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TRENCHING**

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**SECTION 312316.13
TRENCHING**

PART 1 - GENERAL

1.1 SCOPE

- A. Furnish all labor, materials, equipment and incidentals necessary to perform all excavation, trenching and backfill required to complete the work shown on the Drawings and specified herein. The work shall include, but is not limited to; excavation for manholes, vaults, electrical manholes, hand holes, conduits, cables, raceways, and ducts and pipes; all backfilling, embankment and grading; disposal of water and surplus materials; and all related work such as sheeting, bracing and dewatering.
- B. Obtain materials required for backfill, fill or embankments in excess of that available on site from other sources. Include all costs of obtaining off-site materials in contract price.

1.2 REFERENCES

- A. American Association of State Highway and Transportation Officials:
 - 1. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.
- B. ASTM International:
 - 1. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³).
 - 2. ASTM D1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
 - 3. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³).
 - 4. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
 - 5. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
 - 6. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)

1.3 TESTING SERVICES

- A. The Contractor shall give the Engineer timely notice of readiness of the Work for all required inspections, tests, or approvals and shall cooperate with inspection and testing personnel to facilitate required inspections or tests.
- B. The Owner shall employ and pay for the services of an independent testing laboratory to perform all inspections, tests, or approvals required by the Contract Documents except:
 - 1. For inspections, tests, or approvals covered by Paragraphs C and D below;
 - 2. As otherwise specifically provided in the Contract Documents.
- C. If Laws or Regulations of any public body having jurisdiction require any Work (or part thereof) specifically to be inspected, tested, or approved by an employee or other representative of such public body, the Contractor shall assume full responsibility for arranging and obtaining such inspections, tests, or approvals, pay all costs in connection therewith, and furnish the Engineer with the required certificates of inspection or approval.
- D. The Contractor shall be responsible for arranging and obtaining and shall pay all costs in connection with any inspections, tests, or approvals required for the Owner's and the Engineer's acceptance of materials or equipment to be incorporated in the Work; or acceptance of materials, mix designs, or equipment submitted for approval prior to the Contractor's purchase thereof for incorporation in the Work. Such inspections, tests, or approvals shall be performed by organizations acceptable to the Owner and the Engineer.
- E. If any Work (or the work of others) that is to be inspected, tested, or approved is covered by the Contractor without written concurrence of the Engineer, the Contractor shall, if requested by the Engineer, uncover such Work for observation.
- F. Uncovering Work as provided in Paragraph 1.4E shall be at the Contractor's expense unless the Contractor has given the Engineer timely notice of the Contractor's intention to cover the same and the Engineer has not acted with reasonable promptness in response to such notice.

1.4 QUALITY ASSURANCE

- A. Perform Work in accordance with the Contract Documents and current construction standards and details provided by the Owner.

1.5 PROTECTION

- A. Section 017000 - Execution and Closeout Requirements: Protecting finished work.
- B. Dewatering and Drainage
 - 1. The contractor shall at all times during construction provide and maintain proper equipment and facilities to remove all water entering excavations, and shall keep such excavations dry so as to obtain a satisfactory undisturbed sub-grade foundation condition until the fills, structures, or pipes to be built thereon have been completed to such extent

that they will not be floated or otherwise damaged by allowing water levels to return to natural levels. The Contractor shall engage a Geotechnical Engineer, registered in the State of Georgia where required, to design the dewatering system. The Contractor shall submit to the Engineer for review, the design of the dewatering systems prior to commencing work.

2. The Contractor shall furnish, install, maintain, operate and remove a temporary dewatering system, consisting of trenches, sump pits, deep wells, well points or other methods as required, to lower and control the groundwater level so that the pipes may be installed in the dry. The Contractor shall assume full responsibility for the design and installation of an adequate dewatering system. The Contractor shall, at his own expense, correct all damage resulting from inadequacy of the dewatering system or from flooding of the construction site from other causes.
3. The Contractor shall maintain the water level below the excavated area for the various phases of work continuously and shall make such provisions as may be necessary to avoid interruptions due to weather, labor strikes, power failures or other delays. The Contractor shall provide and have ready for immediate use at all times diesel or gasoline powered standby pumping units to serve the system in case of failure of the primary pumping units.
4. Piping and boiling, or any form of uncontrolled seepage, in the bottom of sides of the excavation shall be prevented at all times. If for any reason the dewatering system is found to be inadequate to meet the requirements set forth herein, the Contractor shall at his own expense make such additions, changes, and/or replacements as necessary to provide a satisfactory dewatering system.
5. Dewatering shall at all times be conducted in such a manner as to preserve the undisturbed bearing capacity of the sub-grade soils at proposed bottom of excavation. Well or sump installations shall be constructed with proper sand filters to prevent drawing of finer grained soil from the surrounding ground.
6. Water entering the excavation from surface runoff shall be collected in shallow ditches around the perimeter of the excavation, drained to sumps, and pumped from the excavation to maintain a bottom free from standing water.
7. The Contractor shall take all additional precautions to prevent uplift during construction. The Contractor shall maintain the groundwater level below the pipe so floatation is prevented.
8. Drainage water shall be disposed of through a desilting basin which will prevent the discharge of sediment into any surface waters or existing drains and to prevent flow or seepage back into the excavated areas.
9. Floatation shall be prevented by the Contractor by maintaining a positive and continuous operation of the dewatering system. The Contractor shall be fully responsible and liable for all damages which may result from failure.
10. Removal of dewatering equipment shall be required; the material and equipment constituting the system shall be removed by the Contractor.

C. Culverts and Ditches

1. Protect drainage culverts from damage. If damaged, restore to satisfactory condition at no cost to the Owner.
2. If it is necessary to remove a culvert, do not replace until the proposed pipeline is installed and trench backfilled and compacted to the subgrade of the culvert. Replace culverts to the original line and grade established by the Owner.
3. Backfill minor drainage ditches so that the upper one foot of material between ditch banks is topsoil, loam, or clay.
4. Compact this material for the full ditch width to a minimum of 95% of maximum density as determined by ASTM D 698.
5. Ditches steeper than 2:1 slope shall be protected and reinforced with a synthetic fiber or grid material. Contractor has the option not to use reinforcement for slopes 2:1 or flatter. Correct any ditch erosion occurring as a result of pipeline construction at no cost to the Owner.

D. Water, Sewer, Gas, Telephone, Power, Cable.

1. Protect all other utilities from damage. Call Georgia's Utilities Protection Center by calling 811 or 1-800-282-7411 prior to all excavation. Notify utility owner prior to start of excavation. If, during the work the utility is damaged, notify the utility company and the Owner immediately. Do not attempt to repair or replace damaged utilities unless so directed by the utility company and approved by the Engineer. Payment for restoration of damaged utilities shall be the Contractor's responsibility.

1.6 JOB CONDITIONS

A. Soils

1. The Contractor shall examine the site and review the available test borings or undertake his own soil borings prior to submitting his bid, taking into consideration all conditions that may affect his work. The Owner and the Engineer will not assume responsibility for variations of subsoil quality or conditions at locations other than places shown and at the same time the investigation was made. The Contractor shall accept the site in its existing condition, and shall assume the risk of encountering whatever materials as may occur. Refer also to the paragraph on Differing Site Conditions, in the Supplementary Conditions. Soil borings, if furnished, are indicative of the soils encountered at the particular location of the borings at the time the borings were taken. The Contractor shall make his own determination of the soil structure and site conditions as it may affect the work.

B. Existing Utilities

1. CALL BEFORE YOU DIG – At least (3) days prior to beginning any work, the Contractor shall request a field locate of existing underground utilities in the work area through Georgia's Utilities Protection Center by calling 811 or 1-800-282-7411. If

utilities are to remain in place, provide adequate means of protection during earthwork operations.

2. Should uncharted, or incorrectly charted, piping appear in the excavation, consult the Engineer and the Owner of such piping or utility immediately for directions.
3. Cooperate with the Owner and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to satisfaction of utility owner.
4. Demolish and completely remove from site existing underground utilities indicated on the Drawings to be removed.

C. Protection of Persons and Property

1. Barricade open excavations occurring as part of this work and post with warning lights. Operate warning lights as recommended by authorities having jurisdiction.
2. Protect structures, utilities, sidewalks, pavements and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

1.7 SUBMITTALS

- A. Submit to the Engineer for review in accordance with Section 013300 the proposed methods of construction, including dewatering, excavation, filling, compaction, and backfilling for various portions of the work. Review shall be for method only. The Contractor shall remain responsible for the adequacy and safety of the methods.
- B. Submit to the Engineer for review in accordance with Section 013300 representative samples of each type of proposed fill material weighing approximately 50 lbs. at least 15 days prior to the date of anticipated use of such material.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Backfill materials shall be natural or processed mineral soils, blasted and crushed rock, or masonry rubble. Fill material shall be free of all organic material, trash, snow, ice, frozen soil or other objectionable materials. Clay soils having a natural in-place water content in excess of 3 percent of optimum are considered unsuitable for stockpiling and/or future use. Fill materials to be used have been classified under the categories below.
- B. Excavations shall be backfilled using suitable material recommended in ASTM D 2321 Table 2: Recommendations for Installation and Use of Soils and Aggregates for Foundation, Embedment and backfill.
- C. The suitability of backfill materials shall be as defined in ASTM D 2321 Table 1 Classes of Embedment and Backfill Materials.

- D. Embedment materials listed here include a number of processed materials plus the soil types defined by the USCS Soil Classification System in ASTM D2487. These materials are grouped into categories according to their suitability for this application.
1. Class I: Angular 6 to 40 mm (¼ to 1½ inches) graded stone including a number of fill materials that have regional significance such as coral, slag, cinders, crushed stone and crushed shells.
 2. Class II: Coarse sands and gravels with maximum particle size of 40 mm (1½ inches), including variously graded sands and gravels containing small percentages of fines, generally granular and non-cohesive, either wet or dry. Soil types GW, GP, SW, and SP are included in this class.
 3. Class III: Fine sand and clayey gravel, including fine sands and sand-clay mixtures. Soil types GM, GC, SM, and SC are included in this class.
 4. Class IV: Silt, silty clays and clays including inorganic clays and silts of medium to high plasticity and liquid limits. Soil types MH, CH, and CM are included in this class. These materials are not to be used for bedding, haunching, or initial backfill.
 5. Class V: This class includes the organic soils OL, OH and PT as well as soils containing frozen earth, debris, rocks larger than 40 mm (1½ inches) in diameter, and other foreign materials. These materials shall not be used for bedding, haunching, and initial backfill.
- E. Granular Fill, shall be sound, hard, durable crushed stone meeting the following gradation requirements and shall conform to ASTM C33, Size No. 57.

| <u>Sieve Size</u> | <u>Percent Passing by Weight</u> |
|-------------------|----------------------------------|
| 1½ in. | 100 |
| 1 in. | 90-100 |
| ½ in. | 26-60 |
| No. 4 | 0-7 |
| No. 8 | 0-3 |

- F. Riprap shall be sound, durable rock which is roughly rectangular shape and of suitable quality to insure permanence in the condition in which it is to be used. Rounded stones, boulders, sandstone, or similar soft stone will not be acceptable. Material shall be free from overburden, spoil, shale, and organic material. Each load of riprap shall be reasonably well graded from the smallest to the maximum size specified and shall conform to State of Georgia Department of Transportation Standard Specifications Section 805. Riprap shall consist of a durable field or quarry stone shaped roughly as rectangular blocks. One dimension of each exposed riprap shall be not less than 8-in. The joints in the riprap shall be filled with spalls of suitable size to construct a solid, stable slope, free from large voids and defects.
1. Type 1 Riprap shall be used for Severe Drainage Conditions or Moderate Wave Action, where:
 - a. 100% shall be smaller than 4.2 ft³ or approximately 700 lbs
 - b. 50-90% shall be smaller than 1.8 ft³ or approximately 300 lbs

- c. 20-65% shall be smaller than 0.8 ft³ or approximately 125 lbs
- d. 0-15% shall pass a 4-in square opening sieve
- 2. Type 3 Riprap shall be used for General Use and Normal Drainage Conditions, where:
 - a. 100% shall be smaller than 1.0 ft³ or approximately 165 lbs
 - b. 10-65% shall be smaller than 0.1 ft³ or approximately 15 lbs
 - c. 0-15% shall pass a 2-in square opening sieve
- G. Sand shall conform to ASTM Standard C33 for concrete sand.

PART 3 - EXECUTION

3.1 EXCAVATION

- A. Those performing excavation and trenching are responsible for conforming to all state and federal laws and regulations, and local ordinances related to safety, life, health, and property including but not limited to OSHA regulations, 29 CFR PART 1926, Subpart P, Paragraph 1926.650 through 1926.652 during all excavations and trenching. All excavations shall be adequately guarded with barricades and light in compliance with all OSHA requirements so as to protect the public from hazard. Excavations adjacent to existing or proposed buildings and structures or in paved streets or alleys shall be sheeted, shored, and braced adequately to prevent undermining or subsequent settlement of such structures or pavement. Underpinning of adjacent structures shall be done when necessary to maintain structures in safe condition.
- B. The Contractor shall proceed with caution in the excavation and preparation of the trench so that the exact location of underground structures in the trench zone may be determined before being damaged. He shall be held responsible for the repair or placement of such structures when broken or otherwise damaged because of his operations.
- C. The Contractor shall make explorations and excavations at no additional charge to the Owner to determine the location of existing underground structures.
- D. Utilities and other piping shall be laid in open trenches as shown and specified. Trenches shall be excavated to the designated lines and grades, beginning at the outlet end progressing to the upper end in each case. Trenches for pipe shall be shaped to the lower $\frac{1}{3}$ of the pipe and provide uniform and continuous bearing. Bell holes shall be dug to allow ample room for working fully around each joint.
- E. Trench shall be of minimum width to provide ample working space for making joints and shall be the diameter of the pipe plus 8 to 12 inches on each side of the pipe. Sides of trenches shall be closely vertical to top of pipe and shall be sheet piled and braced where soil is unstable in nature. Above the top of the pipe, trenches may be sloped. The ridge of the trench above this level may be wider for sheeting and bracing and the performance of Work.

- F. Trenches shall be excavated on the alignments shown on the Plans, and to the depth and grade necessary to accommodate the pipes at the elevations shown. Where elevations of the invert or centerline of a pipe are shown at the end of a pipe, the pipe shall be installed at a continuous grade between the two elevations.
- G. Excavation in excess of the depth required for proper shaping shall be corrected by bringing to grade the invert of the ditch with compacted, coarse, granular material at no additional expense to the Owner. Bell holes shall be excavated to relieve bells of all load but small enough to insure that support is provided throughout the length of the pipe barrel.
- H. If trenches are excavated to widths in excess of those specified, or if the trench walls collapse, the pipe shall be laid in accordance with the next better class of bedding at the expense of the Contractor.
- I. The Engineer reserves right to make changes in lines, grades, and depths of utilities when changes are required for Project conditions.
- J. Use laser-beam instrument with qualified operator to establish lines and grades.

3.2 TRENCHING

- A. Trenches shall be maintained in safe condition to prevent hazardous conditions to persons working in or around the trench. It is the responsibility of those performing excavation and trenching to conform to all State and Federal Laws and Regulations, and local ordinances relating to safety, life, health, and property including, but not limited to OSHA regulations 28CFR, Subpart P, Paragraph 1926.650 through 1926.652 during all excavations and trenching. All trenching shall be adequately guarded with barricades and lights in compliance with all OSHA requirements so as to protect the public from hazards.
- B. The top portion of the trench may be excavated with sloping or vertical sides to any width which will not cause damage to adjoining structures, roadways, utilities, etc. The bottom of the trenches shall be graded to provide uniform bearing and support with each section of pipe on undisturbed soil at every point along its entire length, except for the portions of the pipe sections excavated for bell holes and the sealing of pipe joints. Bell holes and depressions for joints shall be dug after the trench bottom has been graded and in order that the pipe rests upon the trench bottom for its full length and shall be only of such length, depth, and width for making the particular types of joints. The bottom of the trench shall be rounded so at least the bottom one-third of the pipe shall rest on undisturbed earth for the full length of the barrel as jointing operations will permit. This part of the excavation shall be done manually only a few feet in advance of the pipe laying by workers skilled in this type of work.
- C. The sides of all trenches and excavation for structures shall be held by stay bracing, or by skeleton or solid sheeting and bracing according to conditions encountered, to protect the excavation, adjoining property and for the safety of personnel. Bracing and shoring may be removed when the level of the backfilling has reached the elevation to protect the pipework and adjacent property. When sheeting and shoring above this level cannot be safely removed, it may be left in place. Timber left in place shall be cut off at least two feet below the surface. No sheeting below the level of the top of the pipe may be removed. Timber shall be treated to prevent rotting or insect infestation.

- D. Trenches shall be kept free of water. No structure shall be built or pipe be laid in water, and water shall not be allowed to flow over or rise upon any concrete, masonry or pipe until the same has been inspected and the concrete or joint materials have thoroughly set. All water pumped, bailed, or otherwise removed from the trench or other excavation shall be conveyed in a proper manner to a suitable place of discharge where it will not cause any injury to the public health or to public or private property or to work completed or in progress, or to the surface of the streets or cause any interference with the use of the same by the public, or to any stream, drainage structure, or body of water. See erosion and sediment control.

3.3 PILING EXCAVATED MATERIAL

- A. All excavated material shall be piled in a manner that will not endanger the work and that will avoid obstructing roadways and remain within the easement.

3.4 LIMIT TO LENGTH OF OPEN TRENCH

- A. Pipe trenches shall not be excavated more than 300 feet in advance of pipe laying and all work shall be performed to cause the least possible inconvenience to the public. Adequate temporary bridges or crossings shall be constructed and maintained where required to permit uninterrupted vehicular and pedestrian traffic.

3.5 REMOVAL OF UNSUITABLE MATERIAL

- A. Should over depth excavation be necessary to remove unsuitable material and to replace with satisfactory material, the Contractor will be paid for this work in accordance with Section 012000 for Removal and Replacement of Unsuitable Materials, based on the following requirements:
 - 1. When the trench is excavated to the plan depth or as required by these Specifications, and soft or other material not suitable for bedding purposes is encountered in the trench, the Contractor shall immediately notify the Engineer for observation and measurement of the unsuitable material to be removed.
 - 2. No over depth excavation or backfilling of the over depth excavated trench shall start until proper measurements of the trench have been taken by the Engineer for the determination of the quantity in cubic yards of unsuitable material excavated. Backfill material and backfilling shall conform to the requirements specified in 3.7 below.
 - 3. No payment will be made for any over depth excavation of soft unstable material due to the failure of the Contractor to provide adequate means to keep the trench dry.
 - 4. No payment will be made for any over depth excavation of the unsuitable material and replacement not observed and measured by the Engineer prior to excavation.

3.6 BEDDING OF SEWER PIPE

- A. All pipe for sewer shall be laid on foundations prepared in accordance with ANSI/AWWA C600 for ductile iron pipe and AWSI/AWWA C605 for PVC pipe as modified herein, and in accordance with the various classes of bedding required by the trench width and trench depth for the size of pipe to be laid. The minimum bedding allowed will be Type 3 for Ductile Iron Pipe. Bedding shall be included in the appropriate unit price bid for the work in which it pertains. Blocking shall not be used to bring pipe to grade.
- B. Bell Holes: Bell holes shall be provided in all classes of bedding to relieve pipe bells of all load, but small enough to ensure that support is provided throughout the length of the barrel.
- C. Class I materials as defined in Paragraph 2.1 shall be used for bedding and haunching for both PVC and Ductile Iron sewer and force mains when rock is encountered, over excavation occurs or subgrade stabilization is required. A minimum of 6" of granular crushed stone shall be used as bedding.
- D. Overwidth Excavation: If trenches are excavated to widths in excess of those specified or if trench walls collapse, pipe shall be laid in accordance with the requirements for at least the next better class of bedding at the expense of the Contractor.
- E. Borrow backfill: Borrow backfill will be required to backfill trenches if there is not sufficient, suitable material available from other parts of the work. Borrow backfill from approved borrow pits shall be used. Only those soils in the borrow pits that meet the specified requirements for suitable material shall be used.
- F. Compaction of foundation, bedding, haunching, and initial backfill shall extend to the trench wall.
- G. Embedment material in the area around the pipe shall be installed with care. Care shall be used to ensure that sufficient material has been worked under the haunch of the pipe to provide adequate side support. Precautions must be taken to prevent movement of the pipe during placing of the material through the pipe haunch.
- H. Avoid contact between the pipe and compaction equipment. Compaction of haunching, initial backfill, and backfill material shall be done in such a way so that compaction equipment will not have a damaging effect on the pipe.
- I. The trench depth shall be as shown on the plans or as required to provide minimum depth of cover as required by the pipe manufacturer.

3.7 BACKFILLING

- A. Backfilling consists of placing suitable materials, removed during the excavation, into the excavated areas, placing embedment materials and compacting the same to a density equal to or greater than what exists before excavation or as specified herein.
- B. All backfill material shall be free of stones, concrete and clay lumps larger than 5 inches in diameter. Roots, stumps and rubbish, which will decompose, will not be permitted in the backfill. Backfill material shall have its moisture content corrected, as may be necessary before

being placed in the trench, to bring the moisture content to approximately “optimum” for good compaction. Any rock, stone, concrete, clay lumps larger than 1/3 cubic foot in volume and rubbish and debris shall be removed from the site and disposed of by the Contractor in a lawful manner.

- C. Select backfill: Select backfill material shall be placed below, around each side, and over the top of the pipe in approximately horizontal layers no exceeding 6-inches in thickness to a minimum height of 6-inches above the pipe crown or greater as detailed herein and on the Drawings. This initial backfill shall be placed immediately after the pipes are laid and joints have been observed by the Engineer to anchor and protect the pipe from damage by subsequent backfill and ensure the uniform distribution of the loads over the top of the pipe. Select material shall include Class I, II, III, and other approved materials. If suitable select materials are not available for trench excavation, the Contractor will be required to obtain select materials elsewhere at no additional cost to the Owner. The Contractor shall backfill both sides of the pipe simultaneously to prevent side pressures and each layer shall be compacted thoroughly with mechanical tamping equipment in such a manner as to not damage the pipe, pipe joints or shift the pipe alignment. Workers shall not be allowed to walk over the pipe until at least 12 inches of compacted fill has been placed over the pipe. The Contractor shall not use water to obtain compaction except for adding water to the backfill material before placing in the trench to bring the moisture content to approximately “optimum” for good compaction.
- D. General Backfilling: After initial select backfill material has been placed and tamped, the remainder of the trench may be backfilled with general excavated material, except that no rock, unless in small shattered fragments, will be permitted to be mixed with other backfill material.
1. Backfilling Under Structures: Backfilling under and within 10 feet of the building line of any structure or proposed structure, consists of placing sand and gravel or other select suitable material excavated from the trench in the trench in 6 inch thick layers from a point 12 inches above the top of the pipe and mechanically tamped or compacted the entire depth by rolling until the backfill density after compaction is equal to 98 percent of the maximum density obtainable at optimum moisture content as determined by the Standard Proctor Test (ASTM D698) at $\pm 3\%$ of optimum moisture content. No water shall be used to secure compaction except to bring moisture content to approximately “optimum” for good compaction.
 2. Backfilling beneath road, walk, proposed improvement: Backfilling under roads, walks, etc., consists of placing sand and gravel or other select suitable material excavated from trench in uniform layers not exceeding six inches (6”) in thickness, with each layer thoroughly compacted with heavy duty mechanical tampers (“Whacker” or equal) to a height of at least thirty six inches (36”) or forty-eight inches (48”) above the top of the pipe barrel. The remainder of the ditch may be backfilled and tamped in the same manner or if the Contractor so selects, he may place backfill in layers not exceeding twelve inches (12”) and use wheel loading or heavy duty mechanical tamping equipment (“Hydra-Hammer or equal). Pipe shall have at least thirty-six inches (36”) of cover before wheel loading and at least forty-eight inches (48”) of cover before using heavy duty tamping equipment (“Hydra-hammer” or equal). The density of the backfilled material after full depth compaction shall be equal to 98% percent of the maximum density obtainable at optimum moisture content as determined by the Standard Proctor Test (ASTM D698) at $\pm 3\%$ of optimum moisture content.

3. Backfill in Road Right-of-Way: Shall be compacted the entire depth to a minimum of 95% of the maximum density as determined by the Standard Proctor Test (ASTM D698) at $\pm 3\%$ of optimum moisture content.
 4. Backfill in loose lifts not exceeding 6 inches when compacting using manual tamping devices (jumping jack).
 5. Backfill in loose lifts not exceeding 6 inches when compacting using vibrating/ramming devices (sheep-foot vibratory roller).
- E. Maintain optimum moisture content of fill materials to attain required compaction density.

3.8 PROTECTION OF WATER DISTRIBUTION SYSTEM PIPES

- A. Horizontal Separation: Sewer and force mains shall be laid at least 10- feet horizontally from any existing or proposed water main. The distance shall be measured edge to edge. In cases where it is not practical to maintain a 10 foot separation, such deviation may allow installation of the sewer or force main closer to the water main, provided that the water main is in a separate trench or on a undisturbed earth shelf located on the side of the sewer or force main and at an elevation so the bottom of the water main is at least 18 inches above the top of the sewer or force main.
- B. Crossings: Sewer and force mains crossing water mains shall be laid to provide a minimum vertical distance of 18 inches between the outside of the water main and the outside of the sewer or force main. This shall be the case where the water main is either above or below the sewer or force main. The crossing shall be arranged so that the sewer or force main joints will be equidistant and as far as possible from the water main joints. Where a water main crosses under a sewer or force main, adequate structural support shall be provide for the sewer or force main to prevent damage to the water main.
- C. Special Conditions: When it is impossible to obtain proper horizontal and vertical separation as stipulated above, the sewer or force main shall be designed and constructed equal to water pipe and shall be pressure tested to assure water tightness prior to backfilling.

3.9 UTILITY CONSTRUCTION IN OTHER EXCAVATION

- A. Where utilities are required to be constructed in areas also requiring excavation and backfill for other work, coordinate the work so that the parts come together properly and the construction of the various parts can be done without damage to other parts. Place bedding which will form bearing for pipes, using suitable material and shaping to the lower $\frac{1}{3}$ of the pipe to provide uniform and continuous bearing. Compaction of backfill material which will form bearing shall be structural backfill.

3.10 TESTING

- A. Moisture Density Tests: Testing shall be in accordance with ASTM Methods D698 and D1557. A test shall be performed on each type of material used in the work regardless of source. Tests will be accompanied by particle-size analyses of the soils tested (ASTM Methods D421 and

D422). Changes in color, gradation, plasticity, or source of fill material will require the performance of additional tests. Copies of all test results shall be furnished to the Engineer in duplicate.

B. Field Density Tests: Tests shall be made in accordance with ASTM Method D698 or D1556. Tests shall be made in accordance with the following minimum schedule or as required by the soils technician or as may be directed by the Engineer:

1. One test for each lift of backfill for each 300 feet of trench or fraction thereof.

C. Submittals

1. The soils technician will submit formal reports of all compaction tests and retests. The reports are to be furnished to the Owner and the Engineer in duplicate as soon as possible upon completion of the required tests.

2. The report information is to include but not be limited to the following:

a. Date of the test and date submitted.

b. Location of test.

c. Wet weight, moisture content, and dry weight of field sample.

d. Description of soil.

e. Maximum dry density and moisture content of the lab sample which best matched the field sample in color, texture, grain size, and maximum dry density.

f. Ratio of field dry density to maximum lab dry density passing expressed as a percentage.

g. Comments concerning the field density passing or failing the specified compaction.

h. Comments about re-compaction if required.

D. Compaction Results

1. If any compaction test reveals that fill or backfill is not compacted as specified, the Contractor shall remove and replace as required to achieve the specified density. Additional compaction tests shall be made to verify proper compaction. These additional tests, required due to failure of the original test, shall be paid for by the Contractor without reimbursement by the Owner.

2. The soils technician is to advise the Engineer and the Contractor's Superintendent immediately of any compaction tests failing to meet the minimum specified requirements. No additional lift is to be placed on a lift with any portion failing.

3.11 CONSTRUCTION ALONG HIGHWAYS, STREETS AND ROADWAYS

A. Excavation, Trenching and Backfilling Operations: Excavation, trenching and backfilling along highways, streets, and roadways shall be in accordance with the applicable regulations of the State Department of Transportation with reference to construction operations, safety, traffic control, road maintenance, and repair.

- B. Protection of Traffic: Provide suitable signs, barricades, and lights for protection of traffic, in location where traffic may be endangered by construction operations. All signs removed by reason of construction shall be replaced as soon as condition which necessitated such removal has been cleared. No highway, street, or roadway shall be closed without first obtaining permission from proper authorities.
- C. Construction Operations: The Contractor shall construct all work along highways, streets and roadways using the following sequence of construction operations, so as to least interfere with traffic.
 - 1. Stripping: Where pipe is laid along the road shoulders, sod, topsoil, and other material suitable for shoulder restoration shall be stripped and stockpiled for replacement.
 - 2. Trenching, Laying and Backfilling: Excavate trenches, install pipeline, and backfill. The trench shall not be opened any further ahead of pipe laying operations than is necessary for proper laying operations. Trenches shall be progressively backfilled and consolidated and excess material removed immediately.
 - 3. Shaping: Immediately after completing backfilling operation, reshape any damage to cut and fill slopes, side ditch lines and shall replace topsoil, sod and any other materials removed from the shoulders.
- D. Excavated Material: Excavated material shall not be placed along highways, streets, and roadways in such a manner as to obstruct traffic. Roadways and pavement will be maintained free of earth material and debris.
- E. Drainage Structures: All side ditches, culverts, cross drains and other drainage structures shall be kept clear of excavated material and be free to drain at all times.
- F. Maintaining Highways, Streets, Roadways and Driveways
 - 1. The Contractor shall furnish a road grader which shall be available for use at all times for maintaining highways, streets, and roadways. All such streets, highways, and roadways shall be maintained in suitable condition until completion and final acceptance of work.
 - 2. Repair all driveways that are cut or damaged. Maintain them in suitable condition until completion and final acceptance of work.

3.12 REMOVING AND RESETTING FENCES

- 1. Where existing fences must be removed to permit construction, the Contractor shall remove such fences. As construction progresses, reset the fences in their original location and to their original condition. All costs of removing and re-setting fences and such temporary works as may be required shall be included in the prices for the utility line.

3.13 PROTECTING TREES, SHRUBBERY AND LAWNS

- A. Trees and shrubbery along the trench lines shall not be disturbed unless absolutely necessary. Trees and shrubbery necessary to be removed shall be properly heeled-in and re-planted. Heeling-in and re-planting shall be done under the direction of an experienced nurseryman.
- B. Where utility trenches cross established lawns, sod shall be cut, removed, stacked, and maintained in suitable condition until replaced. Topsoil in underlying lawn areas shall likewise be removed and kept separate from general excavated materials. Removal and replacement of sod shall be done under the direction of an experienced nurseryman.

3.14 REMOVE AND REPLACE PAVEMENT

A. Remove and Replace Pavement

- 1. Pavement and base course which must be removed for constructing sewer lines and all other appurtenances in streets shall be replaced as specified on the plans and Contract Documents.
 - a. The paving base shoulder shall be carefully removed and kept separate from the rest of the excavated material.
 - b. Trenches required within the existing street shall be backfilled with crushed stone or gravel.
 - c. Work performed to recycle the paving base shall be considered as general clean up along with the removal of surplus excavated materials from the site and the restoring of the surface outside the trench limits to its original condition, the cost of which shall be included in the unit price bid for the utility line.
 - d. Further compaction shall be accomplished by leaving the backfilled trench open to traffic while maintaining the surface with crushed stone or gravel. Settlement in trenches shall be refilled with crushed stone or gravel, and such maintenance shall continue until replacement of pavement.
 - e. Upon completion of trench backfill and compaction the trench shall be capped with a minimum of 8 inches of Portland Cement Concrete, 3000 P.S.I., high early strength. See Construction Details.
 - f. A tack coat shall be applied to the concrete cap prior to placement of pavement. See Construction Details
 - g. A minimum of 1.5 inches of 9.5 mm pavement shall be placed over the tack coat. See Construction Details

3.15 WALKS, DRIVES, CONCRETE CURB AND GUTTER

- A. Walks and drives removed or damaged during the course of construction shall be replaced with 4,000 psi concrete at the same thickness as removed. They will be cut to a neat edge with a masonry saw after backfilling and compacting trench in 6 inch layers to a density not less than 98 percent at +2 percent of the optimum moisture content as determined by the Standard Proctor Test (T99).

- B. Concrete curb and gutter sections removed or damaged during the course of construction shall be replaced in full sections with concrete having compressive strength of at least 3,000 psi.

END OF SECTION 312316.13