SECTION 31 23 16.13 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES

PART 1 - GENERAL

1.1 SUMMARY

A. Work Included:

1. Clearing, excavation, and trenching for utilities and associated appurtenances.
2. Backfilling.
3. Disposal of clearing debris and surplus material.
4. Restoration of trench and disturbed areas associated with the work.

B. Related Sections:
1. Section 33 11 00 -Water Utility Distribution Piping
2. Section 33 12 00 – Water Service Connections
3. Section 33 39 13 – Manholes
4. Section 33 32 00 – Sanitary Sewer Lateral Connections
5. Section 33 31 00 – Gravity Sewer
6. Section 33 34 00 – Force Mains
7. Section 33 05 23.16 – Utility Pipe Jacking

1.2 UNIT PRICE - MEASUREMENT AND PAYMENT

A. The work associated with this section shall be included in the price for the item for which it pertains.

B. For larger diameter pipes which take up more of the trench volume, the excess soil shall be removed if it cannot be spoiled on-site. Hauling shall be included in price for item to which it pertains.

C. Repair of pavement and driveways, special restoration, and landscaping will be handled separately on a unit price basis as defined in the contract documents

D. When classified rock or unsuitable materials are encountered, they will be handled separately on a unit price basis as defined in the Contract Documents.

1.3 REFERENCE STANDARDS

A. All products, installation and testing of force mains and gravity sewers shall meet the requirements of Regulation 61-67, Standards for Wastewater Facility Construction or State Primary Drinking Water Regulations (R61-58).

B. All products, installation and testing of force mains and gravity sewers shall meet the requirements of "Recommended Standards for Wastewater Facilities" (Ten State Standards), latest edition.

C. Any reference to SCDOT standard specifications was obtained from "Standard Specifications for Highway Construction" published by the South Carolina Department of Transportation. Unless otherwise noted, the most current date published applies.

D. American Society for Testing Materials:

1. ASTM C33 - Standard Specification for Concrete Aggregates.
2. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3).
3. ASTM D1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
4. ASTM D1586 - Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils.
5. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
6. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
7. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
8. Additional applicable ASTM standards which are not specifically stated.

E. Occupational Safety and Health Administration:

1. Trenching and Excavation Safety (OSHA 2226-10R 2015)
2. 1926 Subpart P, App B “Sloping and Benching”

F. SCDOT Standard Specifications:

1. Standard Specifications for Highway Construction, 2007 or latest edition, published by the South Carolina Department of Transportation.

G. Local utility standards when working within limits of existing utility lines.

H. National Sanitation Foundation:

1. NSF 61 – Drinking Water System Components – Health Effects

1.4 SUBMITTALS

A. Indicate soil densification grid for each size and configuration footing requiring soil densification.

B. Excavation Protection Plan:

a. Describe sheeting, shoring, and bracing materials and installation, as required, to protect excavations and adjacent structures and property and in accordance with OSHA standards.
b. Submit signed and sealed Shop Drawings with design calculations and assumptions to support plan.

C. Product Data: Submit data for washed stone, shoring design (if required), concrete, geotextile fabric indicating fabric and construction, and other items as required by the Engineer or Owner's Representative.

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

E. Provide proposed backfilling and compaction plan for review.

1.5 COORDINATION

A. Coordination and project conditions:

1. Coordinate scheduling, submittals, and Work of various Sections of Project Manual to ensure efficient and orderly sequence of installation of interdependent construction elements.
2. Verify that utility requirements and characteristics of operating equipment are compatible with related utilities. Coordinate work of various Sections having interdependent responsibilities for installing, connecting to, and placing operating equipment in service.
3. Coordinate space requirements, supports, and installation of mechanical and electrical work indicated diagrammatically on Drawings. Follow routing shown for pipes, ducts, and conduit as closely as practical; place runs parallel with lines of building. Use spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.
4. Coordinate trench width, depth, and bedding types with the Drawings and as specified in Related Sections.

B. Verify Work associated with lower elevation utilities is complete before placing higher elevation utilities.

C. Notify all appropriate parties at least 72-hours prior to construction.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Inspect all materials upon delivery to ensure that proper material has been received.

B. The Contractor shall store and handle materials in accordance with supplier or manufacturer's recommendations and in a manner to prevent excessive moisture, contamination, or other negative impacts to materials.

C. The Contractor shall protect the materials from damage. Damaged material shall be replaced at no additional cost.

1.7 QUALITY ASSURANCE

A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

B. Comply with requirements of governmental agencies having jurisdiction.

C. Testing: A testing laboratory retained by the Contractor who will make such tests as are deemed advisable.

1. Schedule fill and backfill operations to permit a reasonable time for inspection and testing before placing succeeding lifts and keep the laboratory and Engineer informed of progress.
2. Notify the Engineer and allow sufficient time for inspection and/or testing of foundation subgrades prior to commencing any work on the exposed excavation.
3. Provide Engineer and Owner with copies of all testing reports.

D. Work performed within SCDOT right-of-way shall be in accordance with Division 200 of SCDOT Standard Specifications and any other applicable SCDOT standards.

1.8 DEFINITIONS

A. Excavation: Excavation is defined as unclassified excavation of every description regardless of materials encountered, other than solid rock, muck and unsuitable materials as defined in this section.

B. Granular Material: Provide materials free from all organic material, trash, or other debris.

C. Maximum density: Maximum weight in pounds per cubic foot of a specific material.

D. Muck: Materials unsuitable for foundation because of organic content, saturation to the extent that it is somewhat fluid and must be moved by dragline, dredge, or other special equipment, are designated as muck. No extra payment will be made for muck removal.

E. Open areas: Open areas shall be those areas that do not include building sites, paved areas, street right-of-way, and parking areas.

F. Optimum moisture: Percentage of water in a specific material at maximum density, as determined by the compaction test.

G. Rock excavation: Excavation of any hard natural substance which requires the use of explosives and/or special impact tools such as jack hammers, sledges, chisels or similar devices specifically designed for use in cutting or breaking rock, but exclusive of trench excavating machinery. To be considered as rock excavation, the material shall be continuous having a standard penetration resistance as determined by ASTM D158; individual boulders or rocks in soil will not be considered rock excavation. Any material occupying an original volume of more than 1 cubic yard which cannot be excavated with a single-tooth ripper drawn by a crawler tractor

having a minimum draw bar pull rating not less than 56,000 pounds usable pull (Caterpillar D-8K) or a large track mounted backhoe (CAT-325 or larger) is considered rock.

H. Select material: Select material is defined as granular material to be used where indicated on the drawings or where specified herein consisting of soils conforming to the Unified Soil Classification types SW, SM, GW, or GM or as otherwise approved by the Engineer as select fill. Select material shall contain no stones or rubble larger than 1½ inch in diameter.

I. Suitable material (Common Fill): Where the term suitable material is used in specification sections pertaining to earthwork, it means earth or materials designated as being suitable for their intended use by soils technicians or the Engineer. Suitable material shall be designated as meeting the requirements of the Unified Soil Classification System types SW, GW, GC, SC, SM, ML, CL or as designated in these specifications.

J. Unsuitable material: Unsuitable material is defined as earth material unsatisfactory for its intended use and as classified by a soil technician. In addition to organic matter, sod, muck, roots, and rubbish, highly plastic clay soils of the CH and MH descriptions, and organic soils of the OL and OH descriptions, as defined in the Unified Soil Classification System shall be considered as unsuitable material.

K. Utility: Any buried pipe, duct, conduit, or cable.

L. Washed or Crushed Stone (gravel): Stone shall be No. 57 aggregate or equal conforming to ASTM C33.

1.9 WARRANTY

A. Provide a two-year materials and workmanship warranty. The contractor shall be responsible for correcting defects in the Work during the warranty period, including defective material and workmanship.

1.10 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication or laying of utilities.
2. Indicate field measurements on Shop Drawings.

B. Protection of other utilities:

1. Approximate location of certain known underground lines are shown.
2. Existing small lines not shown.
3. Locate small and other possible utility lines using electronic pipe finder, or other approved method.
4. Excavate and expose existing underground utilities ahead of trenching operations.
5. Repair or replace any damaged utility line or structure at no additional cost to Owner.

1.11 JOB CONDITIONS

A. Locations of existing utilities are shown on Contract Drawings for information only, other utilities or structures may exist.

B. Locate all existing utilities and structures within the limits of work prior to beginning trenching work.

C. If conditions encountered during construction warrant additional removal of unsuitable material below foundation subgrades, then remove unsuitable material in accordance with the Contract Documents.

D. All excavation, trenching, sheeting, bracing, backfill, and other activities shall comply with pertinent OSHA standards and local code requirements.

E. Repair any damages associated with completing the work to existing or better conditions.

F. Provide proper notification of intent to excavate in accordance with the South Carolina Underground Utility Damage Prevention Act.

G. Where trench is located in areas with established sod type grasses, replace with new sod or reuse existing sod when properly removed and stored.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. Soil material used as fill, backfill or subgrade for structures shall consist of suitable material.

1. Provide suitable material free from organic matter and deleterious substances, containing no rocks or lumps over 6" in greatest dimension, and with not more than 15% of the rocks or lumps larger than 2" in their greatest dimension.
2. Do not permit rocks having a dimension greater than 1" in the upper 6" of fill or subgrade.

B. Where select material is indicated on the drawings or specified, use select granular material as defined herein and approved by the Engineer.

C. Where indicated on the drawings or specified, use gravel or crushed stone as defined herein.

D. Where indicated on the drawings, provide a lean concrete "mud mat/slab" beneath foundations.

1. Use 2000 psi concrete and a minimum thickness of 2".
2. With prior approval of the Engineer, a "mud mat/slab" may be substituted for gravel base material except where the gravel base is required for drainage or for use with pressure relief valves.

2.2 EXCAVATED MATERIALS

A. Perform all excavation of every description and of whatever substances encountered to depths indicated or specified.

B. Pile material suitable for backfilling in an orderly manner at a safe distance from banks or trenches to avoid overloading and to prevent slides or cave-ins.

C. Remove and depose of unsuitable or excess materials as directed by the Engineer.

2.3 BACKFILL MATERIALS

A. Provide from materials excavated for installation of utility.

1. Use “Select” soil material free from organic matter and deleterious substances, containing no rocks or lumps over 2" in greatest dimension for backfill up to 12" above top of utility being covered.
2. Do not permit rocks larger than 2" in greatest dimension in all of backfill.

B. Backfill in accordance with details shown on Contract Drawings utilizing “suitable” or “select” as specified or directed by the Engineer or Owner’s Representative.

C. Bedding shall be No. 57 washed stone unless indicated otherwise on the Contract Drawings.

2.4 OTHER MATERIALS

A. Concrete: Conforming to Section 701 of the SCDOT Standard Specifications

B. Flowable Fill: Per SCDOT Standard Specifications.

C. Per the Contract Drawings and relatable specifications.

2.5 MISCELLANEOUS MATERIALS

A. As required, provide all other materials for a complete and proper installation for products and installation as described here within.

PART 3 - WORK EXECUTION

3.1 EXCAVATION

A. Protection of persons and property:

1. Protect structures, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, washout and other hazards created by operations under this Section.
2. Unless shown to be removed, locate and protect active utility lines shown on the drawings or otherwise made known to the Contractor prior to excavating. If damaged, repair or replace at no additional cost to the Owner.
3. If active utility lines are encountered and are not shown on the drawings or otherwise made known to the Contractor, promptly notify the Engineer and take necessary steps to assure that service is not interrupted.
4. Barricade open holes and depressions occurring as part of this work, and post warning lights on property adjacent to or with public access. Operating warning lights during hours from dusk to dawn each day and as otherwise required. (Owner reserves the right to require excavations to be backfilled at the end of each workday).
5. Side slopes: Slope, bench and/or shore sides of excavations and trench walls to maintain stability of the wall or sides. Pile materials obtained from the excavation a minimum of four feet from the edge of the excavation in accordance with OSHA standards.
6. Shoring and sheeting: Where necessary, shore and sheet excavations with members of sizes and arrangement sufficient to prevent injury to persons, damage to structures or injurious caving or erosion.
    a. Furnish, put in place, and maintain such sheeting and bracing as may be required to support the sides of excavations, to prevent any movement which could in any way diminish the width of the excavation below that necessary for proper construction, and to protect adjacent structures from undermining or other damage. Any movement or bulging which may occur shall be corrected immediately by the Contractor. Care shall be taken to prevent voids outside of the sheeting, but if voids are formed, they shall be immediately filled and compacted.
    b. Take all precautions to prevent distress of existing structures because of sheeting installation or removal. Where the removal of sheeting may cause damage to existing or newly constructed structures, such sheeting shall be left in place at no expense to the Owner.
    c. All sheeting and shoring operations and maintenance thereof shall be the responsibility of the Contractor.

B. Excavating: Perform excavating of every type of material encountered to the lines, grades and elevations indicated or as necessary for construction of the structures shown.

1. Conform to elevations and dimensions shown within a tolerance of 0.10', and extending a sufficient distance from footings and foundations to permit placing and removing concrete formwork, installation of services, other construction required and for inspection.
2. Where earth will stand, shallow footing excavations may be cut to the exact size of the footing.
3. Separate suitable materials and stockpile for future use.
4. Dispose of unsuitable material and excess suitable material at no additional cost to the owner.

C. Foundation subgrades: Excavate foundations and footings to a level bottom in firm, solid, suitable material.

1. Take care not to disturb the bottom of the excavation unless further compaction of the subgrade is required.
2. Notify the Engineer in due time to permit inspection of the completed excavation prior to performing work on the foundation subgrade.

3. Should unsuitable or soft material be encountered at subgrade elevation, remove such material and replace with compacted suitable material or crushed stone from firm earth up to the indicated elevation.
    a. In wet excavations or where groundwater is normally present, replace unsuitable material with crushed stone or lean concrete.
    b. In dry excavations above the normal groundwater level, replace unsuitable material with compacted suitable material.
    c. Unsuitable material shall be removed and replaced.

4. Where rock is encountered at foundation level:
    a. Use drilling, picking, wedging or similar methods leaving the foundation rock in an entirely solid and unshattered condition.
    b. Roughen approximately level surfaces to provide satisfactory bond with concrete.
    c. Cut steps or benches in sloped surfaces to provide satisfactory bond.
5. Foundation preparation and construction shall be in accordance with the provided geotechnical report and the construction drawings.

D. Drainage: Provide drainage and control grading in the vicinity of the work to prevent drainage into the excavation.

E. Rock excavation:

1. Notify the Engineer upon encountering rock or similar material which cannot be removed or excavated by conventional earth moving or ripping equipment.
2. Do not use explosives without written permission from the Owner. See Paragraph 3.2 below for blasting requirements.
3. When explosives are permitted, use only experienced powdermen or persons who are licensed or otherwise authorized to use explosives. Store, handle and use explosives in strict accordance with all regulatory bodies and the "Manual of Accident Prevention in Construction" of the Associated General Contractors of America, Inc.
4. The Contractor shall be solely responsible for any damage resulting from the use of explosives.
5. The Contractor is responsible for securing all permits required in performing this work.

F. Unauthorized excavation:

1. Excavation of material to depths below the grades indicated unless so directed by the Engineer will be deemed unauthorized excavation.

2. Backfill and compact unauthorized over excavation at no expense to the Owner.
    a. In wet excavations or excavations below normal groundwater elevations: Use crushed stone or lean concrete as directed by the Engineer.
    b. In dry excavations above normal groundwater elevations: Use compacted suitable material or as specified in relatable specifications.

3.2 BLASTING

A. General Requirements:

1. Do not use blasting adjacent to existing buildings or structures. Remove rock at such locations using jack hammers and bull points.
2. Blasting shall be performed in accordance with all laws, regulations, and ordinances in effect at the time of blasting and required by the authority having jurisdiction thereover. Contractor shall engage the services of a qualified blasting engineer to develop blasting procedures and of an independent firm to perform pre-blast and post-blast surveys and assist in monitoring blasting operations. Contractor shall notify all affected adjacent property occupants at least 24 hours prior to any blasting. Contractor shall be responsible for all damage caused by blasting operations and shall be responsible for responding to and resolving all complaints. Suitable methods shall be employed to confine all materials lifted by blasting within the limits of the excavation or trench.
3. All rock which cannot be handled, crushed, processed, and compacted as earth shall be kept separate from other excavated materials and shall not be mixed with backfill or embankment materials except as specified or directed.
4. Blasting or other use of explosives for excavation adjacent to existing utilities, structures, and other facilities shall be in conformity with the requirements of the local ordinance and the authority having jurisdiction there over and shall not cause damage to any adjacent structures. Contractor shall consult with and obtain written approval for blasting procedures from the appropriate utility or agency before blasting adjacent to their utilities, structures, or other facilities. Certain utilities, including gas pipelines and fiber optics, and agencies have requirements that will not permit blasting adjacent to or within a minimum distance from their utilities or structures, including utilities and structures outside the construction easements or on the opposite side of the street, if applicable.
5. The blasting procedures shall be in conformity with the requirements of the utility, if applicable. Prior to blasting, Contractor shall submit to Owner, through Engineer, a copy of the blasting procedures sealed by the blasting engineer for record purposes.
6. Contractor shall be responsible for obtaining all required blasting permits from the city, county, state and federal agencies and shall provide sufficient prior notice as specified by code, ordinance or other regulation to the county engineer, county sheriff, fire districts, police departments, and all other appropriate agencies and authorities where the blasting is to be performed. A copy of the blasting permit shall be on the site before and during the blasting operations. Contractor shall furnish to Owner a copy of all blasting permits at least 7 days prior to blasting.

B. Pre-blast Survey:

1. Contractor shall perform a pre-blast survey of all utilities, structures, and other facilities adjacent to the blast sites to determine the conditions of each utility, house, building, bridge, overpass, and other structures and facilities susceptible to damage from blasting operations. The pre-blast survey shall include all structures and utilities within a minimum of 500 feet radius of the area to be blasted. The survey notification to all property owners, tenants, utilities, and other agencies and the area of survey shall be in conformity with the requirements of the authority having jurisdiction thereover or as determined by

Contractor's insurance company if no local ordinance applies. Contractor shall submit the pre-blast survey report for record purposes, to Owner at least 30 days prior to blasting.

C. Blast Monitoring:

1. Prior to the start of Contractor's blasting, Contractor shall measure background ground vibrations.
2. Seismographs shall be placed on the ground adjacent to structures subjected to ground shock to measure peak particle velocity components in three mutually perpendicular directions during blasting operations.
3. The peak particle velocity, defined as the maximum of the three velocity components of vibration, at any location shall not exceed values that will cause damage to the adjacent structures. Air overpressure shall be measured at adjacent structures. Air overpressure at adjacent structures shall not exceed values that will cause damage to the adjacent structures or personnel. The maximum peak particle velocity and air overpressure values that will not cause damage shall be determined by the blasting engineer retained by Contractor and shall be stated in the blasting procedures.
4. Contractor shall submit measurement records of the blast monitoring to Owner for record purposes within 24 hours after each blast.

D. Post-blast Survey:

1. Contractor shall perform a post-blast survey of the same utilities, structures, and other facilities surveyed in the pre-blast survey to determine the effect of the blasting operations. Contractor shall submit the post-blast survey report to Owner for record purposes within 14 days after completion of blasting.

3.3 DEWATERING

A. Remove all surface and subsurface waters from excavations and maintain the excavation in a dry condition during construction operations.
1. Do not allow water to enter the ends of a pipe section. When work is stopped, plug pipe ends until work restarts.

B. Maintain the water level a minimum of 30 inches below the lowest point of the excavation subgrade during excavation and construction.

1. Material disturbed below the foundation subgrade due to improper dewatering shall be removed and replaced with crushed stone or lean concrete at no expense to the Owner.
2. Use sumps, pumps, drains, trenching or well point system as necessary to maintain a dry excavation.
3. Dewatering by trench pumping will not be permitted if migration of fine-grained natural material (running sand) from bottom, side walls or bedding material will occur.

C. Dispose of water pumped from excavations in storm drains having capacity, canals, trenches or other approved locations.

1. Contractor is responsible for acquiring all permits required to discharge the water and shall protect waterways from erosion and turbidity during the operation.
2. Prevent flooding of streets, roadways, or private property.
3. Provide engines driving dewatering pumps with residential type mufflers.

3.4 BACKFILLING, FILLING AND COMPACTION

A. Use suitable material for all filling and backfilling operations.

B. Fill under structures: Deposit suitable material in layers not exceeding 6" in depth and compact each layer using proper equipment.

1. Do not place rock that will not pass through a 6" diameter ring within the top 12" of the surface of the completed fill or rock that will not pass through a 3" diameter ring within the top 6" of the completed fill.
2. Do not place broken concrete, bricks, or asphaltic pavement in fills.
3. Where indicated on the drawings, provide select granular material.

C. Backfilling:
1. Backfill excavations as promptly as progress of the Work permits, but not until completion of the following:
    a. Inspection and acceptance of construction below finish grade including, where applicable, damp proofing and waterproofing.
    b. Inspecting, testing, approving and recording locations of underground utilities.
    c. Removing concrete formwork.
    d. Removing shoring and bracing, and backfilling of voids with satisfactory materials.
    e. Removing trash and debris.
    f. Foundation walls have been in place for seven days.
2. Backfill trenches in accordance with these specifications and the details contained in the plans.
3. Backfill trenches to contours and elevations with unfrozen and unsaturated fill materials.
4. Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen, or spongy subgrade surfaces.
5. Place geotextile fabric as detailed on Drawings or as directed by the Owner’s Representative prior to placing subsequent fill materials.
6. Place material in continuous layers as follows:
    a. Suitable Fill: Maximum 6 inches compacted depth.
    b. Select Fill: Maximum 6 inches compacted depth.
    c. Washed Stone: Maximum 6 inches compacted depth.
7. Employ placement method that does not disturb or damage foundation perimeter drainage, and utilities in trench.
8. Maintain optimum moisture content of fill materials to attain required compaction density as determined by the Geotechnical Engineer.
9. Do not leave more than 30 feet of trench open at the end of the working day. (Owner reserves the right to require trench to be backfilled at the end of the working day)
10. Protect open trench to prevent danger to Owner and the public.

D. Placing and compacting:

1. Place backfill and fill materials in layers not more than 8" in loose depth.
2. Before compacting, moisten or aerate each layer as necessary to provide the optimum moisture content within +/-2%.
3. Compact each layer to required percentage of maximum density for area.
4. Do not place backfill or fill material on surfaces that are muddy, frozen, or containing frost or ice.
5. Place backfill and fill materials evenly adjacent to structures, to required elevations.
6. Take care to prevent wedging action of backfill against structures by carrying the material uniformly around the structure to approximately the same elevation in each lift.
7. Do not operate heavy equipment closer to foundation or retaining walls than a distance equal to height of backfill above the footing.
   a. Compact remaining area using power driven hand tampers.
8. Where the construction includes basement or other underground walls having structural floors over them, do not backfill such walls until the structural floors are in place and have attained sufficient strength to support the walls.

E. Compaction requirements:
1. Compact soils to not less than the following percentages of maximum dry density as determined in accordance with ASTM D698 (Standard Proctor). Where percentages cannot be achieved, compacted stone may be used as directed by the Engineer.
2. Existing in place subgrade below structures where subgrade has been disturbed by water, improper dewatering, or construction traffic.
   a. Top 12" of subgrade 98%
   b. Below top 12" of subgrade 95%
3. Fill beneath structures and beneath an area extending 10 feet beyond the limits of the foundation:
   a. Top 12" of subgrade 98%
4. Compaction of suitable material used to replace unsuitable material below foundation subgrades:
   a. Top 12" of subgrade 98%
   b. Below top 12" of subgrade 95%

3.5 FIELD QUALITY CONTROL

A. Secure the Engineer's inspection and approval of subgrades and fill layers before subsequent construction is permitted thereon.

B. Field density determinations will be made to ensure that the specified densities are being obtained. Field density tests will be performed as determined by the Engineer, considering the following:

1. At areas to receive paving, at least one field density test for every 5000 sq-ft. of subgrade area, but not less than three tests.
2. In each compacted fill layer, one field density test for every 5000 sq-ft. of overlaying paved area, but not less than three tests.
3. In fill beneath structures, one field density test for every 2,500 square feet in each layer.

4. Other tests as deemed necessary by the Engineer.

C. If, the Engineer's opinion based on reports of the testing laboratory, subgrade or fills that have been placed are below specified density; provide additional compacting and testing until specified requirements are met.

1. Additional testing will be provided by the Owner's selected testing laboratory and all costs for the additional testing will be borne by the Contractor.

D. Proofrolling:

1. Upon request by the Engineer, proof roll the subgrade of structure foundations.
2. Make no less than three passes of a 25 to 50-ton rubber-tired roller over the full area.
3. Unstable, soft or otherwise unsuitable materials revealed by the proof rolling shall be removed and replaced with satisfactory material and compacted as specified herein.

3.6 PROTECTION

A. Prevent displacement or loose soil from falling into excavation and maintain soil stability.

B. Protect bottom of excavations and soil adjacent to and beneath foundation from freezing.

C. Protect structures, utilities, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that may be created by earth operations.

3.7 LINES AND GRADES

A. Lay pipes to lines and grades indicated on Drawings.

1. Engineer and/or Owner reserves the right to make changes in lines, grades, and depths of utilities when changes are required for Project conditions.

B. Use laser-beam instrument with qualified operator to establish lines and grades.

3.8 PREPARATION

A. Call Local Utility Line Information service indicated on the drawings not less than three (3) working days before performing Work.

1. Request underground utilities to be located and marked within and surrounding construction areas.

2. Contractor must receive responses from all utility providers identified in ticket prior to beginning excavation activities.

B. Identify required lines, levels, contours, and datum locations.

C. Protect plant life, lawns, rock outcropping and other features remaining as portion of final landscaping.

D. Protect benchmarks, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.

E. Maintain and protect above and below grade utilities indicated to remain.

F. Establish temporary traffic control and detours when trenching is performed in public right-of-way. Relocate controls and reroute traffic as required during progress of Work.

3.9 TRENCHING

A. Saw cut, in straight lines, all pavement or concrete within the trench route prior to excavation.

B. Strip and stockpile topsoil from grassed areas within trench or disposed of and replaced for final grassing where required.

C. Excavate subsoil required for installation of new utilities while maintaining undisturbed subgrade at trench bottom.

D. Remove lumped subsoil, boulders, and rock up of 1'-6" cubes, measured by volume. Remove Rock as specified in Paragraph 3.3.C below.

E. Rock Excavation:

1. See Section 31 23 16 – Excavation, for classification of rock and methods for rock removal.

F. Unauthorized Excavation:

1. Excavation of material to depths below the grades indicated unless so directed by the Engineer will be deemed unauthorized excavation.
2. Backfill and compact unauthorized excavation at no expense to the Owner.
3. In wet excavations or excavations below normal groundwater elevations: Washed stone or lean concrete as directed by the Engineer.
4. In dry excavations above normal groundwater elevations: Use compacted suitable material or as directed by engineer

G. Perform excavation within 24 inches of existing utility services in accordance with individual utility's requirements.

H. Do not advance open trench more than 200 feet ahead of installed pipe.

I. Cut trenches to width indicated on Drawings and/or sufficiently wide to enable installation and allow inspection. Remove water or materials that interfere with Work.

J. Excavate bottom of trench to dimensions shown on Drawings based on the size of pipe being installed.

K. Excavate trenches to depth indicated on Drawings. Provide uniform and continuous bearing and support for bedding material and pipe.

L. Do not interfere with 45 degree bearing splay of foundations.

M. When subsurface materials at bottom of trench are loose or soft, excavate to greater depth as directed by Engineer until suitable material is encountered.

N. Cut out soft areas of subgrade not capable of compaction in place. Backfill with Fill Type "Suitable" or "Select" and compact to density equal to or greater than requirements for subsequent backfill material.

O. Bell Holes: Hand trim for bell and spigot pipe joints. Remove loose matter.

P. Correct areas over excavated areas with compacted backfill as specified for authorized excavation or replace with fill concrete as directed by Engineer.

Q. Remove excess subsoil not intended for reuse, from site.

3.10 DISPOSAL OF MATERIALS

A. Avoid excessive trench bank loads when storing excavated materials.

B. Remove and dispose of surplus or unusable excavated materials.

C. Where stacking material on trench bank is not possible, store in an approved location until final disposition is determined.

3.11 SHEETING AND SHORING

A. Sheet, shore, and brace excavations to prevent danger to persons, structures and adjacent properties and to prevent caving, erosion, and loss of surrounding subsoil.

B. Support trenches more than 5 feet deep, or as required by OSHA regulations, excavated through unstable, loose, or soft material. Provide sheeting, shoring, bracing, or other protection to maintain stability of excavation.

C. Design sheeting and shoring to be removed at completion of excavation work.

D. When using moveable trench bracing to support the trench walls the following measures shall be taken to prevent movement of the utility:
   1. Rigid Pipe: Raise any bracing that extends below the mid-point of the utility to a point above the mid-point of the utility prior to moving the bracing ahead.

2. Flexible Pipe: Bracing shall not extend to a point below the mid-point of the utility. When removing the bracing, place crushed stone within voids and recompact backfill.
3. All voids left after withdrawal of sheeting or bracing shall be properly filled with sand unless otherwise directed herein.
4. Sheeting driven below the mid-diameter of the utility shall be left in place to a point at least one foot above the crown of the utility.

3.12 RESTORATION

A. Maintain final grade by adding additional backfill as needed where any settlement occurs.

B. Restore all roads and driveways to existing condition or better.

C. Restore sodded areas with new or properly stored sod.

3.13 TOLERANCES

A. Top Surface of Backfilling Under Paved Areas: Plus or minus 1 inch from required elevations.

B. Top Surface of General Backfilling: Plus or minus 1 inch from required elevations.

C. Any backfilled surfaces resulting in “birdbaths” shall be corrected at no additional cost to the Owner.

3.14 FIELD QUALITY CONTROL

A. Perform laboratory material tests in accordance with ASTM D698.

B. Perform in place compaction tests in accordance with the following:

1. Density Tests: ASTM D1556, ASTM D2167, or ASTM D2922.
2. Moisture Tests: ASTM D3017.

C. When tests indicate Work does not meet specified requirements, remove Work, replace, compact, and retest.

D. Frequency of Tests:

1. Field density determinations will be made, at no cost to the contractor, to ensure that the specified densities are being obtained. Field density tests will be performed as determined by the Engineer, considering the following:
   a. At areas to receive paving, at least one field density test for every 5,000 sq-ft. of subgrade area, but not less than three tests.
   b. In each compacted fill layer, one field density test for every 5,000 sq-ft. of overlaying paved area, but not less than three tests.
   c. Other tests as deemed necessary by the Engineer.

2. If, in the Engineer's opinion based on reports of the testing laboratory, subgrade or fills which have been placed are below specified density, provide additional compacting and testing until specified requirements are met.
    a. Additional testing will be provided by the owner's selected testing laboratory and all costs for the additional testing will be borne by the contractor.

3.15 PROTECTION OF FINISHED WORK

A. Reshape and re-compact fills subjected to vehicular traffic during construction.

3.16 SCHEDULE

A. Sanitary Piping:

1. Unpaved Areas: Compact uniformly to minimum 90 percent standard proctor of maximum dry density.
2. Paved (private) Areas: Compact uniformly to minimum 98 percent standard proctor of maximum dry density.

B. Structures:

1. Compact uniformly to minimum 98 percent standard proctor of maximum dry density.

C. Roadways:

1. Compact in accordance with SCDOT or local municipality requirements.

END OF SECTION 31 23 16.13