

**SECTION 02125  
EXCAVATION AND BACKFILL FOR UTILITIES**

**PART I: GENERAL**

**1.1 GENERAL REQUIREMENTS**

- A. Excavation, trenching, foundation, embedment and backfill for installation of utilities, including manholes and other related structures.

**1.2 MEASUREMENT AND PAYMENT**

A. Unit Prices:

1. No separate 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 the Project Manager directs the Contractor to over-excavate trench bottom, the Contractor shall be paid by the unit price bid per linear foot under Bid Item – Six inches (6 In) over-excavation of Trench Bottom.
  - a. No payment shall be paid if the Project Manager does not direct the Contractor to over-excavate trench bottom.
  - b. No over excavation shall be measured or paid when unsuitable conditions result from dewatering system not in conformance with Section 01585 – Control of Ground and Surface Water.
3. No separate payment shall be made for performing Critical Location exploratory excavation. Include cost in the unit price for work requiring critical location.
4. Refer to Section 01270 – Measurement and Payment for unit price procedures.

B. Stipulated Price (Lump Sum):

1. If Contract is Stipulated Price Contract, payment for Work in this Section shall be included in Total Stipulated Price.

**1.3 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 the Drawings 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 (1) 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 (1) 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 twelve inches (12 In) above top of pipe and horizontally from one (1) 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 gradation, plasticity or moisture content.
  - 3. Materials that contain large clods, aggregates, stones greater than two inches (2 In) 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 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 01585 – Control of Ground 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 Clay 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.
  - N. 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.
  - O. 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.
  - P. Trench Dam: Placement of low permeability material in pipe embedment zone or foundation to prohibit ground water flow along trench.
  - Q. 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 the Drawings and backfilled with foundation backfill material.
  - R. 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.
  - S. Trench Safety Systems include both protective systems and shoring systems as defined in Section 02280 – Trench Safety Systems.
  - T. 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.
  - U. 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.
  - V. Special Shoring: Shoring system meeting special shoring as specified in

Paragraph 1.8, Special Shoring Design Requirements, for locations identified on the Drawings.

#### 1.4 REFERENCES

- A. ASTM – American Society for Testing and Materials.
  - 1. ASTM C12 – Standard Practice for Installing Vitrified Clay Pipe Lines.
  - 2. ASTM D558 – Standard Test Methods for Moisture-Density Relations of Soil Cement Mixtures.
  - 3. ASTM D698 – Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft).
  - 4. ASTM D1556 – Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method.
  - 5. ASTM D2321 – Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity Flow Applications.
  - 6. ASTM D2487 – Standard Classification of Soils for Engineering Purposes.
  - 7. ASTM D2922 – Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
  - 8. ASTM D3017 – Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
  - 9. ASTM D4318 – Standard Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils.
- B. CFTS – City of Friendswood Technical Specifications.
- C. OSHA – Occupational Safety and Health Administration.
  - 1. Federal Regulations, 29 CFR Part 1926, Standards-Excavation, Occupational Safety and Health Administration (OSHA).
- D. TxDOT – Texas Department of Transportation.
  - 1. TxDOT Tex-101-E – Preparing Soil and Flexible Base Materials for Testing.
  - 2. TxDOT Tex-110-E – Particle Size Analysis of Soils.

#### 1.5 SCHEDULING

- A. 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 related structures.

#### 1.6 SUBMITTALS

- A. Conform to requirements of Section 01330 – Submittal Procedures.
- B. 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 pre-manufactured trench safety systems are proposed.

- C. Submit backfill material sources and product quality information in accordance with requirements of Section 02140 – Utility Backfill Materials.
- D. Submit trench excavation safety program in accordance with requirements of Section 02280 – Trench Safety Systems. Include designs for special shoring meeting requirements defined in Paragraph 1.8, Special Shoring Design Requirements contained herein.
- E. 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.
- F. Submit eleven inch by seventeen inch (11 In x 17 In) copy of the Drawing with plotted utility or obstruction location titled "Critical Location Report" to the Project Manager.

#### 1.7 TESTING

- A. Testing and analysis of backfill materials for soil classification and compaction during construction shall be performed by an independent laboratory in accordance with requirements of Sections 01470 – Testing Laboratory Services and 01475 – Quality Control Testing Procedures and as specified in this Section.
- B. Perform backfill material source qualification testing in accordance with requirements of Section 02140 – Utility Backfill Materials.

#### 1.8 SPECIAL SHORING DESIGN REQUIREMENTS

- A. Have special shoring designed or selected by the 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 the Contractor's Professional Engineer licensed by the State of Texas to meet project site requirements based on manufacturer's standard design.

### PART II: PRODUCTS

#### 2.1 EQUIPMENT

- A. Perform excavation with hydraulic excavator or other equipment suitable for achieving requirements of this Section.
- B. Use only hand-operated pneumatic or hydraulic tamping equipment until minimum cover of twelve inches (12 In) 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 1.8, Special Shoring Design Requirements.

## 2.2 MATERIAL CLASSIFICATIONS

- A. Embedment and Trench Zone Backfill Materials: Conform to classifications and product descriptions of Section 02140 – Utility Backfill Materials.
- B. Concrete Backfill: Conform to requirements for Class A concrete as specified in Section 03300 – Structural Concrete.
- C. Geotextile (Filter Fabric): Conform to requirements of Section 02015 – Geotextile.
- D. Concrete for Trench Dams: Concrete backfill or three (3) sack premixed (bag) concrete.
- E. Timber Shoring Left in Place: Untreated oak.

## PART III: EXECUTION

### 3.1 STANDARD PRACTICE

- A. 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.
- B. Install rigid pipe to conform to standard practice described in ASTM C12 and as described in this Section. Where an apparent conflict occurs between standard practice and requirements of this Section, this Section governs.
- C. Classification of material will be determined by the Project Manager.

### 3.2 PREPARATION

- A. Establish traffic control to conform to requirements of Section 01555 – Traffic Control and Regulation. Maintain barricades and warning lights for streets and intersections affected by the Work and are considered hazardous to traffic movements.
- B. Perform work to conform to applicable safety standards and regulations. Employ trench safety system as specified in Section 02280 – Trench Safety Systems.
- C. Immediately notify agency or company owning any existing utility line which is damaged, broken or disturbed. Obtain approval from the 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 to requirements of Section 02105 – Removing

Existing Pavements and Structures, as applicable.

- E. Install and operate necessary dewatering and surface-water control measures to conform to Section 01585 – Control of Ground and Surface Water. Provide stable trench to allow installation in accordance with the Technical 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.

### 3.3 CRITICAL LOCATION INVESTIGATION

- A. Horizontal and vertical location of various underground lines shown on the Drawings, 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. **At Critical Locations shown on the Drawings, field verify horizontal and vertical locations of such lines within zone two feet (2 Ft) vertically and four feet (4 Ft) horizontally of the proposed work.**

- 1. Verify location of existing utilities a minimum of seven working days (7 wD) in advance of pipe laying activities based on daily pipe laying rate. Use extreme caution and care when uncovering these lines.
- 2. Notify the Project Manager in writing immediately upon identification of obstruction. In event of failure to identify obstruction a minimum of seven days (7 D) in advance, the Contractor shall not be entitled to extra cost for downtime including, but not limited to, payroll, equipment, overhead, demobilization and remobilization, until seven days (7 D) has passed from the time the Project Manager is notified of obstruction.
- 3. **Verify all locations where there is specified to be a tie-in into existing utilities or infrastructure before the start of excavation, so as to verify all grades and locations.** Failure to do so shall result in the replacement of the installed work at the Contractor's cost for any work installed before finding an error in elevations or locations.

- B. Notify involved utility companies of date and time that excavation will 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 the Project Manager with at least forty-eight hours (48 Hrs) notice prior to excavation or related work.
- C. Survey vertical and horizontal locations of obstructions relative to project baseline and datum and plot results on eleven inch by seventeen inch (11 In x 17 In) copy of the Drawings. For large diameter water lines,

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submit to the Project Manager for approval, with horizontal and vertical alignment dimensions for connections to existing lines tied into project baseline, and signed and sealed by Registered Professional Land Surveyor (R.P.L.S.) licensed by the State of Texas.

### 3.4 PROTECTION

- A. Protect trees, shrubs, lawns, existing structures and other permanent objects outside of grading limits and within grading limits as designated on Drawings and in accordance with requirements of Section 01560 – 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 the Drawings.
- 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 to the City.

### 3.5 EXCAVATION

- A. Except as otherwise specified or shown on the Drawings, install underground utilities in open cut trenches with vertical sides.
- B. Perform excavation work so that pipe, conduit and ducts can be installed to depths and alignments shown on the Drawings. Avoid disturbing surrounding ground and existing facilities and improvements.
- C. Determine trench excavation widths using TABLE 4.1 – TRENCH EXCAVATION WIDTHS as related to pipe outside diameter (O.D.), in this Section.
- D. 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.
- E. Upon discovery of unknown utilities, badly deteriorated utilities, utilities not designated for removal or concealed conditions, discontinue work at that location. Notify the Project Manager and obtain instructions before proceeding.
- F. Shoring of Trench Walls.
  - 1. Install Special Shoring in advance of trench excavation or simultaneously with trench excavation, so that soils within full height of trench excavation walls will remain laterally supported at all times.
  - 2. 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.
- 3. 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 the 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.
- 4. 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.
- 5. 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 one inch (1 In) thick steel plate. As sheeting is removed, fill in voids left with grouting material.
- G. Use of Trench Shields: When trench shield (trench box) is used as worker safety device, the following requirements apply:
  - 1. Make trench excavations of sufficient width to allow shield to be lifted or pulled freely, without damage to trench sidewalls.
  - 2. Move trench shields so that pipe and backfill materials, after placement and compaction, are not damaged nor disturbed, nor degree of compaction reduced. Re-compact after shield is moved if soil is disturbed.
  - 3. 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.
  - 4. Maintain trench shield in position to allow sampling and testing to be performed in safe manner.
  - 5. Conform to applicable Government regulations.
- H. Voids under paving area outside shield caused by the Contractor's work will require removal of pavement, consolidation and replacement of pavement in accordance with the Contract Documents. Repair damage resulting from failure to provide adequate supports.
- I. 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.
- J. Coordinate excavation within fifteen feet (15 Ft) of any products pipeline with company's representative. Support pipeline with methods agreed to by the Pipeline Company's representative. Use small, rubber tired

excavator such as a 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 one foot (1 Ft) of the pipeline. 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 the Pipeline Company's representative.

- K. When, during excavation to uncover pipelines, a screwed collar or an oxyacetylene weld is exposed, immediately notify the Project Manager. Provide supports for collar or welds. Discuss with the Pipeline Company's representative and determine methods of supporting collar or weld during excavation and later backfilling operations. When collar is exposed, request the Pipeline Company to provide welder in a timely manner to weld ends of collar prior to backfilling of excavation.

**3.6 HANDLING EXCAVATED MATERIALS**

- A. Use only excavated materials, which are suitable as defined in this Section and conforming to Section 02140 – Utility Backfill Materials. Place material suitable for backfilling in stockpiles at distance from trench to prevent slides or cave-ins.
- B. When required, provide additional backfill material conforming to requirements of Section 02140 – Utility Backfill Materials.
- C. Do not place stockpiles of excess excavated materials on streets and adjacent properties. Protect backfill material to be used on site. Maintain site conditions in accordance with Section 01505 – 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.

**3.7 TRENCH FOUNDATION**

- A. Excavate bottom of trench to uniform grade to achieve stable trench conditions and satisfactory compaction of foundation or bedding materials.
- B. When wet soil is encountered on trench bottom and dewatering system is not required, over excavate an additional six inches (6 In) with approval by the Project Manager. Place non-woven geotextile fabric and then compact twelve inches (12 In) of crushed stone in one lift on top of fabric. Compact crushed stone with four (4) passes of vibratory-type compaction equipment.
- C. Perform over-excavation, if directed by the Project Manager, in accordance with Paragraph 3.7.B above. Removal of unstable or unsuitable material may be required if approved by the Project Manager;
  - 1. Even though the Contractor has not determined material to be unsuitable or;
  - 2. If unstable trench bottom is encountered and an adequate

ground water control system is installed and operating according to Section 01585 – Control of Ground and Surface Water.

- D. Place trench dams in Class I foundations in line segments longer than one hundred feet (100 Ft) between manholes and not less than one (1) in every five hundred feet (500 Ft) of pipe placed. Install additional dams as needed to achieve workable construction conditions. Do not place trench dams closer than five feet (5 Ft) from manholes.

**3.8 PIPE EMBEDMENT, PLACEMENT AND COMPACTION**

- A. Remove loose, sloughing, caving or otherwise unsuitable soil from bottoms and sidewalls of trenches immediately prior to placement of embedment materials.
- B. Place embedment including bedding, haunching and initial backfill as shown on the Drawings.
- C. 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.
- D. 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.
- E. Place geotextile to prevent particle migration from in-situ soil into open-graded (Class I) embedment materials or drainage layers.
- F. 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.
- G. 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.
- H. Place electrical conduit, if used, directly on foundation without bedding.
- I. Shovel in-place and compact embedment material using pneumatic or hydraulic 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 or jetting shall not allowed.
- J. For water lines construction embedment, use bank run sand concrete sand gem sand pea gravel or crushed limestone as specified in Section 02140 – Utility Backfill Material. For water lines adhere to the following subparagraph numbers 1 and 2; for utility installation other than water, adhere to numbers 3 and 4 below:

- 1. Class I, II and III Embedment Materials:
  - a. Maximum six inches (6 In) compacted lift thickness.

- b. Compact to achieve minimum of ninety-five percent (95%) of maximum dry density as determined according to ASTM D698.
      - c. Moisture content to be within plus or minus three percent ( $\pm 3\%$ ) of optimum as determined according to ASTM D698, unless otherwise approved by the Project Manager.
    - 2. Cement-Stabilized Sand (where required for special installations):
      - a. Maximum six inches (6 In) compacted thickness.
      - b. Compact to achieve minimum of ninety-five percent (95%) of maximum dry density as determined according to ASTM D698.
      - c. Moisture content to be on dry side of optimum as determined according to ASTM D698 but sufficient for effective hydration.
    - 3. Class I Embedment Materials:
      - a. Maximum six inches (6 In) compacted lift thickness.
      - b. Systematic compaction by at least two (2) passes of vibrating equipment. Increase compaction effort as necessary to effectively embed pipe to meet deflection test criteria.
      - c. Moisture content as determined by the Contractor for effective compaction without softening soil of trench bottom, foundation or trench walls.
    - 4. Class II Embedment and Cement-Stabilized Sand:
      - a. Maximum six inches (6 In) compacted thickness.
      - b. Compaction by methods determined by the Contractor to achieve minimum of ninety-five percent (95%) of maximum dry density as determined according to ASTM D698 for Class II materials and according to ASTM D558 for Cement-Stabilized materials.
      - c. Moisture content of Class II materials within three percent ( $\pm 3\%$ ) 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.
  - K. Place trench dams in Class I embedment in line segments longer than one hundred feet (100 Ft) between manholes and not less than one (1) in every five hundred feet (500 Ft) of pipe placed. Install additional dams as needed to achieve workable construction conditions. Do not place trench dams closer than five feet (5 Ft) from manholes.

**3.9 TRENCH ZONE BACKFILL PLACEMENT AND COMPACTION**

- A. Place backfill for pipe or conduits and restore surface as soon as practicable. Leave only minimum length of trench open as necessary for

construction.

- B. For water lines, backfill in trench zone, including auger pits, intermediate and site pits, with bank run sand select fill or random backfill material as specified in Section 02140 – Utility Backfill materials.
- C. For sewer pipes, use backfill materials described by trench limits. For "trench zone backfill" under pavement and to within one foot (1 Ft) back of curb, use Cement-Stabilized sand for pipes of nominal sizes thirty-six inches (36 In) in diameter and smaller to level twelve inches (12 In) below the pavement. For sewer pipes forty-two inches (42 In) in diameter and larger, under pavement or natural ground, in satisfactory soil conditions, backfill from twelve inches (12 In) above top of pipe to twelve inches (12 In) below pavement with suitable on-site material or select backfill. For sewer pipes forty-two inches (42 In) in diameter and larger, under pavement or natural ground, in unsatisfactory soil conditions, backfill from twelve inches (12 In) above top of pipe to twelve inches (12 In) below pavement with suitable on-site material or select backfill. Use select backfill for rigid pavements or flexible base material for asphalt pavements for twelve (12) inch backfill directly under pavement. For backfill materials reference Section 02140 – Utility Backfill Materials.
- D. Where damage to completed pipe installation work is likely to result from withdrawal of sheeting, leave sheeting in place. Cut off sheeting one and one-half feet (1-1/2 Ft) or more above crown of pipe. Remove trench supports within five feet (5 Ft) from ground surface.
- E. When shown on Drawings, random backfill of suitable material may be used in trench zone for trench excavations outside pavements.
- F. Place trench zone backfill in lifts and compact. Fully compact each lift before placement of next lift.
  - 1. Class I, II, III or IV or combination thereof (Random Backfill):
    - a. Maximum eight inches (8 In) compacted lift thickness.
    - b. Compact by vibratory equipment to minimum of ninety-five percent (95%) of maximum dry density determined according to ASTM D698.
    - c. Moisture content within plus or minus three percent ( $\pm 3\%$ ) of optimum determined according to ASTM D698, unless otherwise approved by the Project Manager.
  - 2. Cement-Stabilized Sand:
    - a. Maximum lift thickness determined by the Contractor to achieve uniform placement and required compaction, but not to exceed twelve inches (12 In).
    - b. Compact by vibratory equipment to minimum of ninety-five percent (95%) of maximum dry density determined according to ASTM D558.
    - c. Moisture content on dry side of optimum determined according to ASTM D558 but sufficient for cement hydration.
  - 3. Select Backfill:

- a. Place in maximum eight inch (8 In) loose layers.
  - b. Compaction by equipment providing tamping or kneading impact to minimum of ninety-five percent (95%) of maximum dry density determined according to ASTM D698.
  - c. Moisture content within plus or minus three percent ( $\pm 3\%$ ) above optimum determined according to ASTM D698, unless approved by the Project Manager.
- G. Unless otherwise shown on the Drawings, for trench excavations not under pavement or in the right of way, random backfill of suitable material may be used in trench zone as directed by the Project Manager.
1. Fat clays (CH) may be used as trench zone backfill outside paved areas at the Contractor's option. When required density is not achieved, rework, dry out, use lime stabilization or other approved methods to achieve compaction requirements or use different suitable material at no additional cost to the City.
  2. Maximum eight inch (8 In) compacted lift thickness for clayey soils and maximum eight inch (8 In) lift thickness for granular soils.
  3. Compact to minimum of ninety percent (90%) of maximum dry density determined according to ASTM D698.
  4. Moisture content as necessary to achieve density.
- H. For electric conduits, remove form work used for construction of conduits before placing trench zone backfill.
- I. Water soaking, jetting or compaction by backhoe bucket is not acceptable and shall not be used.

### 3.10 MANHOLES, JUNCTION BOXES AND OTHER PIPELINE STRUCTURES

- A. Meet requirements of adjoining utility installations for backfill of pipeline structures, as shown on the Drawings.
- B. Below paved areas, encapsulate manhole with Cement-Stabilized sand; minimum of one foot (1 Ft) below base, minimum one foot (1 Ft) around walls, up to within twelve inches (12 In) of pavement subgrade. Compact in accordance with Paragraph 3.9.F.2 of this Section.
- C. In unpaved areas, use select fill for backfill. Existing material that qualifies as select material may be used, unless indicated otherwise on the Drawings. Deposit backfill in uniform layers and compact each layer as specified. Maintain backfill material at plus or minus three percent ( $\pm 3\%$ ) of optimum moisture content, unless otherwise approved by the Project Manager. Place fill material in uniform eight inch (8 In) maximum loose layers. Compact fill to at least ninety-five percent (95%) of maximum Standard Proctor Density according to ASTM D698.

### 3.11 FIELD QUALITY CONTROL

- A. Test for material source qualifications as defined in Section 02140 – Utility Backfill Materials.

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- B. Provide excavation and trench safety systems at locations and to depths required for testing and retesting during construction at no additional cost to the City.
- C. Tests will be performed on minimum of three (3) 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 the Project Manager.
- D. At least three (3) 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 D2922 and ASTM D3017 and at following frequencies and conditions:
  - 1. For open cut construction projects and auger pits: Unless otherwise approved by the Project Manager, successful compaction to be measured by one (1) test per one hundred linear feet (100 Lf) measured along pipe for compacted embedment and one (1) test per one hundred linear feet (100 Lf) measured along pipe for compacted trench zone backfill material and one (1) test at each auger pit.
  - 2. A minimum of three (3) density tests for each full shift of Work.
  - 3. Density tests shall be distributed among placement areas. Placement areas are: foundation, bedding, haunching, initial backfill and trench zone.
  - 4. 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.
  - 5. Density tests at various depths below fill surface, if required, shall be performed by pit excavation. Material in previously placed lifts may therefore be subject to acceptance/rejection.
  - 6. Two (2) verification tests shall be performed adjacent to in-place tests showing density less than acceptance criteria. Placement will be rejected unless both verification tests show acceptable results.
  - 7. Recompacted placement shall be retested at same frequency as first test series, including verification tests.
  - 8. Identify elevation of test with respect to natural ground or pavement.
- F. Recondition, recompact and retest at the Contractor's expense if tests indicate the Work does not meet specified compaction requirements. For

hardened soil cement with nonconforming density, core and test for compressive strength at the Contractor's expense.

- G. Acceptability of crushed rock compaction will be determined by inspection.

**3.12 DISPOSAL OF EXCESS MATERIAL**

- A. Excess material shall be the property of the Contractor and shall be disposed of properly with no cost to the City. Dispose of excess materials in accordance with requirements of Section 01580 – Waste Material Disposal.

**PART IV: TABLES**

**4.1 TABLE EXCAVATION WIDTHS**

Nominal Pipe Size, inches	Minimum Trench Width, inches
Less than 18"	O.D. + 18"
18" to 30"	O.D. + 24"
36" to 42"	O.D. + 36"
Greater than 42"	O.D. + 48"

**END OF SECTION**