Natural Resources Conservation Service, 2003. National Soil Survey Handbook, title 430-VI. Available Online.

   C. US Composting Council *www.compostingcouncil.org* *and* http://compostingcouncil.org/admin/wp-content/plugins/wp-*pdfupload/pdf/191/LandscapeArch_Specs.pdf*.

   D. *Methods of Soil Analysis*, as published by the Soil Science Society of America (http://www.soils.org/).

   E. Up by Roots: healthy soils and trees in the built environment. 2008. J. Urban. International Society of Arboriculture, Champaign, IL.

3. Definitions

   A. Acceptable Drainage: Drainage rate is sufficient for the plants to be grown. Not too fast and not too slow. Typical rates for installed Planting Soil are between 1 - 5 inches per hour. Turf soils are often higher, but drainage rates above 2 - 3 inches per hour will dry

out very fast. In natural undisturbed soil a much lower drainage rate, as low as 1/8th inch per hour can still support good plant growth. Wetland plants can grow on top of perched water layers or even within seasonal perched water layers, but could become unstable in high wind events.

B. Amendment: Material added to Topsoil to produce Planting Soil Mix. Amendments are classified as general soil amendments, fertilizers, biological, and pH amendments.

C. Biological Amendment: Amendments including living organisms' specific to the support of plant growth such as Mycorrhizal additives, compost tea or other products intended to change the soil biology.

D. Compacted Soil: Soil where the density of the soil is greater that the threshold for root limiting, and further defined in this specification.

E. Compost: Well decomposed stable organic material as defined by the US Composting Council and further defined in this specification.

F. Drainage: The rate at which soil water moves through the soil transitioning the soil from saturated condition to field capacity. Most often expressed as saturated hydraulic conductivity (Ksat; units are inches per hour).

G. End of Warranty Acceptance: The date when the Owner's Representative accepts that the plants and work in this section meet all the requirements of the warranty. It is intended that the materials and workmanship warranty for Planting, Planting Soil, and Irrigation (if applicable) work run concurrent with each other, and further defined in this specification.

H. Existing Soil: Mineral soil existing at the locations of proposed planting after the majority of the construction within and around the planting site is completed and just prior to the start of work to prepare the planting area for soil modification and/or planting.

I. Fertilizer: Amendment used for the purpose of adjusting soil nutrient composition and balance.

J. Fine Grading: The final grading of the soil to achieve exact contours and positive drainage, often accomplished by hand rakes, drag rakes or other suitable devices.

K. Finished Grade: Surface or elevation of planting soil after final grading and 12 months of settlement of the soil.

L. Graded Soil: Soil where the A horizon has been stripped and relocated or re-spread; cuts and fills deeper than 12 inches.

M. Installed Soil: Planting soil and existing site soil that is spread and or graded to form a planting soil.

N. Minor Disturbance: Minor grading as part of work that only adjusts the A horizon soil, minor surface compaction in the top 6 inches of the soil, applications of fertilizers, installation of utility pipes smaller than 18 inches in diameter thru the soil zone.

O. Owner's Representative: The person or entity, appointed by the Owner to represent their interest in the review and approval of the work and to serve as the contracting authority with the Contractor. The Owner's Representative may appoint other persons to review and approve any aspects of the work.

P. Ped: A clump or clod of soil held together by a combination of clay, organic matter, and fungal hyphae, retaining the original structure of the harvested soil.

Q. Planting Soil: Topsoil, or planting soil mixes which are imported or existing at the site, or made from components that exist at the site, or are imported to the site.

R. Poor Drainage: Soil drainage that is slower than that to which the plants can adapt. This is a wide range of metrics, but generally if the soil is turning grey in color it is reasonable to plant moisture adaptive plants at smaller sizes that are young in age with shallow root balls or look at options to improve the drainage

S. Scarify: Loosening and roughening the surface of soil and sub soil prior to adding additional soil on top.

T. Soil Fracturing: Deep loosening the soil to the depths specified by using a back hoe.

U. Soil Horizons: as defined in the USDA national soil survey handbook. *http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242*.

V. Soil Ripping: Loosening the soil by dragging a ripping shank or chisel thru the soil to the depths and spacing specified.

W. Soil Tilling: Loosening the surface of the soil to the depths specified with a rotary line tilling machine, roto tiller, or spade tiller**.**

X. Subgrade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill, before placing planting soil.

Y. Substantial Completion Acceptance: The date at the end of the Planting, Planting Soil, and Irrigation installation (if applicable) where the Owner's Representative accepts that all work in these sections is complete and the Warranty period has begun. This date may be different than the date of substantial completion for the other sections of the project, and further defined in this specification.

Z. Topsoil: Naturally produced and harvested soil from the A horizon or upper layers or the soil.

AA. Undisturbed Soil: Soils with the original A horizon intact that have not been graded or compacted. Soils that have been farmed, subjected to fire or logged but not graded, and natural forested land will be considered as undisturbed.

4. Design Standards

A. Imported topsoil is fertile, friable soil containing less than 5% total volume of the combination of subsoil, refuse, roots larger than 1 inch diameter, heavy, sticky or stiff clay, stones larger than 2 inches in diameter, noxious seeds, sticks, brush, litter, or any substances deleterious to plant growth. The percent (%) of the above objects shall be controlled by source selection not by screening the soil. Topsoil shall be suitable for the germination of seeds and the support of vegetative growth. Imported topsoil shall not contain weed seeds in quantities that cause noticeable weed infestations in the final planting beds. Imported topsoil shall meet the following physical and chemical criteria:

1. Soil texture: USDA loam, sandy clay loam or sandy loam with clay content between 15 and 25%. And a combined clay/silt content of no more than 55%.

2. Ph value shall be between 5.5 and 7.0.

3. Percent organic matter (om): 2.0-5.0%, by dry weight.

4. Soluble salt level: less than 2 mmho/cm.

5. Soil chemistry suitable for growing the plants specified.

6. Imported topsoil harvested from fields or development sites' organic content and particle size distribution shall be the result of natural soil formation.

a. Manufactured soils where coarse sand, composted organic material or chemical additives has been added to the soil shall not be acceptable.

b. Retained soil peds shall be the same color on the inside as is visible on the outside.

7. Imported topsoil for planting soil shall not have been screened and shall retain soil peds or clods larger than 2 inches in diameter throughout the stockpile after harvesting.

8. Stockpiled existing topsoil at the site meeting the above criteria may be acceptable.

B. Compost: blended and ground leaf, wood and other plant based material, composted for a minimum of 9 months and at temperatures sufficient to break down all woody fibers, seeds and leaf structures, free of toxic material at levels that are harmful to plants or humans. Source material shall be yard waste trimmings blended with other plant or manure based material designed to produce compost high in fungal material.

1. Compost shall be commercially prepared compost and meet us compost council sta/tmecc criteria or as modified in this section for “compost as a landscape backfill mix component”. http://compostingcouncil.org/admin/wp-content/plugins/wp-pdfupload/pdf/191/landscapearch_specs.pdf

2. Compost shall comply with the following parameters:

   a. Ph: 5.5 - 8.0.

   b. Soil salt (electrical conductivity): maximum 5 ds/m (mmhos/cm).

   c. Moisture content %, wet weight basis: 30 – 60.

   d. Particle size, dry weight basis: 98% pass through 3/4 inch screen or smear.

   e. Stability carbon dioxide evolution rate: mg co_2-c/ g om/ day < 2.

   f. Solvita maturity test: > 6.

   g. Physical contaminants (inerts), %, dry weight basis: <1%.

   h. Chemical contaminants, mg/kg (ppm): meet or exceed us EPA class a standard, 40cfr § 503.13, tables 1 and 3 levels.

   i. Biological contaminants select pathogens fecal coliform bacteria, or salmonella, meet or exceed us EPA class a standard, 40 cfr § 503.32(a) level requirements.

C. Coarse Sand shall be clean, washed, sand, free of toxic materials.

1. Coarse concrete sand, ASTM c-33 fine aggregate, with a fines modulus index of 2.8 and 3.2.

2. Coarse sands shall be clean, sharp, natural coarse sands free of limestone, shale and slate particles. Manufactured coarse sand shall not be permitted.

3. Ph shall be lower than 7.0.

4. Provide coarse sand with the following particle size distribution:

Sieve	Percent Passing
3/8 inch (9.5 mm)	100
no 4 (4.75 mm)	95-100
no 8 (2.36 mm)	80-100
no 16 (1.18 mm)	50-85
no 30 (.60 mm)	25-60
no 50 (.30 mm)	10-30
no 100 (.15 mm)	2-10
no 200 (0.75 mm	2-5

D. Fertilizer shall be used only as necessary in unmodified soils as determined by soils tests and at the prescribed recommended rates.

E. Lime

1. ASTM c 602, agricultural limestone containing a minimum 80 percent calcium carbonate equivalent and as follows:

   a. Class: class t, with a minimum 99 percent passing through no. 8 (2.36-mm) sieve and a minimum 75 percent passing through no. 60 (0.25-mm) sieve.

   b. Provide lime in form of dolomitic limestone.

2. Provide manufacturer's literature and material certification that the product meets the requirements.

F. Soil Moisture

1. Volumetric soil moisture level, in both the planting soil and the root balls of all plants, prior to, during and after planting shall be above permanent wilting point and below field capacity for each type of soil texture within the following ranges.

Soil type	**Permanent wilting point**	**Field capacity**
Sand, loamy sand, sandy loam	5-8%	12-18%
Loam, sandy clay, sandy clay loam	14-25%	27-36%
Clay loam, silt loam	11-22%	31-36%
Silty clay, silty clay loam	22-27%	38-41%

   a. Volumetric soil moisture shall be measured with a digital moisture meter. The meter shall be the digital soil moisture meter, dsmm500 by general specialty tools and instruments, or approved equivalent.

2. The contractor shall confirm the soil moisture levels with a moisture meter. If the moisture is too high, suspend planting operations until the soil moisture drains to below field capacity.

5. Documentation and Review Requirements

A. Observation of the Work

1. The Owner's Representative will perform periodic site reviews included but not limited to the following :

   a. Soil Mockup: At the construction of all soil mockups.

b. Existing Soil Conditions: Prior to the start of any soil modification that will utilize or modify the existing soil.

c. Excavation: Observe each area of excavation prior to the installation of any planting soil.

d. Drain Line Installation: Upon completion of the drain line(s) installation and prior to the installation of any planting soil.

e. Completion of Soil Modifications: Upon completion of all soil modification and installation of planting soil.

f. Completion of Fine Grading and Surface Soil Modifications: Upon completion of all surface soil modifications and fine grading but prior to the installation of shrubs, ground covers, or lawns.

B. Prepare a soil stock pile plan for approval.

C. Quality Assurance

1. Soil testing laboratory qualifications: an independent laboratory, with the experience and capability to conduct the testing indicated and that specializes in USDA agricultural soil testing, planting soil mixes, and the types of tests to be performed. Geotechnical engineering testing labs shall not be used.

2. All delivered and installed planting soil shall conform to the approved submittals sample color, texture and approved test analysis.

   a. The Owner's Representative may request samples of the delivered or installed soil be tested for analysis to confirm the planting soil conforms to the approved material.

   b. All testing shall be performed by the same soil lab that performed the original planting soil testing.

   c. Testing results shall be within 10% plus or minus of the values measured in the approved planting soil mixes.

   d. Any planting soil that fails to meet the above criteria, if requested by the Owner's Representative, shall be removed and new soil installed.

3. Soil Compaction Testing: following installation or modification of soil, test soil compaction with a penetrometer.

   a. Maintain at the site at all times a soil cone penetrometer with pressure dial and a soil moisture meter to check soil compaction and soil moisture.

b. Prior to testing the soil with the penetrometer check the soil moisture and penetrometer readings in the mockup soils. Penetrometer readings are impacted by soil moisture and excessively wet or dry soils will read significantly lower or higher than soils at optimum moisture.

c. The penetrometer readings shall be within 20% plus or minus of the readings in the approved mockup when at similar moisture levels.

4. For coarse sand provide a two gallon sample with manufacturer's literature and material certification that the product meets the requirements.

6. Installation and Performance Requirements

A. Protection of Work, Property and person

1. The Contractor shall adequately protect the work, adjacent property, and the public, and shall be responsible for any damages or injury due to the Contractor's actions or inaction.

2. Protect soil from compaction during the delivery of plants to the planting locations, digging of planting holes and installing plants.

3. Deliver plants and trees that require the use of heavy mechanized equipment prior to final soil preparation and tilling.

4. Restrict the driving lanes to one area instead of driving over and compacting a large area of soil. Till to a depth of 6 inches, all soil that has been driven over during the installation of plants.

B. Soil Installation Mockup

1. Prior to installation or modification of topsoil, site soil, planting soil, or planting soil mixes, construct at the site, a mockup of each soil type using the means and methods and equipment proposed by the contractor to complete the work.

2. Installation of the mockup shall be in the presence of the Owner's Representative. and as follows:

a. Following acceptance of soil submittals, in areas protected from disturbance and further compaction, install mockups of each soil type and soil modification, 20 foot x 20 foot x the full depth of the deepest installation. Compaction methods, including the type of compaction equipment and number of passes required to achieve the required compaction, shall be evaluated and results measured.

b. Penetrometer test Compaction in the mockup soil (minimum four readings) from each planting soil at the specified depths of the soil profile. Record the soil moisture at each penetrometer test site. If penetrometer readings exceed the specified densities, reconstruct the mockup, adjusting the soil density to achieve

the desired results. Where the modification requires ripping, tilling or fracturing soils that are over compacted, start the procedure in a new location so that the process is working on soil that is similar to the density of the expected soil.

c. Submit a report of the final methods of soil installation, the penetrometer and soil moisture readings to the Owner's Representative.

d. The mockup area may remain as part of the installed work at the end of the project if protected from further compaction, contamination or other disturbance.

e. Provide a protective 4 foot high fence on metal posts around each mockup to keep all work and equipment from entering the surface of the mockup area.

3. Existing Soil (acceptable for planting with minimum modifications)

a. The Owner's Representative shall verify that the soil in the designated areas is suitable at the beginning of planting bed preparation work.

b. Damaged existing soil no longer suitable to support the plants may require modification including removal and replacement with soil of equal quality to the soil that existed prior to construction.

c. Protect existing soil from compaction, contamination, and degradation during the construction process.

d. Unless otherwise instructed, remove all existing plants, root thatch, and non-soil debris from the surface of the soil using equipment that does not increase compaction of soil to root limiting levels.

e. Modifications:

(1) When results of soil tests recommend chemical adjustments, till surface soil to six inches or greater after chemical adjustments have been are applied.

(2) Remove existing turf thatch, ground cover plants and weeds.

(3) Provide pre-emergent weed control if indicated.

(4) Make chemical adjustment as recommended by the soil test.

4. Modified Existing Soil (soil suitable for planting with indicated modification).

a. The Owner's Representative shall verify that the soil is suitable for modification at the beginning of planting bed preparation work.

b. General requirements for all soil modifications:

(1) Take soil samples, test for chemical properties, and make appropriate adjustments.

(2) Unless otherwise instructed, remove all existing plants, root thatch, and non-soil debris from the surface of the soil using equipment that does not add to the compaction in the soil.

(3) All soil grading, tilling and loosening must be completed at times when the soil moisture is below field capacity. Allow soil to drain for at least two days after any rain event more than 1 inch in 24 hours, or long enough so that the soil does not make the hand muddy when squeezed.

(4) If appropriate, provide pre-emergent weed control after the soil work is complete and plants planted but prior to adding mulch to the surface, if indicated by weed type and degree of threat.

c. Existing soil suitable for reuse as planting soil is to be harvested, stockpiled and re-spread with or without further modifications as indicated:

(1) Excavate existing soil from the areas and to depths designated.

(2) Stockpile in zones.

(3) Excavate soil using equipment and methods to preserve the clumps and peds in the soil.

(4) Protect stock piles from erosion by compacting or tracking the soil surface, covering with breathable fabric or planting with annual grasses as appropriate for the season, location, and length of expected time of storage.

(5) Re-spread soil as required in part 3 of this specification.

d. Compacted surface soil (tilling option) is to be modified when surface soil compaction is a maximum of 6 inches deep from traffic or light grading. Original horizon may be previously removed or graded but lower profile intact with acceptable compaction levels and limited grading.The soil organic matter, ph and chemistry in the A horizon may not be suitable for the proposed plants and may need to be modified as required.

(1) Till top 6 inches or deeper of the soil surface, with a *roto tiller, spade tiller,* ripper or agricultural plow. Spread 2 - 3 inches of compost on the surface of the tilled soil and make any chemical adjustment as recommended by the soil test.

(2) Spade tillers shall be the preferred tool

(3) Till or disk the compost into the loosened soil. Smooth out grades with a drag rake or drag slip.

e. Compacted surface soil (radial trenching option) is to be modified when surface soil compaction is a maximum of 24 inches deep from traffic or light grading. Original horizon may be previously removed or graded but lower profile below 24

inches intact with acceptable compaction levels and limited grading. The soil organic matter, ph and chemistry in the A horizon may not be suitable for the proposed plants and may need to be modified as required.

(1) Using a trenching machine, dig trenches to the extent and depth shown on the project plans and details.

(2) Backfill the trench with the soil removed from the trench. Add additional site soil if needed to fill the trench to be flush to the existing grade after the soil settlement.

f. Compacted subsoil is to be modified when deep soil compaction is the result of previous grading, filling and dynamic or static compaction forces. Original horizon likely removed or buried. The soil organic matter, ph and chemistry in the horizon is likely not suitable for the proposed plants and should be modified as required.

(1) Soil ripping: for large areas (1/4 acre or greater), accessible by large grading machines with no underground utilities

(a) After grading and removing all plants and debris from the surface, using a tracked dozer or similar large grading equipment, loosen the soil by dragging a ripping shank or chisel thru the soil to depths of 24 inches with ripping shanks spaced 18 inches or less apart in two directions. The number of shanks per pull is dependent on the degree of soil compaction and the size of the dozer.

(b) Spread 3-4 inches of compost over the ripped area and till into the top 6 inches of the soil surface.

(2) Soil fracturing: for small to medium size spaces

(a) After grading and removing all plants and debris from the surface, spread 2 – 3 inches of compost over the surface of the soil. Loosen the soil to depth of 18 - 24 inches, using a backhoe to dig into the soil through the compost. Lift and then drop the loosened soil immediately back into the hole. The bucket then moves to the adjacent soil and repeats the process until the entire area indicated has been loosened.

(b) Spread 3-4 inches of compost over the ripped area and till into the top 6 inches of the soil surface.

(3) Trenching: for areas only accessible by small equipment such as a walk behind trencher

(a) After grading and removing all plants and debris from the surface using a chain trenching machine, dig 24 inch deep trenches, 24 inches

apart across the entire area. Maintain an 18-inch standoff from the edges of all curbs, paving and structures. Backfill the trenches with compost.

(b) Spread 3-4 inches of compost over the trenches area and till into the top 6 inches of the soil surface. Compost tilling treatment shall extend to the edges of curbs, paving and structures.

(4) Following soil ripping or fracturing the average penetration resistance should be less than 250 psi to the depth of the ripping or fracturing.

(5) Do not start planting into ripped or fractured soil until soil has been settled or leave grades sufficiently high to anticipate settlement of 10 – 15% of ripped soil depth.

g. Low soil organic matter and/or missing a horizon but soil is not compacted except for some minor surface compaction. The soil organic matter, ph and/or chemistry are likely not suitable for the proposed plants and should be modified as required.

(1) Spread 3 - 4 inches of compost over the surface of the soil and make chemical adjustment as recommended by the soil test.

(2) Till compost into the top 6 inches of the soil.

h. Soil within the root zone of existing established trees and surface compaction near or above root limited levels in the upper soil horizon the result of traffic or other mechanical compaction modifications as follows:

(1) Remove the tops of all plants to be removed from the root zone. Remove sod with a walk behind sod cutter. Do not grub out the roots of plats to be removed.

(2) Use a pneumatic air knife to loosen the top 9 – 12 inches of the soil. Surface roots may move and separate from soil during this process but the bark on roots should not be broken

(3) Make chemical adjustment as recommended by the soil test and add 2 - 3 inches of compost over the soil.

(4) Using the pneumatic air knife, mix the compost into the top 6 – 8 inches of the loosened soil.

(5) Work in sections such that the entire process - including irrigation - can be completed in one day. Apply approximately one inch of water over the loosened soil at the completion of each day's work. Apply mulch or turf as indicated on the drawings within one week of the completion of work.

5. Planting Soil Mixes

a. Planting mix for moderately slow draining soil for trees and shrub beds

(1) A mix of imported topsoil, coarse sand and compost. The approximate mix ratio shall be:

Mix component	% by moist volume
Imported topsoil unscreened	45-50%
Coarse sand	40-45%
Compost	10%

(2) Final tested organic matter between 2.75 and 4% (by dry weight).

(3) Mix the coarse sand and compost together first and then add to the topsoil. Mix with a loader bucket to loosely incorporate the topsoil into the coarse sand/compost mix. Do not over mix! Do not mix with a soil blending machine. Do not screen the soil. Clumps of soil, compost and coarse sand will be permitted in the overall mix.

(4) At the time of final grading, add fertilizer if required to the planting soil at rates recommended by the testing results for the plants to be grown.

(5) Provide a two gallon sample with testing data that includes recommendations for chemical additives for the types of plants to be grown. Samples and testing data shall be submitted at the same time.

6. Pre-Emergent Herbicides

a. Chemical herbicides are designed to prevent seeds of selective plants from germinating. Exact type of herbicide shall be based on the specific plants to be controlled and the most effective date of application.

b. Submit report of expected weed problems and the recommendation of the most effective control for approval by Owner’s Representative. Provide manufacturer’s literature and material certification that the product meets the requirements.

7. Drain Pipes

a. Shall be 4 inches in diameter, perforated with holes in the pipe on the bottom quadrant. When pipe has perforations on all quadrants, drape a 12 inch wide 4 mil plastic sheet over the length of the pipe to force water to the bottom of the pipe.

b. All fittings, elbows, unions, t's and screw caps shall be the same material and from the same manufacturer as the pipe. "t" and elbow joints shall be sanitary type connections. All joints shall be solvent welded.

c. Submit manufacturer’s product literature for approval by the Owner's Representative.

d. Clean out risers shall be 4 inch diameter schedule 40 pvc solid pipe compatible with the bottom fitting and clean out screw cap. Elbow fitting at the bottom of the clean out riser. When the cleanout is in the middle of a pipe run the fitting shall be a sanitary t fitting. Screw cap fitting shall be pvc schedule 40.

e. Heavy Duty Pipe Drain Pipe shall be pvc, schedule 40 pipe. All joints shall be solvent welded. Submit manufacturer's product literature for approval by the Owner's Representative.

f. Medium Duty Pipe Drain Pipe shall be 4 inch diameter, perforated, pvc, double wall (smooth interior wall / corrugated exterior wall) pipe. All joints shall be gasketed bell and spigot. Example source a -2000 by contech construction products or approved equal.

g. Light Duty Pipe Drain Pipe shall be 4 inch diameter, perforated, hdpe, and single wall corrugated exterior pipe. ASTM f405. All joints shall be gasketed bell and spigot. Example source ads single wall pipe by advance drainage systems

C. Execution

1. Site Examination

a. Prior to installation of planting soil, examine site to confirm that existing conditions are satisfactory for the work of this section to proceed.

(1) Confirm the subgrade is at the proper elevation and compacted as required. Subgrade elevations shall slope toward the under drain lines.

(2) Confirm the surface of areas to be filled with planting soil are free of construction debris, refuse, compressible or biodegradable materials, stones greater than 2 inches diameter, soil crusting films of silt or clay that reduces or stops drainage from the planting soil into the subsoil; and/or standing water. Remove unsuitable material from the site.

(3) Confirm no adverse drainage conditions are present.

(4) Confirm no conditions are present which are detrimental to plant growth.

(5) Confirm utility work has been completed (if required).

(6) Confirm irrigation work has been completed(if required)..

b. If unsatisfactory conditions are encountered, notify the Owner's Representative immediately to determine corrective action before proceeding.

2. Coordination With Project Work

a. The contractor shall coordinate with all other work that may impact the completion of the work.

b. Prior to the start of work, prepare a detailed schedule of the work for coordination with other trades.

c. Coordinate the relocation of any irrigation lines, heads or the conduits of other utility lines that are in conflict with plant locations. Root balls shall not be altered to fit around lines. Notify the Owner's Representative of any conflicts encountered.

3. Grade And Elevation Control

a. Provide grade and elevation control during installation of planting soil. Utilize grade stakes, surveying equipment, and other means and methods to assure that grades and contours conform to the grades indicated on the plans.

4. Site Preparation

a. Excavate to the proposed subgrade. Maintain all required angles of repose of the adjacent materials. Do not over excavate compacted subgrades of adjacent pavement or structures. Maintain a supporting 1:1 side slope of compacted subgrade material along the edges of all paving and structures where the bottom of the paving or structure is above the bottom elevation of the excavated planting area.

b. Remove all construction debris and material including any construction materials from the subgrade.

c. Confirm that the subgrade is at the proper elevation and compacted as required. Subgrade elevations shall slope approximately parallel to the finished grade and/or toward the subsurface drain lines as shown on the drawings.

d. In areas where planting soil is to be spread, confirm subgrade has been scarified.

e. Protect adjacent walls, walks and utilities from damage or staining by the soil. Use 1/2 inch plywood and/or plastic sheeting as directed to cover existing concrete, metal and masonry work and other items as directed during the progress of the work.

(1) At the end of each working day, clean up any soil or dirt spilled on any paved surface.

(2) Any damage to the paving or site features or work shall be repaired at the contractor's expense.

5. Drain Pipe Installation

a. Trench lines to depths and widths per the project plans.

b. Place 2 – 3 inches coarse sand as bedding for pipes.

c. Place pipe holes facing down.

(1) If pipe has holes on all sides drape a piece of 4 mil plastic 12 inches wide over top of pipe.

(2) Cover sides and top of pipe with a minimum 4 inches of coarse sand above top of pipe.

(3) Backfill trench with planting soil compacted to same level as planting soil requirements.

(4) Add cleanout pipe reaching the surface at the uphill end of each pipe run.

(5) Connect pipes to manhole or daylight outfall.

6. Planting Soil And Planting Soil Mix Installation

a. Prior to installing any planting soil the Owner's Representative shall approve the condition of the subgrade and the previously installed subgrade preparation and the installation of subsurface drainage.

b. All equipment utilized to install or grade planting soils shall be wide track or balloon tire machines rated with a ground pressure of 4 psi or less. All grading and soil delivery equipment shall have buckets equipped with 6 inch long teeth to scarify any soil that becomes compacted.

c. In areas of soil installation above existing subsoil, scarify the subgrade material prior to installing planting soil.

(1) Scarify the subsoil of the subgrade to a depth of 3 – 6 inches with the teeth of the back hoe or loader bucket, tiller or other suitable device.

(2) Immediately install the planting soil. Protect the loosened area from traffic. Do not allow the loosened subgrade to become compacted.

(3) In the event that the loosened area becomes overly compacted, loosen the area again prior to installing the planting soil.

d. Install the planting soil in 12 - 18 inch lifts to the required depths. Apply compacting forces to each lift as required to attain the required compaction. Scarify the top of each lift prior to adding more planting soil by dragging the teeth of a loader bucket or backhoe across the soil surface to roughen the surface.

e. Phase work such that equipment to deliver or grade soil does not have to operate over previously installed planting soil. Work in rows of lifts the width of the

extension of the bucket on the loader. Install all lifts in one row before proceeding to the next. Work out from the furthest part of each bed from the soil delivery point to the edge of the each bed area.

f. Installing soil with soil or mulch blowers or soil slingers shall not be permitted.

g. Where travel over installed soil is unavoidable, limit paths of traffic to reduce the impact of compaction in planting soil.

h. To achieve final grades after settlement and shrinkage of the compost material. Install the planting soil at a higher level to anticipate this reduction of planting soil volume. A minimum settlement of approximately 10 - 15% of the soil depth is expected. All grade increases are assumed to be as measured prior to addition of surface compost till layer, mulch, or sod.

7. Compaction Requirements For Installed Or Modified Planting Soil

a. Compact installed planting soil to the compaction rates indicated and using the methods approved for the soil mockup. Compact each soil lift as the soil is installed.

b. Existing soil that is modified by tilling, ripping or fracturing shall have a density to the depth of the modification, after completion of the loosening, such that the penetrometer reads approximately 75 to 250 psi at soil moisture approximately the mid-point between wilting point and field capacity. This will be approximately between 75 and 82% of maximum dry density standard proctor.

c. Installed planting soil mix and re-spread existing soil shall have a soil density through the required depth of the installed layers of soil, such that the penetrometer reads approximately 75 to 250 psi at soil moisture approximately the mid-point between wilt point and field capacity. This will be approximately between 75 and 82% of maximum dry density standard proctor.

d. Planting soil compaction shall be tested at each lift using a penetrometer calibrated to the mockup soil and its moisture level. The same penetrometer and moisture meter used for the testing of the mockup shall be used to test installed soil throughout the work.

e. Maintain moisture conditions within the planting soil during installation or modification to allow for satisfactory compaction. Suspend operations if the planting soil becomes wet. Apply water if the soil is overly dry.

f. Provide adequate equipment to achieve consistent and uniform compaction of the planting soils. Use the smallest equipment that can reasonably perform the task of spreading and compaction. Use the same equipment and methods of compaction used to construct the planting soil mockup.

g. Do not pass motorized equipment over previously installed and compacted soil except as authorized below.

(1) Light weight equipment such as trenching machines or motorized wheel barrows is permitted to pass over finished soil work.

(2) If work after the installation and compaction of soil compacts the soil to levels greater than the above requirements, follow the requirements of the paragraph "over compaction reduction" below.

8. Over Compaction Reduction

a. Any soil that becomes compacted to a density greater than the specified density and/or the density in the approved mockup shall be dug up and reinstalled. This requirement includes compaction caused by other sub-contractors after the planting soil is installed and approved.

b. Surface roto tilling shall not be considered adequate to reduce over compaction at levels 6 inches or greater below finished grade.

9. Installation Of Chemical Additives

a. Following the installation of each soil and prior to fine grading and installation of the compost till layer, apply chemical additives as recommended by the soil test, and appropriate to the soil and specific plants to be installed.

b. Types, application rates and methods of application shall be approved by the Owner’s Representative prior to any applications.

10. Fine Grading

a. The Owner’s Representative shall approve all rough grading prior to the installation of compost, fine grading, planting, and mulching.

b. Grade the finish surface of all planted areas to meet the required grades allowing the finished grades to remain higher (10 – 15% of depth of soil modification) than the grades on the grading plan, as defined in paragraph planting soil installation, to anticipate settlement over the first year.

c. Utilize hand equipment, small garden tractors with rakes, or small garden tractors with buckets with teeth for fine grading to keep surface rough without further compaction. Do not use the flat bottom of a loader bucket to fine grade, as it will cause the finished grade to become overly smooth and or slightly compressed.

d. Provide for positive drainage from all areas toward the existing inlets, drainage structures and or the edges of planting beds. Adjust grades as directed to reflect actual constructed field conditions of paving, wall and inlet elevations. Notify the

Owner's Representative in the event that conditions make it impossible to achieve positive drainage.

e. Provide smooth, rounded transitions between slopes of different gradients and direction. Modify the grade so that the finish grade before adding mulch and after settlement is one or two inches below all paving surfaces or as required for the project.

f. Fill all dips and remove any bumps in the overall plane of the slope. The tolerance for dips and bumps in shrub and ground cover planting areas shall be a 2 inch deviation from the plane in 10 feet. The tolerance for dips and bumps in lawn areas shall be a 1 inch deviation from the plane in 10 feet.

11. Installation Of Compost Till Layer

a. After planting soil mixes are installed in planting bed areas and just prior to the installation of shrub or groundcover plantings, spread 3 – 4 inches of compost over the beds and roto till into the top 4 - 6 inches of the planting soil. This step will raise grades slightly above the grades required in paragraph "fine grading". Additional settlement as defined in paragraph "planting soil and planting soil mix installation" must still be accounted for in the setting of final grades.

12. Clean-up

a. During installation, keep the site free of trash, pavements reasonably clean and work area in an orderly condition at the end of each day. Remove trash and debris in containers from the site no less than once a week.

(1) Immediately clean up any spilled or tracked soil, fuel, oil, trash or debris deposited by the contractor from all surfaces within the project or on public right of ways and neighboring property.

b. Once installation is complete, wash all soil from pavements and other structures. Ensure that mulch is confined to planting beds and that all tags and flagging tape are removed from the site.

(1) Make all repairs to grades, ruts, and damage to the work or other work at the site.

(2) Remove and dispose of all excess planting soil, subsoil, mulch, plants, packaging, and other material brought to the site by the contractor.

13. Planting Soil And Modified Existing Soil Protection

a. Utilize fencing and matting as required or directed to protect the finished soil work from damage including contamination and over compaction due to other soil installation, planting operations, and operations by other contractors or

trespassers. Maintain protection during installation until acceptance. Treat, repair or replace damaged planting soil immediately.

b. Loosen compacted planting soil and replace planting soil that has become contaminated as determined by the Owner's Representative. Planting soil shall be loosened or replaced at no expense to the Owner.

(1) Till and restore grades to all soil that has been driven over or compacted during the installation of plants.

(2) Where modified existing soil has become contaminated and needs to be replaced, provide imported soil that is of similar composition, depth and density as the soil that was removed.

14. Protection During Construction

a. The contractor shall protect planting and related work and other site work from damage due to planting operations, operations by other contractors or trespassers.

(1) Maintain protection during installation until the date of plant acceptance (see specifications section – 32 90 00 Planting). Treat, repair or replace damaged work immediately.

(2) Provide temporary erosion control as needed to stop soil erosion until the site is stabilized with mulch, plantings or turf.

b. Damage done by the contractor, or any of their sub-contractors to existing or installed plants, or any other parts of the work or existing features to remain, including large existing trees, soil, paving, utilities, lighting, irrigation, other finished work and surfaces including those on adjacent property, shall be cleaned, repaired or replaced by the contractor at no expense to the Owner. The Owner's Representative shall determine when such cleaning, replacement or repair is satisfactory. Damage to existing trees shall be assessed by a certified arborist.

15. Substantial Completion Acceptance

a. Upon written notice from the contractor, the Owners Representative shall review the work and make a determination if the work is substantially complete.

b. The date of substantial completion of the planting soil shall be the date when the Owner's Representative accepts that all work is complete.

7. <u>As-built Requirements</u>

A. Final Acceptance / Soil Settlement

1. At the end of the plant warrantee and maintenance period, (see specification section 32 01 90 Operation and Maintenance of Planting) the Owner's Representative shall observe the soil installation work and establish that all provisions of the contract are complete and the work is satisfactory.

    a. Restore any soil settlement and or erosion areas to the grades shown on the drawings. When restoring soil grades remove plants and mulch and add soil before restoring the planting. Do not add soil over the root balls of plants or on top of mulch.

2. Failure to pass acceptance: if the work fails to pass final acceptance, any subsequent observations must be rescheduled as per above. The cost to the Owner for additional observations will be charged to the contractor at the prevailing hourly rate of the Owner's Representative.

B. All changes to the product or quantity used as well as the location of the installation should be reflected in the as-built drawings.