

Section 02317

EXCAVATION AND BACKFILL FOR UTILITIES

PART 1 GENERAL

1.01 SUMMARY

This Section includes excavation, trenching, foundation, embedment, and backfill for installation of utilities, including manholes and other pipeline structures.

1.02 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. No additional payment will be made for trench excavation, embedment, and backfill under this Section. Include cost in unit price for installed underground piping, sewer, conduit, or duct work.
2. When Project Manager directs Contractor to overexcavate trench bottom, Contractor shall be paid by unit price bid per linear foot under bid item – 6-Inch Overexcavation of Trench Bottom.
 - a. No payment will be made if Project Manager does not direct Contractor to overexcavate trench bottom.
 - b. No overexcavation shall be measured or paid when unsuitable conditions result from dewatering system not in conformance with Section 01578 – “Control of Ground Water and Surface Water”.
3. No additional payment shall be made for performing Critical Location exploratory excavation. Include cost in unit price for installed underground piping, sewer, conduit, or duct work.
4. Refer to Section 01270 – “Measurement and Payment” for unit price procedures.

B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for Work in this Section is included in total Stipulated Price.

1.03 REFERENCES

- A. ASTM C12 – Standard Practice for Installing Vitrified Clay Pipe Lines.
- B. ASTM D558 – Standard Test Methods for Moisture-Density Relations of Soil Cement Mixtures.

- C. ASTM D698 – Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft).
 - D. ASTM D1556 – Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method.
 - E. ASTM D2321 – Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity Flow Applications.
 - F. ASTM D2487 – Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).
 - G. ASTM D6938 – Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
 - H. ASTM D4318 – Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
 - I. TxDOT Tex-101-E – Preparing Soil and Flexible Base Materials for Testing.
 - J. TxDOT Tex-110-E – Particle Size Analysis of Soils.
 - K. Federal Regulations, 29 CFR Part 1926, Standards-Excavation, Occupational Safety and Health Administration (OSHA).
 - L. ASTM C76 REV A – Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
- 1.04 SUBMITTALS
- A. Conform to requirements of Section 01330 – “Submittal Procedures”.
 - B. Submit proposed vacuum excavation method and qualifications of proposed subcontractor for approval by Project Manager.
 - C. Submit planned typical method of excavation, backfill placement, and compaction including:
 - 1. Trench widths.
 - 2. Procedures for foundation and pipe zone bedding placement, and trench backfill compaction.
 - 3. Procedures for assuring compaction against undisturbed soil when premanufactured trench safety systems are proposed.
 - D. Submit backfill material sources and product quality information in accordance with requirements of Section 02320 – “Utility Backfill Materials”.

- E. Submit trench excavation safety program in accordance with requirements of Section 02260 – “Trench Safety System”. Include designs for special shoring meeting requirements defined in Paragraph 1.08, Special Shoring Design Requirements contained herein.
- F. Submit record of location of utilities as installed, referenced to survey control points. Include locations of utilities encountered or rerouted. Give stations, horizontal dimensions, elevations, inverts, and gradients.
- G. Submit 11 inch by 17 inch copy of Plans with plotted utility or obstruction location titled “Critical Location Report” to Project Manager. The Critical Location Report shall be a prerequisite for the approval of any proposed lay schedules for water line projects utilizing the following pipe materials: Ductile Iron Pipe (Section 02501 – for pipelines 30” and larger), Prestressed Concrete Cylinder Pipe (Section 02507), Large Diameter Steel Pipe (Section 02518), or Bar Wrapped Steel Cylinder Pipe (Section 02613). See also paragraph 3.03, Critical Location investigation.

1.05 RELATED REQUIREMENTS

- A. Section 01270 – “Measurement and Payment”
- B. Section 01330 – “Submittal Procedures”
- C. Section 01454 – “Testing Laboratory Services”
- D. Section 01504 – “Temporary Facilities and Controls”
- E. Section 01555 – “Traffic Control and Regulation”
- F. Section 01562 – “Tree and Plant Protection”
- G. Section 01576 – “Waste Material Disposal”
- H. Section 01578 – “Control of Ground Water and Surface Water”
- I. Section 01725 – “Field Surveying”
- J. Section 02221 – “Removing Existing Pavements and Structures”
- K. Section 02260 – “Trench Safety System”
- L. Section 02320 – “Utility Backfill Materials”
- M. Section 02321 – “Cement Stabilized Sand”
- N. Section 02501 – “Ductile Iron Pipe and Fittings”
- O. Section 02506 – “Polyvinyl Chloride Pipe”

- P. Section 02507 – “Prestressed Concrete Cylinder Pipe”
- Q. Section 02518 – “Steel Pipe and Fittings for Large Diameter Water Lines”
- R. Section 02613 – “Bar Wrapped Steel Cylinder Pipe”
- S. Section 02621 – “Geotextile”
- T. Section 03315 – “Concrete for Utility Construction”
- U. Special Shoring Design Requirements

Have special shoring designed or selected by Contractor’s Professional Engineer to provide support for sides of excavations, including soils and hydrostatic ground water pressures as applicable, and to prevent ground movements affecting adjacent installations or improvements such as structures, pavements, and utilities. Special shoring may be a premanufactured system selected by Contractor’s Professional Engineer to meet project site requirements based on manufacturer’s standard design.

1.06 QUALITY ASSURANCE

- A. Tests
 - 1. Testing and analysis of backfill materials for soil classification and compaction during construction shall be performed by an independent laboratory provided by the Owner in accordance with requirements of Section 01454 – “Testing Laboratory Services” and as specified in this Section.
 - 2. Perform backfill material source qualification testing in accordance with requirements of Section 02320 – “Utility Backfill Materials”.

1.07 – 1.09 NOT USED

1.10 DEFINITIONS

- A. Pipe Foundation: Suitable and stable native soils that are exposed at trench subgrade after excavation to depth of bottom of bedding as shown on Plans, or foundation backfill material placed and compacted in over-excavations.
- B. Pipe Bedding: Portion of trench backfill that extends vertically from top of foundation up to level line at bottom of pipe, and horizontally from one trench sidewall to opposite sidewall.
- C. Haunching: Material placed on either side of pipe from top of bedding up to springline of pipe and horizontally from one trench sidewall to opposite sidewall.

- D. Initial Backfill: Portion of trench backfill that extends vertically from springline of pipe (top of haunching) up to level line 12 inches above top of pipe, and horizontally from one trench sidewall to opposite sidewall.
- E. Pipe Embedment: Portion of trench backfill that consists of bedding, haunching, and initial backfill.
- F. Trench Zone: Portion of trench backfill that extends vertically from top of pipe embedment up to pavement subgrade or up to final grade when not beneath pavement.
- G. Unsuitable Material: Unsuitable soil materials are the following:
 - 1. Materials that are classified as ML, CL–ML, MH, PT, OH, and OL according to ASTM D2487.
 - 2. Materials that cannot be compacted to required density due to either gradation, plasticity, or moisture content.
 - 3. Materials that contain large clods, aggregates, stones greater than 4 inches in any dimension, debris, vegetation, waste or any other deleterious materials.
 - 4. Materials that are contaminated with hydrocarbons or other chemical contaminants.
- H. Suitable Material: Suitable soil materials are those meeting specification requirements. Materials mixed with lime, fly ash, or cement that can be compacted to required density and meeting requirements for suitable materials may be considered suitable materials, unless otherwise indicated.
- I. Backfill: Suitable material meeting specified quality requirements, placed, and compacted under controlled conditions.
- J. Ground Water Control Systems: Installations external to trench, such as well points, eductors, or deep wells. Ground water control includes dewatering to lower ground water, intercepting seepage which would otherwise emerge from side or bottom of trench excavation, and depressurization to prevent failure or heaving of excavation bottom. Refer to Section 01578 – “Control of Ground Water and Surface Water”.
- K. Surface Water Control: Diversion and drainage of surface water runoff and rain water away from trench excavation. Rain water and surface water accidentally entering trench shall be controlled and removed as part of excavation drainage.
- L. Excavation Drainage: Removal of surface and seepage water in trench by sump pumping and using drainage layer, as defined in ASTM D2321, placed on foundation beneath pipe bedding or thickened bedding layer of Class I material.
- M. Trench Conditions are defined with regard to stability of trench bottom and trench walls of pipe embedment zone. Maintain trench conditions that provide for effective

placement and compaction of embedment material directly on or against undisturbed soils or foundation backfill, except where structural trench support is necessary.

1. **Dry Stable Trench:** Stable and substantially dry trench conditions exist in pipe embedment zone as result of typically dry soils or achieved by ground water control (dewatering or depressurization) for trenches extending below ground water level.
 2. **Stable Trench with Seepage:** Stable trench in which ground water seepage is controlled by excavation drainage.
 - a. **Stable Trench with Seepage in Clayey Soils:** Excavation drainage is provided in lieu of or to supplement ground water control systems to control seepage and provide stable trench subgrade in predominately clayey soils prior to bedding placement.
 - b. **Stable Wet Trench in Sandy Soils:** Excavation drainage is provided in embedment zone in combination with ground water control in predominately sandy or silty soils.
 3. **Unstable Trench:** Unstable trench conditions exist in pipe embedment zone if ground water inflow or high water content causes soil disturbances, such as sloughing, sliding, boiling, heaving, or loss of density.
- N. **Sub-trench:** Sub-trench is special case of benched excavation. Sub-trench excavation below trench shields or shoring installations may be used to allow placement and compaction of foundation or embedment materials directly against undisturbed soils. Depth of sub-trench depends upon trench stability and safety as determined by Contractor.
- O. **Trench Dam:** Placement of low permeability material in pipe embedment zone or foundation to prohibit ground water flow along trench.
- P. **Over-Excavation and Backfill:** Excavation of subgrade soils with unsatisfactory bearing capacity or composed of otherwise unsuitable materials below top of foundation as shown on Plans, and backfilled with foundation backfill material.
- Q. **Foundation Backfill Materials:** Natural soil or manufactured aggregate of controlled gradation, and geotextile filter fabrics as required, to control drainage and material separation. Foundation backfill material is placed and compacted as backfill to provide stable support for bedding. Foundation backfill materials may include concrete seal slabs.
- R. **Trench Safety Systems** include both protective systems and shoring systems as defined in Section 02260 – “Trench Safety Systems”.

- S. Trench Shield (Trench Box): Portable worker safety structure moved along trench as Work proceeds, used as protective system and designed to withstand forces imposed on it by cave-in, thereby protecting persons within trench. Trench shields may be stacked if so designed or placed in series depending on depth and length of excavation to be protected.
- T. Shoring System: Structure that supports sides of an excavation to maintain stable soil conditions and prevent cave-ins, or to prevent movement of ground affecting adjacent installations or improvements.
- U. Special Shoring: Shoring system meeting special shoring as specified in Paragraph 1.08, Special Shoring Design Requirements.
- V. Vacuum Excavation: An excavation technique performed by an experienced subcontractor in which water or air jets are used to slough off and vacuum away soil.

1.11 SEQUENCING (NOT USED)

1.12 SCHEDULING

Schedule Work so that pipe embedment can be completed on same day that acceptable foundation has been achieved for each section of pipe installation, manhole, or other structures.

1.13 WARRANTY (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURER(S) (NOT USED)

2.02 MATERIALS AND/OR EQUIPMENT

- A. Perform excavation with hydraulic excavator or other equipment suitable for achieving requirements of this Section.
- B. Use only hand-operated tamping equipment until minimum cover of 12 inches is obtained over pipes, conduits, and ducts. Do not use heavy compacting equipment until adequate cover is attained to prevent damage to pipes, conduits, or ducts.
- C. Use trench shields or other protective systems or shoring systems which are designed and operated to achieve placement and compaction of backfill directly against undisturbed native soil.
- D. Use special shoring systems where required which may consist of braced sheeting, braced soldier piles and lagging, slide rail systems, or other systems meeting requirements as specified in Paragraph 1.08, Special Shoring Design Requirements.

2.03 FABRICATION (NOT USED)

2.04 SOURCE QUALITY CONTROL

A. Material Classifications

1. Embedment and Trench Zone Backfill Materials: Conform to classifications and product descriptions of Section 02320 - "Utility Backfill Materials" and Section 02321 - "Cement Stabilized Sand".
2. Concrete Backfill: Conform to requirements for Class B concrete as specified in Section 03315 – "Concrete for Utility Construction".
3. Geotextile (Filter Fabric): Conform to requirements of Section 02621 – "Geotextile".
4. Concrete for Trench Dams: Concrete backfill or 3 sack premixed (bag) concrete.

PART 3 EXECUTION

3.01 GENERAL / MANUFACTURER(S) (NOT USED)

3.02 PREPARATION

- A. Establish traffic control to conform with requirements of Section 01555 – "Traffic Control and Regulation". Maintain barricades and warning lights for streets and intersections affected by Work, and are considered hazardous to traffic movements.
- B. Perform Work to conform with applicable safety standards and regulations. Employ trench safety system as specified in Section 02260 – "Trench Safety Systems".
- C. Immediately notify agency or company owning any existing utility line which is damaged, broken, or disturbed. Obtain approval from Project Manager and agency for any repairs or relocations, either temporary or permanent.
- D. Remove existing pavements and structures, including sidewalks and driveways, to conform with requirements of Section 02221 – "Removing Existing Pavements and Structures", as applicable.
- E. Install and operate necessary dewatering and surface water control measures to conform to Section 01578 – "Control of Ground Water and Surface Water". Provide stable trench to allow installation in accordance with Specifications.
- F. Maintain permanent benchmarks, monumentation, and other reference points. Unless otherwise directed in writing, replace those which are damaged or destroyed in accordance with Section 01725 – "Field Surveying".
- G. Limit concrete removal, pavement removal, and dewatering to less than five pipe laying days in advance of pipe laying.

3.03 ERECTION/INSTALLATION APPLICATION AND/OR CONSTRUCTION

A. Standard Practice

1. Install flexible pipe, including “semi-rigid” pipe, to conform to standard practice described in ASTM D2321, and as described in this Section. Where an apparent conflict occurs between standard practice and requirements of this Section, this Section governs.
2. Install rigid pipe to conform with standard practice described in ASTM C12 or C76 REV A as applicable, and as described in this Section. Where an apparent conflict occurs between standard practice and requirements of this Section, this Section governs.

B. Critical Location Investigation

1. The contractor shall properly locate and identify all critical locates shown on the Plans. Prior to manufacturing pipe of types and sizes listed in paragraph 1.06.G all critical locate activities shall be complete. The contractor shall confirm critical utilities using vacuum excavation or other suitable excavation method and provide a submittal to the Owner with their findings and proof of completion, in accordance with the requirements of paragraph 1.06. Field verify horizontal and vertical locations of such lines within a zone of 2 feet vertically above and below, and 4 feet horizontally on each side of proposed Work. Exclude water jetting at PCCP water lines. Survey vertical and horizontal locations of obstructions relative to project baseline and datum and plot on 11 inch by 17 inch copy of Plans. In addition, include horizontal and vertical alignment dimensions for connections to existing lines, tied into project baseline. Use extreme caution and care when uncovering utilities designated by Critical Locate.
2. Notify involved utility companies of date and time that investigation excavation shall occur and request that their respective utility lines be marked in field. Comply with utility or pipeline company requirements that their representative be present during excavation. Provide Project Manager with 48 hours’ notice prior to field excavation or related Work.

C. Existing Utility Investigation

1. Horizontal and vertical location of various underground lines shown on Plans, including but not limited to water lines, gas lines, storm sewers, sanitary sewers, telecommunication lines, electric lines or power ducts, pipelines, concrete and debris, are based on best information available but are only approximate locations.
2. The Contractor shall verify location of existing utilities in proximity to the water line corridor. Verify location of existing utilities a minimum of 7

working days in advance of pipe laying activities based on daily pipe laying rate or prior to beginning installation of auger pit or tunnel shaft. Notify Project Manager in writing immediately upon identification of obstruction.

3. In event of failure to identify obstruction a minimum of 7 days in advance of pipe laying, Contractor shall not be entitled to extra cost for downtime including, but not limited to, payroll, equipment, overhead, demobilization and remobilization, until 7 days has passed from time Project Manager is notified of obstruction.
4. Notify involved utility companies of date and time that investigation excavation shall occur and request that their respective utility lines be marked in field. Comply with utility or pipeline company requirements that their representative be present during excavation. Provide Project Manager with 48 hours' notice prior to field excavation or related Work.

D. Excavation

1. Except as otherwise specified or shown on Plans, install underground utilities in open cut trenches with vertical sides.
2. Perform excavation Work so that pipe, conduit, and ducts can be installed to depths and alignments shown on Plans. Avoid disturbing surrounding ground and existing facilities and improvements.
3. Trench excavation widths shall meet the following requirements:
 - a. Minimum Allowable Trench Width: O.D. + 36 inches.
 - b. Maximum Allowable Trench Width: O.D. + 48 inches.

Excavate trench so that pipe is centered in trench. Do not obstruct sight distance for vehicles utilizing roadway or detours with stockpiled materials.

4. Use sufficient trench width or benches above embedment zone for installation of well point headers or manifolds and pumps where depth of trench makes it uneconomical or impractical to pump from surface elevation. Provide sufficient space between shoring cross braces to permit equipment operations and handling of forms, pipe, embedment, and backfill, and other materials.
5. Upon discovery of unknown utilities, badly deteriorated utilities not designated for removal, or concealed conditions, discontinue Work at that location. Notify Project Manager and obtain instructions before proceeding.

6. Shoring of Trench Walls.
 - a. Install Special Shoring in advance of trench excavation or simultaneously with trench excavation, so that soils within full height of trench excavation walls shall remain laterally supported at all times.
 - b. For all types of shoring, support trench walls in pipe embedment zone throughout installation. Provide trench wall supports sufficiently tight to prevent washing trench wall soil out from behind trench wall support.
 - c. Leave sheeting driven into or below pipe embedment zone in place to preclude loss of support of foundation and embedment materials, unless otherwise directed by Project Manager. Leave rangers, walers, and braces in place as long as required to support sheeting, which has been cut off, and trench wall in vicinity of pipe zone.
 - d. Employ special methods for maintaining integrity of embedment or foundation material. Before moving supports, place and compact embedment to sufficient depths to provide protection of pipe and stability of trench walls. As supports are moved, finish placing and compacting embedment.
 - e. If sheeting or other shoring is used below top of pipe embedment zone, do not disturb pipe foundation and embedment materials by subsequent removal. Maximum thickness of removable sheeting extending into embedment zone shall be equivalent of 1-inch-thick steel plate. As sheeting is removed, fill in voids left with grouting material.

7. Use of Trench Shields. When trench shield (trench box) is used as worker safety device, the following requirements apply:
 - a. Make trench excavations of sufficient width to allow shield to be lifted or pulled freely, without damage to trench sidewalls.
 - b. Move trench shields so that pipe, and backfill materials, after placement and compaction, are not damaged nor disturbed, nor degree of compaction reduced. Recompact after shield is moved if soil is disturbed.
 - c. When required, place, spread, and compact pipe foundation and bedding materials beneath shield. For backfill above bedding, lift shield as each layer of backfill is placed and spread. Place and compact backfill materials against undisturbed trench walls and foundation.
 - d. Maintain trench shield in position to allow sampling and testing to be performed in safe manner.

- e. Conform to applicable Government regulations.
8. Voids under paving area outside shield caused by Contractor's Work shall require removal of pavement, consolidation and replacement of pavement in accordance with Contract Documents. Repair damage resulting from failure to provide adequate supports.
9. Place sand or soil behind shoring or trench shield to prevent soil outside shoring from collapsing and causing voids under pavement. Immediately pack suitable material in outside voids following excavation to avoid caving of trench walls.
10. Coordinate excavation within 15 feet of pipeline with Company's representative. Support pipeline with methods agreed to by Pipeline Company's representative. Use small, rubber-tired excavator, such as backhoe, to do exploratory excavation. Bucket that is used to dig in close proximity to pipelines shall not have teeth or shall have guard installed over teeth to approximate bucket without teeth. Excavate by hand within 1 foot of Pipeline Company's line. Do not use larger excavation equipment than normally used to dig trench in vicinity of pipeline until pipelines have been uncovered and fully exposed. Do not place large excavation and hauling equipment directly over pipelines unless approved by Pipeline Company's representative.
11. When, during excavation to uncover Pipeline Company's pipelines, screwed collar or an oxyacetylene weld is exposed, immediately notify Project Manager. Provide supports for collar or welds. Discuss with Pipeline Company's representative and determine methods of supporting collar or weld during excavation and later backfilling operations. When collar is exposed, request Pipeline Company to provide welder in a timely manner to weld ends of collar prior to backfilling of excavation.

E. Handling Excavated Materials

1. Use only excavated materials which are suitable as defined in this Section and conforming with Section 02320 – "Utility Backfill Materials". Place material suitable for backfilling in stockpiles at distance from trench to prevent slides or cave-ins.
2. When required, provide additional backfill material conforming to requirements of Section 02320 – "Utility Backfill Materials".
3. Do not place stockpiles of excess excavated materials on streets or adjacent properties. Protect excess stockpiles for use on site. Maintain site conditions in accordance with Section 01504 – "Temporary Facilities and Controls". Excavate trench so that pipe is centered in trench. Do not obstruct sight distance for vehicles utilizing roadway or detours with stockpiled materials.

F. Trench Foundation

1. Excavate bottom of trench to uniform grade to achieve stable trench conditions and satisfactory compaction of foundation or bedding materials.
2. When wet soil is encountered on trench bottom and dewatering system is not required, overexcavate an additional 6 inches with approval by Project Manager. Place nonwoven geotextile fabric and then compact 12 inches of crushed stone in one lift on top of fabric. Compact crushed stone with four passes of vibratory-type compaction equipment.
3. Perform over excavation, when directed by Project Manager, in accordance with Paragraph 3.07B above.
 - a. Even though Contractor has not determined material to be unsuitable, or
 - b. If unstable trench bottom is encountered and an adequate ground water control system is installed and operating according to Section 01578 – Control of Ground Water and Surface Water.
4. Place trench dams in Class I foundations in line segments longer than 100 feet between manholes and not less than one in every 500 feet of pipe placed. Install additional dams as needed to achieve workable construction conditions. Do not place trench dams closer than 5 feet from manholes.

G. Pipe Embedment, Placement, and Compaction

1. Remove loose, sloughing, caving, or otherwise unsuitable soil from bottoms and sidewalls of trenches immediately prior to placement of embedment materials.
2. Place embedment including bedding, haunching, and initial backfill as shown on Plans.
3. For pipe installation, manually spread embedment materials around pipe to provide uniform bearing and side support when compacted. Protect flexible pipe from damage during placing of pipe zone bedding material. Perform placement and compaction directly against undisturbed soils in trench sidewalls, or against sheeting which is to remain in place.
4. Do not place trench shields or shoring within height of embedment zone unless means to maintain density of compacted embedment material are used. If moveable supports are used in embedment zone, lift supports incrementally to allow placement and compaction of material against undisturbed soil.

5. Place geotextile to prevent particle migration from in-situ soil into open-graded (Class I) embedment materials or drainage layers.
6. Do not damage coatings or wrappings of pipes during backfilling and compacting operations. When embedding coated or wrapped pipes, do not use crushed stone or other sharp, angular aggregates.
7. Place haunching material manually around pipe and compact it to provide uniform bearing and side support. If necessary, hold small-diameter or lightweight pipe in place during compaction of haunch areas and placement beside pipe with sand bags or other suitable means.
8. Place electrical conduit, if used, directly on foundation without bedding.
9. Shovel in-place and compact embedment material using pneumatic tampers in restricted areas, and vibratory-plate compactors or engine-powered jumping jacks in unrestricted areas. Compact each lift before proceeding with placement of next lift. Water tamping is not allowed.
10. For water lines construction embedment, use bank run sand or concrete sand as specified in Section 02320 – “Utility Backfill Material”. Adhere to the following subparagraph numbers a and b.
 - a. Class I, II, and III Embedment Materials:
 - 1) Maximum 6 inch compacted lift thickness.
 - 2) Compact to achieve minimum of 95 percent of maximum dry density as determined according to ASTM D698.
 - 3) Moisture content to be within –3 percent to +5 percent of optimum as determined according to ASTM D698, unless otherwise approved by Project Manager.
 - b. Cement Stabilized Sand (where required for special installations):
 - 1) Maximum 6 inch compacted thickness.
 - 2) Compact to achieve minimum of 95 percent of maximum dry density as determined according to ASTM D698.
 - 3) Moisture content to be on dry side of optimum as determined according to ASTM D698 but sufficient for effective hydration.
11. For storm sewers and sanitary sewers other than force mains, provide cement stabilized sand per subparagraph b below. For Sanitary Sewer force mains adhere to the following subparagraph numbers a and b, and the embedment requirements shown on the Plans. Embedment materials for storm sewers and

sanitary sewers including force mains shall meet the requirements of Section 02320 – “Utility Backfill Material”.

- a. Class I Embedment Materials.
 - 1) Maximum 6 inch compacted lift thickness.
 - 2) Systematic compaction by at least two passes of vibrating equipment. Increase compaction effort as necessary to effectively embed pipe to meet deflection test criteria.
 - 3) Moisture content as determined by Contractor for effective compaction without softening soil of trench bottom, foundation, or trench walls.
 - b. Class II Embedment and Cement Stabilized Sand.
 - 1) Maximum 6 inch compacted thickness.
 - 2) Compaction by methods determined by Contractor to achieve minimum of 95 percent of maximum dry density as determined according to ASTM D698 for Class II materials and according to ASTM D558 for cement stabilized materials.
 - 3) Moisture content of Class II materials within 3 percent of optimum as determined according to ASTM D698. Moisture content of cement stabilized sands on dry side of optimum as determined according to ASTM D558 but sufficient for effective hydration.
12. Place trench dams in Class I embedment in line segments longer than 100 feet between manholes, and not less than one in every 500 feet of pipe placed. Install additional dams as needed to achieve workable construction conditions. Do not place trench dams closer than 5 feet from manholes.

H. Trench Zone Backfill Placement and Compaction

1. Place backfill for pipe or conduits and restore surface as soon as practicable. Leave only minimum length of trench open as necessary for construction.
2. For water lines, under pavement and to within one foot back of curb, use backfill materials described by trench limits.
 - a. For water lines 20 inches in diameter and smaller, use bank run sand or select backfill materials up to pavement base or subgrade.
 - b. For water lines 24 inches in diameter and larger, backfill with suitable on-site material up to 12 inches below pavement base or subgrade.

- Place minimum of 12 inches of select backfill below pavement base or subgrade.
3. For sewer pipes under pavement and to within one foot back of curb, use backfill materials described by trench limits.
 - a. For sewer pipes 36 inches in diameter and smaller use cement stabilized sand up to pavement base or subgrade.
 - b. For sewer pipes 42 inches in diameter and larger, backfill with suitable on-site material or select backfill up to 12 inches below pavement base or subgrade. Place minimum of 12 inches of select backfill below pavement base or subgrade.
 4. Where damage to completed pipe installation Work is likely to result from withdrawal of sheeting, leave sheeting in place. Cut off sheeting 1.5 feet or more above crown of pipe. Remove trench supports within 5 feet from ground surface.
 5. If unsuitable materials are discovered notify Engineer, remove unsuitable material from the site, and backfill with suitable material.
 6. Unless otherwise shown on Plans. Use one of the following trench zone backfills under pavement and to within one foot of edge of pavement. Place trench zone backfill in lifts and compact. Fully compact each lift before placement of next lift.
 - a. Class I, II, or III or combination thereof:
 - 1) Place in maximum 12-inch thick loose layers.
 - 2) Compact by vibratory equipment to minimum of 95 percent of maximum dry density determined according to ASTM D698.
 - 3) Moisture content within zero percent to +5 percent of optimum determined according to ASTM D698, unless otherwise approved by Project Manager.
 - b. Cement-Stabilized Sand:
 - 1) Maximum lift thickness determined by Contractor to achieve uniform placement and required compaction, but do not exceed 12 inches.
 - 2) Compact by vibratory equipment to minimum of 95 percent of maximum dry density determined according to ASTM D538.

- 3) Moisture content on dry side of optimum determined according to ASTM D558 but sufficient for cement hydration.
 - c. Class IVA and IVB (Clay Soils):
 - 1) Place in maximum 8-inch thick loose lifts.
 - 2) Compact by vibratory Sheepfoot Roller to minimum of 95 percent of maximum dry density determined according to ASTM D698.
 - 3) Moisture content within zero percent to +5 percent above optimum determined according to ASTM D698, unless approved by Project Manager.
7. Unless otherwise shown on Plans, for trench excavations not under pavement, backfill of suitable material may be used in trench zone.
 - a. Class IVA and IVB (Clay Soils) may be used as trench zone backfill outside paved areas at Contractor's option. When required density is not achieved, at no additional cost to the Owner, rework, dry out, use lime stabilization or other approved methods to achieve compaction requirements or use different suitable material.
 - b. Maximum 9-inch compacted lift thickness for clayey soils and maximum 12-inch lift thickness for granular soils.
 - c. Compaction by appropriate equipment to minimum of 95 percent of maximum dry density determined according to ASTM D698.
 - d. Moisture content as necessary to achieve density.
8. For electric conduits, remove form work used for construction of conduits before placing trench zone backfill.
9. Buried warning and identification tape for non-metallic pipe.

Polyethylene plastic and metallic core or metallic-faced, acid- and alkali-resistant, polyethylene plastic warning tape manufactured specifically for warning and identification of buried utility lines. Provide tape on rolls, 4 inch minimum width, blue color for water line with warning and identification imprinted in bold black letters continuously over the entire tape length. Warning and identification to read, "CAUTION, BURIED WATER LINE BELOW" or similar wording. Color and printing shall be permanent, unaffected by moisture or soil. Warning and identification tape shall be centered above water main and buried 36-inches below finished grade.

10. Tracer wire for non-metallic pipe: provide trace wire and test stations as shown on plans and per Section 02506 Polyvinyl Chloride (PVC) Pipe. Tracer wire shall be AWG #8 solid strung soft drawn copper insulated with high molecular weight HDPE, suitable for direct bury application.

I. Manholes, Junction Boxes, and Other Pipeline Structures

Encapsulate manhole, junction box and other pipeline structures with cement stabilized sand; minimum of 1 foot below base, minimum 1 foot around walls, up to within 12 inches of pavement subgrade or finished grade. Compact in accordance with Paragraph 3.09.F.2 of this Section.

J. Disposal of Excess Material

Dispose of excess materials in accordance with requirements of Section 01576 – “Waste Material Disposal”.

3.04 REPAIR/RESTORATION (NOT USED)

3.05 FIELD QUALITY CONTROL

- A. Test for material source qualifications as defined in Section 02320 – “Utility Backfill Materials”.
- B. Provide excavation and trench safety systems at locations and to depths required for testing and retesting during construction at no additional cost.
- C. Tests shall be performed on minimum of three different samples of each material type for plasticity characteristics, in accordance with ASTM D4318, and for gradation characteristics, in accordance with Tex-101-E and Tex-110-E. Additional classification tests shall be performed whenever there is noticeable change in material gradation or plasticity, or when requested by Project Manager.
- D. At least three tests for moisture-density relationships shall be performed initially for backfill materials in accordance with ASTM D698, and for cement-stabilized sand in accordance with ASTM D558. Perform additional moisture-density relationship tests once a month or whenever there is noticeable change in material gradation or plasticity.
- E. In-place density tests of compacted pipe foundation, embedment and trench zone backfill soil materials shall be performed according to ASTM D1556, or ASTM D6938, and at following frequencies and conditions.
 1. For open cut construction projects: Unless otherwise approved by Project Manager, successful compaction to be measured by one test per 40 linear feet measured along pipe for compacted embedment and two tests per 40 linear feet measured along pipe for compacted trench zone backfill material.

2. For construction within auger pits: Unless otherwise approved by Project Manager, successful compaction to be measure by one test per 40 linear feet measured along pipe for compacted embedment zone (minimum one test per auger pit) and two tests per 40 linear feet measured along pipe for compaction of trench zone backfill material (minimum two test per auger pit).
 3. A minimum of three density tests for each full shift of Work.
 4. Density tests shall be distributed among placement areas. Placement areas are: foundation, bedding, haunching, initial backfill, and trench zone.
 5. The number of tests shall be increased if inspection determines that soil type or moisture content are not uniform or if compacting effort is variable and not considered sufficient to attain uniform density, as specified.
 6. Density tests may be performed at various depths below fill surface by pit excavation. Material in previously placed lifts may therefore be subject to acceptance/rejection.
 7. Two verification tests shall be performed adjacent to in-place tests showing density less than acceptance criteria. Placement shall be rejected unless both verification tests show acceptable results.
 8. Recompact placement shall be retested at same frequency as first test series, including verification tests.
 9. Identify elevation of test with respect to natural ground or pavement.
- F. Recondition, recompact, and retest at Contractor's expense if tests indicate Work does not meet specified compaction requirements. For hardened soil cement with nonconforming density, core and test for compressive strength at Contractor's expense.
- G. Acceptability of crushed rock compaction shall be determined by inspection.

3.06 – 3.08 NOT USED

3.09 PROTECTION

- A. Protect trees, shrubs, lawns, existing structures, and other permanent objects outside of grading limits and within grading limits as designated on Plans, and in accordance with requirements of Section 01562 – “Tree and Plant Protection”.
- B. Protect and support above-grade and below-grade utilities which are to remain.
- C. Restore damaged permanent facilities to pre-construction conditions unless replacement or abandonment of facilities is indicated on Plans.

- D. Take measures to minimize erosion of trenches. Do not allow water to pond in trenches. Where slides, washouts, settlements, or areas with loss of density or pavement failures or potholes occur, repair, recompact, and pave those areas at no additional cost.

3.10 SCHEDULES (NOT USED)

END OF SECTION