

**TECHNICAL SPECIFICATIONS**  
**DIVISION 2**  
**SITE WORK**

**Section 02200****SITE PREPARATION****1.0 GENERAL****1.01 SECTION INCLUDES**

- A Removal of topsoil, stripping and stockpiling, clearing and grubbing.
- B Removal and disposal of waste materials, excess materials, debris and trash.
- C Removal of obstructions.
- D Excavation and fill.
- E Salvaging of designated item.
- F References to Technical Specifications:
  - 1. Section 01200 – Measurement and Payment Procedures
  - 2. Section 01350 – Submittals
  - 3. Section 01450 – Testing Laboratory Services
  - 4. Section 01500 – Temporary Facilities and Controls
  - 5. Section 02255 – Bedding, Backfill and Embankment Material
  - 6. Section 02330 – Embankment
  - 7. Section 01140 – Contractor’s Use of Premises
- G Referenced Standards:
  - 1. American Society for Testing and Materials (ASTM)
    - a. ASTM D 4318, “Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils”

**1.02 MEASUREMENT AND PAYMENT**

- A Unless indicated as a Bid Item, no separate payment will be made for Work performed under this Section. Include cost in Bid Items for which this Work is a component.
- B If Site Preparation is included as a Bid Item, measurement will be based on the Units shown in Section 00300 – Bid Proposal and in accordance with Section 01200 – Measurement and Payment Procedures.

**1.03 SUBMITTALS**

- A Make Submittals required by this Section under the provisions of Section 01350 – Submittals.
- B Submit embankment material sources and product quality information in accordance this Section.

**1.04 TESTING**

- A Testing and analysis of product quality, material sources, or field quality shall be performed by an independent testing laboratory provided by the Owner under the provisions of Section 01450 – Testing Laboratory Services and as specified in this Section.

**1.05 PROTECTION OF PEOPLE AND PROPERTY**

- A Contractor shall conduct all construction operations under this Contract in conformance with the practices described in Section 01500 – Temporary Facilities and Controls.

**2.0 PRODUCTS****2.01 MATERIALS**

- A Contractor shall provide materials used as embedment, backfill, back-dressing, and embankment identified on the Plans in accordance with Section 02255 – Bedding, Backfill and Embankment Material.

**3.0 EXECUTION****3.01 CLEARING AND GRUBBING.**

- A Clear Project Site of trees, shrubs, and other vegetation, except for those designated by Owner to be left standing.
- B Use only hand methods for grubbing inside drip line of trees designated to remain.
- C Completely remove stumps, roots, and other debris protruding through ground surface.
  - 1. On areas required for roadway, channel, or structural excavation, remove stumps, 2" diameter or larger limbs and roots, to depth of 2 feet below lower elevation of excavation.
  - 2. On areas required for embankment construction, remove 2" diameter limbs, stumps and roots to depth of 2 feet below ground surface
  - 3. Trees and stumps may be cut off as close to natural ground as practicable on areas which are to be covered by at least 3 feet of embankment
- D Fill depressions caused by clearing and grubbing operations with satisfactory soil material, unless further excavation or earthwork is indicated.
  - 1. Place fill material in horizontal layers not exceeding 6 inches loose depth, and thoroughly compact to density equal to adjacent original ground.
- E Complete operations by bulldozing, blading, and grading so that prepared area is free of holes, unplanned ditches, abrupt changes in elevations and irregular contours, and preserve drainage of area.
  - 1. Blade entire area to prevent ponding of water and to provide drainage, except in areas to be immediately excavated

**3.02 TOPSOIL STRIPPING AND STOCKPILING**

- A Obtain approval of topsoil quality before excavating and stockpiling.
- B Excavate topsoil for esplanades and areas to receive grass or landscaping from areas to be further excavated.
- C Topsoil Stripping:
  - 1. Remove growths of grass from areas before stripping.
  - 2. Topsoil is defined as surface soil found of depth of not less than 4 inches.
  - 3. Strip topsoil to depths encountered.
  - 4. Perform stripping in a manner to prevent intermingling of topsoil with underlying sterile subsoil and remove objectionable materials, including clay lumps, stones over 2 in. in diameter, weeds, roots, leaves, and debris.
  - 5. Where trees are designated by Owner to be left standing, stop topsoil stripping at extreme limits of tree drip line to prevent damage to main root system.
- D Topsoil Stockpiling:
  - 1. Stockpile in areas designated on Plans.
  - 2. Construct storage piles to freely drain surface water.
  - 3. Cover storage piles, if required to prevent wind-blown dust.
  - 4. Stockpile topsoil to depth not exceeding 8 feet. Stockpile in a manner to prevent erosion.

**3.03 UNSUITABLE MATERIAL**

- A Undercut, remove, and replace material which Engineer designates as unsuitable for subsequent construction.
- B Material used to replace unsuitable material shall be suitable material from site excavation or as indicated on Plans.

**3.04 EXCAVATION AND FILL**

- A Construction surveying shall be performed by qualified personnel under the direction of the contractor. Contractor shall be responsible for the accuracy and correctness of this work. In the event that the work consists of significant alteration of the topographic features of natural grade, contractor shall perform enough topographic survey to substantiate existing pre-construction elevations. No claim shall be made for additional excavation or grade adjustment in excess of quantities contained in the contract documents without demonstrable evidence that such conditions existed prior to start of the work
- B Depressed site areas shall be filled using material from high areas, insofar as practicable.

C When fill obtained from high areas is exhausted, fill to indicated rough grade elevations under roadways with “Structural Fill” and open areas not under structures or roadways with “General Fill”, or as indicated on Plans.

D Place and compact fill in accordance with Section 02330 – Embankment.

**3.05 SALVAGEABLE ITEMS AND MATERIAL**

A Items designated by Engineer to be salvaged are to be carefully removed, so as to cause no damage to the salvaged items and delivered to Owner’s storage yard.

**3.06 CLEAN-UP AND RESTORATION**

A Perform clean-up and restoration in and around construction zone in accordance with Section 01140 – Contractor’s Use of Premises.

END OF SECTION

**Section 02220****SITE DEMOLITION****1.0 GENERAL****1.01 SECTION INCLUDES**

- A Demolishing and removing existing pavements, structures, equipment and materials only to the extent as indicated on the Plans.
- B Removing concrete paving, asphaltic concrete pavement, and base courses.
- C Removing concrete curbs, concrete curb and gutters, sidewalks and driveways.
- D Removing pipe culverts and sewers.
- E Removing miscellaneous structures of wood, plastics, metals, concrete, masonry, or combination of concrete and masonry, etc.
- F Disposing of demolished materials and equipment.
- G References to Technical Specifications:
  - 1. Section 01200 – Measurement and Payment Procedures
  - 2. Section 01350 – Submittals
  - 3. Section 01500 – Temporary Facilities and Control
  - 4. Section 01100 – Summary of Work
  - 5. Section 01730 – Cutting and Patching
  - 6. Section 01140 – Contractor’s Use of Premises
  - 7. Section 01562 – Waste Material Disposal

**1.02 MEASUREMENT AND PAYMENT**

- A Unless indicated as a Bid Item, no separate payment will be made for removing and disposing of existing pavement and structures under this Section. Include cost for removing and disposing of existing pavement and structures in Bid Items for which this Work is a component.
- B If indicated as a Bid Item, measurement will be as follows:
  - 1. Measurement for removing and disposing of concrete base and surfacing, and removing asphaltic surfacing, is on a square yard basis measured between lips of gutters.
  - 2. Measurement for removing and disposing of cement stabilized shell base course, with or without asphalt surfacing, is on a square yard basis.
  - 3. Measurement for removing and disposing of concrete base and surfacing with curbs, is on a square yard basis measured from back to back of curbs. Payment includes removal of all base, asphaltic surfacing, concrete pavement, esplanade curbs, curb and gutters, and paving headers.

4. Measurement for removing and disposing of concrete pavement is on a square yard basis measured from back to back of curbs.
  5. Measurement for removing and disposing of monolithic curb and gutter, removing monolithic concrete curb, and removing concrete curb, is on a lineal foot basis measured along the face of the curb.
  6. Measurement for removing and disposing of concrete sidewalk and driveway is on a square yard basis.
  7. Measurement for removing and disposing of miscellaneous concrete and masonry removal is on a cubic yard basis of the structure in place.
  8. Measurement for removing and disposing of pipe culverts and sewers is on a lineal foot basis for each diameter of type of pipe removed.
  9. Measurement for removing and disposing of unlisted materials shall be on the lump sum basis.
- C No payment will be made for work outside maximum payment limits indicated on Plans, or in areas removed for Contractor's convenience.
- D Refer to Section 01200 – Measurement and Payment Procedures.

### **1.03 SUBMITTALS**

- A Make Submittals required by this Section under the provisions of Section 01350 – Submittals.
- B Submit proposed methods, equipment, materials and sequence of operations for demolition. Describe coordination for shutting off, capping, and removing temporary utilities. Plan operations to minimize temporary disruption of utilities to existing facilities or adjacent property.
- C Submit proposed demolition and removal schedule for approval. Notify Engineer in writing at least 48 hours before starting demolition.
- D Submit an approved copy of demolition schedule to Engineer prior to commencement of demolition operations.
- E Obtain a permit for building demolition, as required.

### **1.04 PROTECTION OF PEOPLE AND PROPERTY**

- A Contractor shall conduct all construction operations under this Contract in conformance with the practices described in Section 01500 – Temporary Facilities and Controls.
- B The Contractor shall be responsible for safety and integrity of adjacent structures and shall be liable for any damage due to movement or settlement. Provide proper framing and shoring necessary for support. Cease operations if an adjacent structure appears to be endangered. Resume demolition only after proper protective measures have been taken.

**1.05 OWNERSHIP OF MATERIAL AND EQUIPMENT**

- A Materials and equipment designated for reuse or salvage are listed in Section 01100 – Summary of Work. Protect items designated for reuse or salvage from damage during demolition, handling and storage. Restore damaged items to satisfactory condition.
- B Materials and equipment not designated for reuse or salvage become the property of the Contractor.

**1.06 STORAGE AND HANDLING**

- A Store and protect materials and equipment designated for reuse until time of installation.
- B Deliver and unload items to be salvaged to storage areas indicated on Plans.
- C Remove equipment and materials not designated for reuse or salvage and all waste and debris resulting from demolition from site. Remove material as work progresses to avoid clutter.

**2.0 PRODUCTS****2.01 EQUIPMENT AND MATERIALS FOR DEMOLITION**

- A Use equipment and materials approved as prescribed in this Section, 1.03 “Submittals”.
- B Use of a “drop hammer” must have the Engineer’s prior approval.

**3.0 EXECUTION****3.01 EXAMINATION**

- A Prior to demolition, make an inspection with Engineer to determine the condition of existing structures and features adjacent to items designated for demolition.
- B Engineer will mark or list existing equipment to remain the property of the Owner.
- C Do not proceed with demolition or removal operations until after the joint inspection and subsequent authorization by Engineer.
- D Stop demolition and notify Engineer if underground fuel storage tanks, asbestos, PCB's, contaminated soils, or other hazardous materials are encountered.

**3.02 UTILITY SERVICES**

- A Follow rules and regulations of authorities or companies having jurisdiction over communications, pipelines, and electrical distribution services.
- B Notify and coordinate with utility company and adjacent building occupants when temporary interruption of utility service is necessary.



- C When required by the Work, cutting, patching, and fitting of Work to existing facilities, accommodating installation or connection of Work with existing facilities, or uncovering Work for access, inspection, or testing shall be performed in accordance with Section 01730 – Cutting and Patching

### 3.03 MECHANICAL WORK ITEMS

- A Mechanical removals consist of dismantling and removing existing piping, pumps, motors, water tanks, equipment and other appurtenances. It includes cutting, capping, and plugging required to restore use of existing utilities.
- B Remove existing process, water, chemical, gas, fuel oil and other piping not required for new work. Take out piping to the limits shown or to a point where it will not interfere with the new work. Piping not indicated to be removed or which does not interfere with new work shall be removed to the nearest solid support, capped, and the remainder left in place. Purge chemical and fuel lines and tanks. Verify that such lines are safe prior to removal or capping.
- C Where piping that is to be removed passes through existing walls, cut and cap piping on each side of the wall. Use cap appropriate for pipe material to be capped. Provide fire-rated sealant for walls classified as fire-rated.
- D When underground piping, which is not located in the public right-of-way, is to be altered or removed, cap the remaining piping. Abandoned underground piping may be left in place unless it interferes with new work or is shown or specified to be removed. Piping less than 15 inches in diameter may be plugged and abandoned in place. For piping 15 inches in diameter and greater to be abandoned, fill with sand, pressure grout or other approved method and plug with concrete or brick masonry bulkhead.
- E Remove waste and vent piping to points shown. Plug pipe and cleanouts and plugs. Where vent stacks pass through an existing roof that is to remain, remove the stack and patch the hole in the roof, making it watertight. Comply with requirements of existing roof installer so as to maintain roof warranty.
- F Conform to applicable codes when making any changes to plumbing and heating systems.

### 3.04 ELECTRICAL WORK ITEMS

- A Electrical removals consist of disconnecting and removing existing switchgear, distribution switchboards, control panels, bus duct, conduits and wires, panel boards, lighting fixtures, and miscellaneous electrical equipment.
- B Remove existing electrical equipment and fixtures to prevent damage to allow continued operation of existing systems and to maintain the integrity of the grounding systems.

- C Remove poles and metering equipment, if designated for removal on the Plans. Coordinate electrical removals with the power company, as necessary. Verify that power is properly de-energized and disconnected.
- D Where shown or otherwise required, remove wiring in underground duct systems. Verify function of wiring before disconnecting and removing. Plug ducts which are not to be reused at entry to buildings.
- E Changes to electrical systems shall conform to applicable codes.

**3.05 CLEAN-UP AND RESTORATION**

- A Perform clean-up and restoration in and around construction zone in accordance with Section 01140 – Contractor’s Use of Premises.
- B Remove from the site all items contained in or upon the structure not designated for reuse or salvage in accordance with this Section and Section 01562 – Waste Material Disposal.
- C Follow method of disposal as required by regulatory agencies.

END OF SECTION

**Section 02252****CEMENT STABILIZED SAND****1.0 GENERAL****1.01 SECTION INCLUDES**

- A Cement stabilized sand for backfill and bedding.
- B References to Technical Specifications:
  - 1. Section 01350 – Submittals
  - 2. Section 02255 – Bedding, Backfill, and Embankment Materials
  - 3. Section 01450 – Testing Laboratory Services
- C Referenced Standards:
  - 1. American Society for Testing and Materials (ASTM)
    - a. ASTM D 558, “Standard Test Methods for Moisture-Density (Unit Weight) Relations of Soil-Cement Mixtures”
    - b. ASTM D 1632, “Practice for Making and Curing Soil-Cement Compression and Flexure Test Specimens in the Laboratory”
    - c. ASTM D 1633, “Standard Test Method for Compressive Strength of Molded Soil-Cement Cylinders”
    - d. ASTM C 150, “Standard Specification for Portland Cement”
    - e. ASTM C 33, “Standard Specification for Concrete Aggregates”
    - f. ASTM D 2487, “Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System)”
    - g. ASTM C 142, “Standard Test Method for Clay Lumps and Friable Particles in Aggregates”
    - h. ASTM C 123, “Standard Test Method for Lightweight Particles in Aggregate”
    - i. ASTM C 40, “Standard Test Method for Organic Impurities in Fine Aggregates for Concrete”
    - j. ASTM C 4318, “Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils”
    - k. ASTM C 94, “Standard Specification for Ready-Mixed Concrete”
    - l. ASTM C 31, “Standard Practice for Making and Curing Concrete Test Specimens in the Field”

**1.02 MEASUREMENT AND PAYMENT**

- A Unless indicated as an Extra Item, no separate payment will be made for cement stabilized sand under this Section. Include cost in Bid Items for applicable utility or structure installation.
- B If use of cement stabilized sand is allowed, based on the Engineer's direction, and indicated in Section 00300 – Bid Proposal as an Extra Item, measurement will be on a per ton basis. A conversion between volumes calculated based on theoretical limits and total weight will be made based on a ratio of 1.64 tons per cubic yard.

**1.03 SUBMITTALS**

- A Make Submittals required by this Section under the provisions of Section 01350 – Submittals.
- B Submit material qualification and design mix tests to include:
  - 1. Three series of tests of sand or fine aggregate material from the proposed source. Tests shall include procedures defined in this Section, 2.01 “Materials”.
  - 2. Three moisture-density relationship tests prepared using the material qualified by the tests in this Section, 1.03B1. Blends of fine aggregate from crushed concrete and bank run sand shall be tested at the ratio to be used for the design mix testing.
  - 3. Design mix report to meet the specifications of this Section, 1.04 “Design Requirements”. The design mix shall include compressive strength tests after 48-hours and 7 days curing.

**1.04 DESIGN REQUIREMENTS**

- A Design sand-cement mixture to produce a minimum unconfined compressive strength of 100 pounds per square inch in 48 hours when compacted to a minimum 95 percent in accordance with ASTM D 558 and when cured in accordance with ASTM D 1632, and tested in accordance with ASTM D 1633. Mix shall contain a minimum of 1-1/2 sacks of cement per cubic yard. Compact mix with a moisture content on the dry side of optimum.

**2.0 PRODUCTS****2.01 MATERIALS**

- A Cement shall be Type 1 Portland cement conforming to ASTM C 150.
- B Sand shall be clean, durable, and meet grading requirements for fine aggregates of ASTM C 33 and the following requirements:
  - 1. Classified as SW, SP or SM by the United Soil Classification System of ASTM D 2487.
  - 2. Deleterious material content:
    - a. Clay lumps shall comprise less than 0.5 percent by ASTM C 142.
    - b. Lightweight pieces shall comprise less than 5.0 percent by ASTM C 123.
    - c. Organic impurities shall produce color no darker than the standard color by ASTM C 40 ASTM.
  - 3. Plasticity index of 4 or less when tested in accordance with ASTM D 4318.
- C Fine aggregate, manufactured from crushed concrete meeting the quality requirements for crushed rock material in Section 02255 - Bedding, Backfill, and Embankment Materials, may be used as a complete or partial substitute for Bank Sand. The blending ratio of fine aggregate from crushed concrete and Bank Sand shall be defined in the mix design report.

- D Water shall be potable, free of oils, acids, alkalies, organic matter, or other deleterious substances, meeting requirements of ASTM C 94.

## **2.02 MIXING MATERIALS**

- A Thoroughly mix sand, cement and water in proportions of the mix design using a pugmill-type mixer. The plant shall be equipped with automatic weight controls to ensure correct mix proportions.
- B Stamp batch ticket at plant with time of loading directly after mixing. Material not placed and compacted within 4 hours after mixing shall be rejected.

## **3.0 EXECUTION**

### **3.01 PLACEMENT AND COMPACTION**

- A Place sand-cement mixture in 8-inch-thick loose lifts and compact to a minimum of 95 percent of ASTM D 558, unless otherwise specified on Plans. The moisture content during compaction shall be on the dry side of optimum but sufficient for hydration. Perform and complete compaction of sand-cement mixture within 4 hours after addition of water to mix at the plant.
- B Do not place or compact sand-cement mixture in standing or free water.

### **3.02 FIELD QUALITY CONTROL**

- A Testing will be performed under provisions of Section 01450 - Testing Laboratory Services.
- B Mixing plant inspections will be performed periodically. Material samples will be obtained and tested in accordance with this Section, 2.01 "Materials", if there is evidence of change in material characteristic.
- C One sample of cement stabilized sand shall be obtained for each 150 tons of material placed per day with no less than one sample per day of production. Random samples of delivered cement stabilized sand shall be taken in the field at point of delivery in accordance with ASTM 3665. Obtain three individual samples of approximately 12 to 15 lb each from the first, middle, and last third of the truck and composite them into one sample for test purpose.
- D Prepare and mold four specimens (for each sample obtained) in accordance with ASTM D558, Method A, without adjusting moisture content. Samples will be molded at approximately same time material is being used, but no later than 4 hours after water is added to mix.
- E After molding, specimens will be removed from molds and cured in accordance with ASTM D 1632.

- F Specimens will be tested for compressive strength in accordance with ASTM D 1633, Method A. Two specimens will be tested at 48 hours plus or minus 2 hours and two specimens will be tested at 7 days plus or minus 4 hours.
- G A strength test will be average of strengths of two specimens molded from same sample of material and tested at same age. Average daily strength will be average of strengths of all specimens molded during one day's production and tested at same age.
- H Precision and Bias: Test results shall meet recommended guideline for precision in ASTM D 1633 Section 9.
- I Reporting: Test reports shall contain, as a minimum, the following information:
1. Supplier and plant number
  2. Time material was batched
  3. Time material was sampled
  4. Test age (exact hours)
  5. Average 48-hour strength
  6. Average 7-day strength
  7. Specification section number
  8. Indication of compliance / non-compliance
  9. Mixture identification
  10. Truck and ticket numbers
  11. The time of molding
  12. Moisture content at time of molding
  13. Required strength
  14. Test method designations
  15. Compressive strength data as required by ASTM D 1633
  16. Supplier mixture identification
  17. Specimen diameter and height, in.
  18. Specimen cross-sectional area, sq. in.
- J The cement content will be checked on samples obtained in the field whenever there are apparent changes in the mix properties.

### 3.03 ACCEPTANCE

- A Strength level of material will be considered satisfactory if:
1. The average 48-hour strength is greater than 100 psi with no individual strength test below 70 psi.
  2. All 7-day individual strength tests (average of two specimens) are greater than or equal to 100 psi.
- B Material will be considered deficient when 7-day individual strength test (average of two specimens) is less than 100 psi but greater than 70 psi. See Paragraph 3.04 Adjustment for Deficient Strength.
- C The material will be considered unacceptable and subject to removal and replacement at Contractors expense when individual strength test (average of two specimens) has 7-day strength less than 70 psi

- D When moving average of three daily 48-hour averages falls below 100 psi, discontinue shipment to project until plant is capable of producing material, which exceeds 100 psi at 48 hours. Five 48-hour strength tests shall be made in this determination with no individual strength tests less than 100 psi.
- E Testing laboratory shall notify Contractor, Project Manager, and material supplier by facsimile of tests indicating results falling below specified strength requirements within 24 hours.
- F If any strength test of laboratory cured specimens falls below the specified strength, Contractor may, at his own expense, request test of cores drilled from the area in question in accordance with ASTM C42. In such cases, three (3) cores shall be taken for each strength test that falls below the values given in 3.03.A.
- G Cement stabilized sand in an area represented by core tests shall be considered satisfactory if the average of three (3) cores is equal to at least 100 psi and if no single core is less than 70 psi. Additional testing of cores extracted from locations represented by erratic core strength results will be permitted.

#### **3.04 ADJUSTMENT FOR DEFICIENT STRENGTH**

- A When mixture produces 7-day compressive strength greater than or equal to 100 psi, then material will be considered satisfactory and bid price will be paid in full.
- B When mixture produces 7-day compressive strength less than 100 psi and greater than or equal to 70 psi, material shall be accepted contingent on credit in payment. Compute credit by the following formula:

$$\text{Credit per Cubic Yard} = \frac{\$30.00 \times 2 (100 \text{ psi} - \text{Actual psi})}{100}$$

- C When mixture produces 7-day compressive strength less than 70 pounds per square inch, then remove and replace cement-sand mixture and paving and other necessary work at no cost to City.

END OF SECTION

**Section 02255****BEDDING, BACKFILL, AND EMBANKMENT MATERIALS****1.0 GENERAL****1.01 SECTION INCLUDES**

- A A reference source for materials used as embedment, backfill, back-dressing, and embankment, specified elsewhere in the Technical Specifications, and their associated material qualification testing requirements.
- B Source qualifications and handling of these materials.
- C Material use and application is specified on the Plans or in individual Technical Specifications referencing materials either by Material Classification or by Product Description.
- D References to Technical Specifications:
  - 1. Section 03300 – Cast-in-Place Concrete
  - 2. Section 02910 – Topsoil
  - 3. Section 02252 – Cement Stabilized Sand
- E Referenced Standards:
  - 1. American Society for Testing and Materials (ASTM)
    - a. ASTM D 2487, “Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System)”
    - b. ASTM C 142, “Standard Test Method for Clay Lumps and Friable Particles in Aggregates”
    - c. ASTM C 123, “Standard Test Method for Lightweight Particles in Aggregate”
    - d. ASTM C 40, “Standard Test Method for Organic Impurities in Fine Aggregates for Concrete”
    - e. ASTM C 4318, “Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils”
    - f. ASTM D 1140, “Standard Test Methods for Amount of Material in Soils Finer the No. 200 (70-um) Sieve”
    - g. ASTM C 33, “Standard Specification for Concrete Aggregates”
    - h. ASTM C 136, “Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates”
    - i. ASTM C 131, “Standard Test Methods for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine”



## 2.0 PRODUCTS

### 2.01 MATERIAL CLASSIFICATIONS

- A Materials shall be classified for the purpose of quality control in accordance with the Unified Soil Classification Symbols as defined in ASTM D 2487.
1. Class I: Well-graded gravels and sands, gravel-sand mixtures, crushed well-graded rock, little or no fines (GW, SW):
    - a. Plasticity index: non-plastic.
    - b. Gradation:  $D_{60}/D_{10}$  - greater than 4 percent; amount passing No. 200 sieve - less than or equal to 5 percent.
  2. Class II: Poorly graded gravels and sands, silty gravels and sands, little to moderate fines:
    - a. Plasticity index: non-plastic to 4.
    - b. Gradations:  
Gradation (GP, SP): amount passing No. 200 sieve - less than 5 percent.  
Gradation (GM, SM): amount passing No. 200 sieve - between 12 percent and 50 percent.
    - c. Borderline gradations with dual classifications (e.g., SP-SM): amount passing No. 200 sieve - between 5 percent and 12 percent.
  3. Class III: Clayey gravels and sands, poorly graded mixtures of gravel, sand, silt, and clay (GC, SC, and dual classifications, e.g., SP-SC):
    - a. Plasticity index: greater than 7.
    - b. Gradation: amount passing No. 200 sieve - between 12 percent and 50 percent.
  4. Class IVA: Lean clays (CL).
    - a. Plasticity Indexes:  
Plasticity index: greater than 7, and above A line.  
Borderline plasticity with dual classifications (CL-ML): PI between 4 and 7.
    - b. Liquid limit: less than 50.
    - c. Gradation: amount passing No. 200 sieve - greater than 50 percent.
    - d. Inorganic.
  5. Class IVB: Fat clays (CH)
    - a. Plasticity index: above A line.
    - b. Liquid limit: 50 or greater.
    - c. Gradation: amount passing No. 200 sieve - greater than 50 percent.
    - d. Inorganic.
- B Use soils with dual class designation according to ASTM D 2487, and which are not defined above, according to the more restrictive class.

### 2.02 PRODUCT DESCRIPTIONS

- A 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 D 2487.
  2. Materials that cannot be compacted to the required density due to either gradation, plasticity, or moisture content.
  3. Materials that contain large clods, aggregates, stones greater than 3 inches in any dimension, debris, vegetation, waste or any other deleterious materials.
  4. Materials that are contaminated with hydrocarbons or other chemical contaminants.
- B Suitable Material. Soil materials meeting specification requirements. Unsuitable soils meeting specification requirements for suitable soils after treatment with, for example, lime or cement shall be considered suitable, unless otherwise indicated.
- C General Fill. Material that is free of stones greater than 3 inches, free of roots, waste, debris, trash, organic material, unstable material, non-soil matter, hydrocarbon or other contamination, conforming to the following limits for deleterious materials:
1. Clay lumps: Less than 0.5 percent for Class I, and less than 2.0 percent for Class II, when tested in accordance with ASTM C 142.
  2. Lightweight pieces: Less than 5 percent when tested in accordance with ASTM C 123.
  3. Organic impurities: No color darker than standard color when tested in accordance with ASTM C 40.
- D Random Fill. Soils defined by ASTM D 2487 as Class I, II, III, IV, or fat clay (CH), sand, gravel, or a combination, from excavation or borrow, which can be compacted to form stable embankments, and conforming to:
1. Liquid Limit: 65 maximum, ASTM - D4318.
  2. Plasticity Index: 0 minimum, 45 maximum, ASTM - D4318.
  3. Free from trash, vegetation, organic matter, large stones, hard lumps of earth and frozen, corrosive or perishable material.
  4. Well broken up, free of clods greater than 6 inches, hard earth, rocks, and stones greater than 2-inch dimension.
- E Structural Fill. Soils defined by ASTM D 2487 as Class I, II, III, or IV, sand, gravel, or a combination, from excavation or borrow, which can be compacted to form stable embankments and fills conforming to:
1. Liquid Limit: 45 maximum, ASTM D 4318.
  2. Plasticity Index: 12 minimum, 20 maximum, ASTM D 4318.
  3. Free from trash, vegetation, organic matter, large stones, hard lumps of earth and frozen, corrosive or perishable material.
  4. Well broken up, free of clods greater than 6 inches, hard earth, rocks, and stones greater than 2-inch dimension.
- F Select Fill. Class III clayey gravel or sand or Class IV lean clay or clayey soils treated with lime or cement, and conforming to:

1. Plasticity Index: 7 minimum, 20 maximum, ASTM D 4318.
  2. Free from trash, vegetation, organic matter, large stones, hard lumps of earth and frozen, corrosive or perishable material.
  3. Well broken up, free of clods greater than 6 inches, hard earth, rocks, and stones greater than 2-inch dimension.
- G Concrete Fill. Conform to requirements for Class B concrete as specified in Section 03300 - Cast-in-Place Concrete.
- H Topsoil. Conform to requirements specified in Section 02910 - Topsoil.
- I Bank Sand: Durable Bank Sand classified as SP, SW, or SM by the Unified Soil Classification System (ASTM D 2487) meeting the following requirements:
1. Less than 15 percent passing the number 200 sieve when tested in accordance with ASTM D 1140. The amount of clay lumps or balls not exceeding 2 percent.
  2. Material passing the number 40 sieve shall meet the following requirements when tested in accordance with ASTM D 4318:
    - a. Liquid limit: not exceeding 25 percent.
    - b. Plasticity index: not exceeding 7.
- J Cement Stabilized Sand. Conform to requirements of Section 02252 - Cement Stabilized Sand.
- K Concrete Sand. Natural sand, manufactured sand, or a combination of natural and manufactured sand conforming to the requirements of ASTM C 33 and graded within the following limits when tested in accordance with ASTM C 136:

<b>SIEVE</b>	<b>PERCENT PASSING</b>
3/8"	100
No. 4	95 to 100
No. 8	80 to 100
No. 16	50 to 85
No. 30	25 to 60
No. 50	10 to 30
No. 100	2 to 10

- L Gem Sand. Sand conforming to the requirements of ASTM C 33 for course aggregates specified for number 8 size and graded within the following limits when tested in accordance with ASTM C 136:

<b>SIEVE</b>	<b>PERCENT PASSING</b>
3/8"	95 to 100
No. 4	60 to 80
No. 8	15 to 40

- M Pea Gravel. Durable particles composed of small, smooth, rounded stones or pebbles and graded within the following limits when tested in accordance with ASTM C 136:

SIEVE	PERCENT PASSING
1/2"	100
3/8"	85 to 100
No. 4	10 to 30
No. 8	0 to 10
No. 16	0 to 5

- N Crushed Aggregates. Crushed aggregates consist of durable particles obtained from an approved source and meeting the following requirements:

1. Materials of one product delivered for the same construction activity from a single source.
2. Non-plastic fines.
3. Los Angeles Abrasion Test wear not exceeding 45 percent when tested in accordance with ASTM C 131.
4. Crushed aggregate shall have a minimum of 90 percent of the particles retained on the No. 4 sieve with 2 or more crushed faces as determined by TxDOT Tex-460-A, Part I.
5. Crushed stone: Produced from oversize plant processed stone or gravel, sized by crushing to predominantly angular particles from a naturally occurring single source. Uncrushed gravel are not acceptable materials for embedment where crushed stone is shown on the applicable utility embedment drawing details.
6. Crushed Concrete: Crushed concrete is an acceptable substitute for crushed stone as utility backfill. Gradation and quality control test requirements are the same as crushed stone. Provide crushed concrete produced from normal weight concrete of uniform quality; containing particles of aggregate and cement material, free from other substances such as asphalt, reinforcing steel fragments, soil, waste gypsum (calcium sulfate), or debris.
7. Gradations, as determined in accordance with TxDOT Tex-110-E.

SIEVE	PERCENT PASSING BY WEIGHT FOR PIPE EMBEDMENT BY RANGES OF NOMINAL PIPES SIZES		
	>15"	15" - 8"	<8"
1"	95 - 100	100	-
3/4"	60 - 90	90 - 100	100
1/2"	25 - 60	-	90 - 100
3/8"	-	20 - 55	40 - 70
No. 4	0 - 5	0 - 10	0 - 15
No. 8	-	0 - 5	0 - 5

**3.0 EXECUTION****3.01 SOURCE QUALIFICATIONS FOR BORROW MATERIAL**

- A Use of material encountered in excavations is acceptable, provided applicable requirements are satisfied. If excavation material is not acceptable, provide from other approved source.
- B Identify off-site sources for materials at least 14 days ahead of intended use so that the Engineer may obtain samples for verification testing.
- C Obtain approval for each material source by the Engineer before delivery is started. If sources previously approved do not produce uniform and satisfactory products, furnish materials from other approved sources. Materials may be subjected to inspection or additional verification testing after delivery. Materials which do not meet the requirements will be rejected. Do not use material which, after approval, has become unsuitable for use due to segregation, mixing with other materials, or by contamination. Once a material is approved by the Engineer, a Change Order is required to change to a different material.
- D Bank sand, select fill, and random fill, if available in the project excavation, may be obtained by selective excavation and acceptance testing. Obtain additional quantities of these materials and other materials required to complete the Work from off-site sources.
- E The Owner does not represent or guarantee that any soil found in the excavation work will be suitable and acceptable as backfill material.

**3.02 MATERIAL HANDLING**

- A When material is obtained from either a commercial or non-commercial borrow pit, open the pit to expose the vertical faces of the various strata for identification and selection of approved material to be used. Excavate the selected material by vertical cuts extending through the exposed strata to achieve uniformity in the product.
- B Establish temporary stockpile locations for practical material handling and control, and verification testing by the Engineer in advance of final placement. Obtain approval from landowner for storage of backfill material on adjacent private property.
- C When stockpiling material near the Project Site, use appropriate methods to eliminate blowing of materials into adjacent areas and prevent runoff containing sediments from entering the drainage system.
- D Place material suitable for backfilling in stockpiles at a distance from the trench to prevent slides or cave-ins. Do not place stockpiles of excavated materials on public streets.

- E Place stockpiles in layers to avoid segregation of processed materials. Load material by making successive vertical cuts through entire depth of stockpile.

END OF SECTION

**Section 02316****EXCAVATION AND BACKFILL FOR ROADWAYS****1.1 GENERAL****1.2 SECTION INCLUDES**

- A. Excavation of materials for roadways.
- B. Excavation of materials for roadside ditches.
- C. References to Technical Specifications:
  - 1. Section 01200 – Measurement and Payment Procedures
  - 2. Section 01350 – Submittals
  - 3. Section 01760 – Project Record Documents
  - 4. Section 01450 – Testing Laboratory Services
  - 5. Section 01500 – Temporary Facilities and Controls
  - 6. Section 02255 – Bedding, Backfill and Embankment Material
  - 7. Section 01570 – Trench Safety Systems
  - 8. Section 01564 – Control of Ground Water and Surface Water
  - 9. Section 01720 – Field Surveying
  - 10. Section 02220 – Site Demolition
  - 11. Section 02200 – Site Preparation
  - 12. Section 02330 – Embankment
  - 13. Section 01140 – Contractor’s Use of Premises
- D. Referenced Standards:
  - 1. American Society for Testing and Materials (ASTM)
    - a. ASTM D 698, “Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort”
    - b. ASTM D 1556, “Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method”
    - c. ASTM D 2922, “Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)”
    - d. ASTM D 3017, “Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)”

**1.3 MEASUREMENT AND PAYMENT**

- A. Measurement shall be by the cubic yard measured in place, including labor, equipment, tools and incidentals necessary to complete the work.

- B. Payment includes control of ground water and surface water, trench safety systems, removal of existing pavements and structures, repair and maintenance of excavated or backfilled areas, and other measures specified in this Section and not included in payment elsewhere.
- C. Refer to Section 01200 – Measurement and Payment Procedures.
- D. No payment will be made for material excavated under the following conditions:
  - 1. More than 2 feet outside of vertical planes behind back of curbs.
  - 2. For portion within limits of trench for utilities constructed by open-cut methods.
  - 3. As indicated otherwise on Drawings.
- E. Construction Surveying shall be performed by qualified personnel under the direction of the Contractor. Contractor shall be responsible for the accuracy and correctness of this work. In the event that the Work consists of significant alteration of the topographic features of natural grade, Contractor shall perform enough topographic survey to substantiate existing pre-construction elevations. No claim shall be made for additional excavation or grade adjustment in excess of quantities contained in the contract documents without demonstrable evidence that such conditions existed prior to start of the Work.
- F. Excavation and Backfill quantities that exceed the construction plans shall be substantiated with topographic survey of finished grade by survey (RPLS) and verified by the Engineer at contractor's expense.

#### 1.4 SUBMITTALS

- A. Make Submittals required by this Section under the provisions of Section 01350 – Submittals.
- B. Submit product quality, material sources, and field quality information in accordance with this Section.
- C. Submit field red lines documenting location of roadway excavation as installed, referenced to survey Control Points, under the provisions of Section 01760 – Project Record Documents, 1.04C. Include location of utilities and structures encountered or rerouted. Give horizontal dimensions, elevations, inverts and gradients.

#### 1.5 TESTING

- A. Testing and analysis of product quality, material sources, or field quality shall be performed by an independent testing laboratory provided by the Owner under the provisions of Section 01450 – Testing Laboratory Services and as specified in this Section.



**1.6 PROTECTION OF PEOPLE AND PROPERTY**

- A. Contractor shall conduct all construction operations under this Contract in conformance with the practices described in Section 01500 – Temporary Facilities and Controls.

**2.1 PRODUCTS**

**2.2 MATERIALS**

- A. Contractor shall provide materials used as embedment, backfill, back-dressing, and embankment identified on the Plans in accordance with Section 02255 – Bedding, Backfill and Embankment Material.

**3.1 EXECUTION**

**3.2 PREPARATION**

- A. Employ a Trench Safety Plan as specified in Section 01570 – Trench Safety Systems.
- B. Install and operate necessary dewatering and surface water control measures in accordance with requirements of Section 01564 – Control of Ground Water and Surface Water.
- C. Identify required lines, levels, and datum. Coordinate with Section 01720 – Field Surveying.
- D. Identify existing structures and utilities above and below grade. Stake and flag their location.
- E. Remove existing pavements and structures, including sidewalks and driveways, in conformance with requirements of Section 02220 – Site Demolition, as applicable.
- F. Area shall be cleared and grubbed under the provisions of Section 02200 – Site Preparation prior to excavation.
- G. Strip and stockpile topsoil under the provisions of Section 02200 – Site Preparation.
- H. Upon discovery of unknown or badly deteriorated utilities, or concealed conditions, discontinue work. Notify Engineer and obtain instructions before proceeding in such areas.

**3.3 EXCAVATION**

- A. Excavate to lines and grades shown on Plans.

- B. Areas of unsuitable material shall be removed, backfilled with embankment materials, and compacted under the provisions of Section 02330 – Embankment.
  
- C. At intersections, grade back at minimum slope of one inch per foot. Produce a smooth riding junction with intersecting street. Maintain proper drainage.

- D. Fill over-excavated areas in accordance with requirements of Section 02330 – Embankment at no cost to the Owner.

**3.4 COMPACTION REQUIREMENTS**

- A. Maintain moisture content of embankment materials to attain required compaction density.
- B. Compact to minimum densities at moisture content of optimum to 3 percent above optimum as determined by ASTM D 698, unless otherwise indicated on the Drawings.
  - 1. Areas under future paving and shoulders: Minimum density of 95 percent of maximum dry density.
  - 2. Other areas: Minimum density of 90 percent of maximum dry density.

**3.5 TOLERANCES**

- A. Top of compacted surface: Plus or minus 1/2 inch in cross section, or in 16 foot length.

**3.6 FIELD QUALITY CONTROL**

- A. Compaction Testing will be performed in accordance with ASTM D 1556 or ASTM D 2922 and ASTM D 3017 under provisions of Section 01450 – Testing Laboratory Services.
- B. Three or more tests, at Engineer’s/Owner’s option, will be taken for each 1,000 linear feet per lane of roadway or 500 square yards of embankment per lift.
- C. If tests indicate work does not meet specified compaction requirements, recondition, re-compact, and retest at Contractor's expense.

**3.7 CLEAN-UP AND RESTORATION**

- A. Perform clean-up and restoration in and around construction zone in accordance with Section 01140 - Contractor’s Use of Premises.
- B. In unpaved areas, grade surface as a uniform slope from installed appurtenances to natural grade and stabilize as indicated on Plans.

**3.8 PROTECTION OF THE WORK**

- A. Maintain excavation and embankment areas until start of subsequent work. Repair and re-compact slides, washouts, settlements, or areas with loss of density at no cost to the Owner
- B. Prevent erosion at all times. Maintain ditches and cut temporary swales to allow natural drainage in order to avoid damage to roadway. Do not allow water to pond in excavations.
- C. Distribute construction traffic evenly over compacted areas, where practical, to aid in obtaining uniform compaction. Protect exposed areas having high moisture content from wheel loads that cause rutting.

**END OF SECTION**

**Section 02318****EXCAVATION AND BACKFILL FOR UTILITIES****1.0 GENERAL****1.01 SECTION INCLUDES**

- A. Excavation, trenching, foundation, embedment, and backfill for installation of utilities, storm sewers including manholes, pipeline structures and other associated appurtenances.
- B. References to Technical Specifications:
  - 1. Section 01200 – Measurement and Payment Procedures
  - 2. Section 01350 – Submittals
  - 3. Section 01570 – Trench Safety System
  - 4. Section 01564 – Control of Ground Water and Surface Water
  - 5. Section 01760 – Project Record Documents
  - 6. Section 01450 – Testing Laboratory Services
  - 7. Section 01500 – Temporary Facilities and Controls
  - 8. Section 02255 – Bedding, Backfill, and Embankment Materials
  - 9. Section 02370 – Geotextile
  - 10. Section 02220 – Site Demolition
  - 11. Section 01140 – Contractor’s Use of Premises
- C. Referenced Standards:
  - 1. American Society for Testing and Materials (ASTM)
    - a. ASTM D 2321, “Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications”
    - b. ASTM D 698, “Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort”
    - c. ASTM D 558, “Standard Test Methods for Moisture-Density (Unit Weight) Relations of Soil-Cement Mixtures”
    - d. ASTM D 4318, “Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils”
    - e. ASTM D 1556, “Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method”
    - f. ASTM D 2922, “Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)”
    - g. ASTM D 3017, “Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)”

2. Texas Department of Transportation (TxDOT)
  - a. Tex-101-E, Preparing Soil and Flexible Base Materials for Testing
  - b. Tex-110-E, Particle Size Analysis of Soils

D. Definitions:

1. Excavation - Any man-made cut, cavity, trench, or depression in an earth surface, formed by removal of material.
  - a. Extra Hand Excavation- excavation by manual labor at locations designated by the Engineer, which is not included in other Bid Items.
  - b. Extra Machine Excavation- excavation by machine at locations designated by the Engineer, which is not included in other Bid Items.
  - c. Special Excavation-excavation necessitated by obstruction of pipes, ducts, or other structures, not shown on Plans, which interfere with installation of utility piping by normal methods of excavation or augering. Contractor shall be responsible for locating such underground obstructions, sufficiently in advance of trench excavation or augering, to preclude damage to the obstructions.
2. Pipe Foundation - suitable and stable native soils that are exposed at the trench subgrade after excavation to depth of bottom of the bedding as shown on the Plans, or foundation backfill material placed and compacted in over-excavations.
3. Pipe Bedding - the portion of trench backfill that extends vertically from top of foundation up to a level line at bottom of pipe, and horizontally from one trench sidewall to opposite sidewall.
4. Haunching - the material placed on either side of pipe from top of bedding up to spring-line of pipe and horizontally from one trench sidewall to opposite sidewall.
5. Initial Backfill - the portion of trench backfill that extends vertically from spring-line of pipe (top of haunching) up to a level line 12 inches above top of pipe, and horizontally from one trench sidewall to opposite sidewall.
6. Pipe Embedment - the portion of trench backfill that consists of bedding, haunching, and initial backfill.
7. Trench Zone - the 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.

8. Trench Conditions - description of the 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.
  - a. Dry Stable Trench: Stable and substantially dry trench conditions exist in pipe embedment zone as a result of typically dry soils or achieved by ground water control (dewatering or depressurization) for trenches extending below ground water level.
  - b. Stable Trench with Seepage: Stable trench in which ground water seepage is controlled by excavation drainage.
    - 1) 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.
    - 2) Stable Wet Trench in Sandy Soils: Excavation drainage is provided in the embedment zone in combination with ground water control in predominately sandy or silty soils.
  - c. Unstable Trench: Unstable trench conditions exist in the pipe embedment zone if ground water inflow or high water content causes soil disturbances, such as sloughing, sliding, boiling, heaving or loss of density.
9. Sub-trench - a 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 a sub-trench depends upon trench stability and safety as determined by the Contractor.
10. Trench Dam - a placement of low permeability material in pipe embedment zone or foundation to prohibit ground water flow along the trench.
11. 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.
12. Foundation Backfill Materials - natural soil or manufactured aggregate of controlled gradation, and geo-textile 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.

13. Trench Shield (Trench Box) - a portable worker safety structure moved along the trench as work proceeds, used as a Protective System and designed to withstand forces imposed on it by cave-in, thereby protecting persons within the trench. Trench shields may be stacked if so designed or placed in a series depending on depth and length of excavation to be protected.

## 1.02 MEASUREMENT AND PAYMENT

- A. Unless indicated as a Bid Item, no separate payment will be made for trench excavation, embedment, and backfill under this Section. Include cost in Bid Items for all excavation and backfill associated with the placement and construction of: underground piping, boxes, manholes and associated appurtenances including conduit, or duct work.
- B. If Special Excavation is allowed, based on the Engineer's direction, and indicated in Section 00300 – Bid Proposal as an Extra Item, measurement will be on a cubic yard basis, measured in place, without deduction for space occupied by portions of pipes, ducts, or other structures left in place across trenches excavated under this item.
  1. Payment for Special Excavation shall include:
    - a. Dewatering and surface water control.
    - b. Protection of pipes, ducts, or other structures encountered including bracing, shoring, and sheeting necessary for support.
    - c. Replacement of pipes, ducts, or structures damaged by special excavation operations, except where payment for replacement is authorized by Engineer due to deteriorated condition of pipes, ducts, or structure.
    - d. Temporary disconnecting, plugging, and reconnecting of low volume water pipes, to allow machine excavation or augering, when approved by Engineer. Pipe for replacement shall be new and conform to specification requirements for type of existing pipe removed.
    - e. Placement of material from Special Excavation.
    - f. Geo-textile material and concrete trench dams required to complete the placement of material from Special Excavation.
    - g. Re-sodding required for surface restoration within designated limits of Special Excavation.
    - h. Disposal of excess excavated material not suitable for bedding or backfill, or not required for the Work.
  2. The items listed below will not be included in payment for Special Excavation. Include cost in Bid Items for which the Work is a component:



- 
- a. Trench safety system including sheeting and shoring.
  - b. Utility piping installed in trenches excavated under this item.
  - c. Removal and replacement of associated streets, driveways, and sidewalks.
- C. If Extra Hand Excavation is allowed, based on the Engineer's direction, and indicated in Section 00300 – Bid Proposal as an Extra Item, measurement will be on a cubic yard basis, measured in place.
1. Payment for Extra Hand Excavation shall include:
    - a. Dewatering and surface water control.
    - b. Disposal of excess excavated material not suitable for bedding or backfill, or not required for the Work.
    - c. Placement of material from Extra Hand Excavation.
    - d. Re-sodding required for surface restoration within designated limits of Extra Hand Excavation.
  2. The items listed below will not be included in payment for Special Excavation. Include cost in Bid Items for which the Work is a component.:
    - a. Trench safety system including sheeting and shoring.
    - b. Removal and replacement of associated streets, driveways, and sidewalks.
- D. If Extra Machine Excavation is allowed, based on the Engineer's direction, and indicated in Section 00300 – Bid Proposal as an Extra Item, measurement will be on a cubic yard basis, measured in place.
1. Payment for Extra Machine Excavation shall include:
    - a. Dewatering and surface water control.
    - b. Disposal of excess excavated material not suitable for bedding or backfill, or not required for the Work.
    - c. Placement of material from extra machine excavation.
    - d. Re-sodding required for surface restoration within designated limits of Extra Machine Excavation.
  2. The items listed below will not be included in payment for Special Excavation. Include cost in Bid Items for which the Work is a component:
    - a. Trench safety system including sheeting and shoring.
    - b. Removal and replacement of associated streets, driveways, and sidewalks.

- E. Refer to Section 01200 - Measurement and Payment Procedures. No payment will be made for delays in completion of Work resulting from Extra Item Work.

### **1.03 SUBMITTALS**

- A. Make Submittals required by this Section under the provisions of Section 01350 – Submittals.
- B. Submit a written description for information only of the planned typical method of excavation, backfill placement and compaction, including:
  - 1. Sequence of work and coordination of activities.
  - 2. Selected trench widths.
  - 3. Procedures for foundation and embedment placement, and compaction.
  - 4. Procedure for use of trench boxes and other pre-manufactured systems while assuring specified compaction against undisturbed soil.
  - 5. Procedure for installation of Special Shoring at locations identified on the Plans.
- C. Submit product quality, material sources, and field quality information in accordance with this Section.
- D. Submit field red lines documenting location of Utilities as installed, referenced to survey Control Points, under the provisions of Section 01760 – Project Record Documents, 1.04C. Include location of utilities and structures encountered or rerouted. Give horizontal dimensions, elevations, inverts and gradients.

### **1.04 TESTING**

- A. Testing and analysis of product quality, material sources, or field quality shall be performed by an independent testing laboratory provided by the Owner under the provisions of Section 01450 – Testing Laboratory Services and as specified in this Section.

### **1.05 PROTECTION OF PEOPLE AND PROPERTY**

- A. Contractor shall conduct all construction operations under this Contract in conformance with the practices described in Section 01500 – Temporary Facilities and Controls.

**1.06 SPECIAL SHORING DESIGN REQUIREMENTS**

- A. Special Shoring shall be, in accordance with Section 01570 – Trench Safety System, designed by a Professional Engineer, licensed by the State of Texas, At Contractor's expense.
- B. Special Shoring shall be designed to provide support for the sides of the 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.
- C. Special Shoring may be a pre-manufactured system or a field fabricated system that meets the requirements of the Work.

**2.0 PRODUCTS****2.01 MATERIALS**

- A. Contractor shall provide materials used as embedment, backfill, back-dressing, and embankment identified on the Plans in accordance with Section 02255 – Bedding, Backfill and Embankment Material.
- B. Manufactured materials, such as crushed concrete, may be substituted for natural soil or rock products where indicated in the product specification, and approved by the Engineer, provided that the physical property criteria are determined to be satisfactory by testing.
- C. Geotextile (Filter Fabric): Conform to requirements of Section 02370 – Geotextile.
- D. Concrete for Trench Dams: Concrete backfill or 3 sack premixed (bag) concrete.
- E. Timber Shoring Left in Place: Untreated oak.

**2.02 EQUIPMENT**

- A. Perform excavation with track mounted excavator or other equipment suitable for achieving the requirements of this Section.
- B. Use only hand-operated tamping equipment until a 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 the Special Shoring design requirements.

**3.0 EXECUTION**

**3.01 PREPARATION**

- A. Employ a Trench Safety Program as specified in Section 01570 – Trench Safety Systems.
- B. Install and operate necessary dewatering and surface water control measures conform to Section 01564 – Control of Ground Water and Surface Water.
- C. Remove existing pavements and structures, including sidewalks and driveways, to conform with requirements of Section 02220 – Site Demolition, as applicable.
- D. Area shall be cleared and grubbed under the provisions of Section 02200 – Site Preparation prior to excavation.
- E. Strip and stockpile topsoil under the provisions of Section 02200 – Site Preparation
- F. Schedule work so that pipe embedment can be completed on the same day that acceptable foundation has been achieved for each section of pipe installation, manhole, or other structures.

**3.02 EXCAVATION**

- A. Except as otherwise specified or shown on the Plans, 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 Plans. Avoid disturbing surrounding ground and existing facilities and improvements.
- C. Determine trench excavation widths using the following schedule as related to pipe outside diameter (O.D.). Maximum trench width shall be the minimum trench width plus 24 inches.

<b>NOMINAL PIPE SIZE, INCHES</b>	<b>MINIMUM TRENCH WIDTH, INCHES</b>
Less than 18	O.D. + 18
18 to 30	O.D. + 24
Greater than 30	O.D. + 36

- 
- D. Use sufficient trench width or benches above the embedment zone for installation of well point headers or manifolds and pumps where depth of trench makes it uneconomical or impractical to pump from the 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 not designated for removal, or concealed conditions, discontinue work at that location. Notify the Engineer and obtain instructions before proceeding.
- F. Shoring of Trench Walls.
1. Install Special Shoring in advance of trench excavation or simultaneously with the trench excavation, so that the soils within the full height of the trench excavation walls will remain fully laterally supported at all times.
  2. For all types of shoring, support trench walls in the pipe embedment zone throughout the installation. Provide trench wall supports sufficiently tight to prevent washing the trench wall soil out from behind the trench wall support.
  3. Unless otherwise directed by the Engineer, leave sheeting driven into or below the pipe embedment zone in place to preclude loss of support of foundation and embedment materials. Leave rangers, walers, and braces in place as long as required to support sheeting, which has been cut off, and the trench wall in the vicinity of the pipe zone.
  4. Employ special methods for maintaining the 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 the pipe embedment zone, do not disturb pipe foundation and embedment materials by subsequent removal. Maximum thickness of removable sheeting extending into the embedment zone 1 inch. Fill voids left on removal of supports with compacted backfill material.
- G. Use of Trench Shields. When a trench shield (trench box) is used as a 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 the trench sidewalls.
  2. Move trench shields so that pipe, and backfill materials, after placement and compaction, are not damaged nor disturbed, nor the degree of compaction reduced.

3. When required, place, spread, and compact pipe foundation and bedding materials beneath the shield. For backfill above bedding, move the shield as backfill is placed and ramped in. 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 a safe manner.

### **3.03 TRENCH FOUNDATION**

- A. Excavate bottom of trench to uniform grade to achieve stable trench conditions and satisfactory compaction of foundation or bedding materials.
- B. 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.

### **3.04 PIPE EMBEDMENT PLACEMENT AND COMPACTION**

- A. Immediately prior to placement of embedment materials, the bottoms and sidewalls of trenches shall be free of loose, sloughing, caving, or otherwise unsuitable soil.
- B. Place Geotextile, if specified, to prevent particle migration from the in-situ into open-graded (Class I) embedment materials or drainage layers.
- C. Place embedment including bedding, haunching and initial backfill to meet requirements indicated on Plans. PVC & HDPE require cement stabilized sand bedding and backfill to one foot below subgrade or below grade if under pavement, or one foot above top of pipe if not under pavement.
- D. For pipe installation, manually spread embedment materials around the pipe to provide uniform bearing and side support when compacted. Do not allow materials to free-fall from heights greater than 24 inches above top of pipe. Perform placement and compaction directly against the undisturbed soils in the trench sidewalls, or against sheeting which is to remain in place.
- E. Do not place trench shields or shoring within height of the embedment zone unless means to maintain the density of compacted embedment material are used. If moveable supports are used in embedment zone, lift the supports incrementally to allow placement and compaction of the material against undisturbed soil.
- 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 the 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 the pipe with sand bags or other suitable means.
- H. Place electrical conduit directly on foundation without bedding.
- I. Shovel pipe embedment material in place and compact it using pneumatic tampers in restricted spaces, and vibratory-plate compactors or engine-powered jumping jacks in unrestricted spaces. Compact each lift before proceeding with placement of the next lift.
  - 1. Class I embedment materials.
    - a. Maximum 6-inches compacted lift thickness.
    - b. Systematic compaction by at least two passes of vibrating equipment. Increase compaction effort as necessary to effectively embed the pipe to meet the deflection test criteria.
    - c. Moisture content as determined by Contractor for effective compaction without softening the soil of trench bottom, foundation or trench walls.
  - 2. Class II embedment and cement stabilized sand.
    - a. Maximum 6-inches compacted thickness.
    - b. Compaction by methods determined by Contractor to achieve a minimum of 95 percent of the maximum dry density as determined according to ASTM D 698 for Class II materials and according to ASTM D 558 for cement stabilized materials.
    - c. Moisture content of Class II materials within 3 percent of optimum as determined according to ASTM D 698. Moisture content of cement stabilized sands on the dry side of optimum as determined according to ASTM D 558 but sufficient for effective hydration.
- J. Place trench dams in Class I embedments 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.

### **3.05 TRENCH ZONE BACKFILL PLACEMENT AND COMPACTION**

- A. Place backfill for pipe or conduits and restore surface as soon as practicable. Leave only the minimum length of trench open as necessary for construction. Backfill placement and compaction shall apply to all soils excavated for the trench especially including any areas that were “benched” or over-excavated in place of trenched shoring. All disturbed soils generated during excavation, whether inside the trench or associated with it, shall be considered to fall under this requirement.

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- B. Where damage to completed pipe installation work is likely to result from withdrawal of sheeting, leave the sheeting in place. Cut off sheeting 1.5 feet or more above the crown of the pipe. Remove trench supports within 5 feet from the ground surface.
- C. For sewer pipes, use backfill materials described here as determined by trench limits. As trench zone backfill in paved areas for streets and to one foot back of curbs and pavements, use cement stabilized sand for pipe of nominal sizes less than 36 inches, or Bank Sand for pipe of nominal sizes 36 inches and larger as indicated on the Drawings. Uniformly backfill trenches unless specified otherwise according to the paved area criteria. Use select backfill within one foot below pavement subgrade for rigid pavement. For asphalt concrete, use flexible base material within one foot below pavement subgrade.
- D. For water lines, backfill in trench zone, including auger pits, with Bank Sand, Select Fill, or Random Fill material as specified in this Section.
- E. For trench excavations under pavement, place trench zone backfill in lifts and compact by methods indicated below. Fully compact each lift before placement of the next lift.
1. Bank Sand.
    - a. Maximum 9-inches compacted lift thickness.
    - b. Compaction by vibratory equipment to a minimum of 95 percent of the maximum dry density determined according to ASTM D 698.
    - c. Moisture content within 3 percent of optimum determined according to ASTM D 698
  2. Cement Stabilized Sand.
    - a. Maximum lift thickness determined by Contractor to achieve uniform placement and required compaction, but not exceeding 24 inches.
    - b. Compaction by vibratory equipment to a minimum of 95 percent of the maximum dry density determined according to ASTM D 558.
    - c. Moisture content on the dry side of optimum determined according to ASTM D 558 but sufficient for cement hydration.
  3. Select Fill.
    - a. Maximum 6-inches compacted thickness.
    - b. Compaction by equipment providing tamping or kneading impact to a minimum of 95 percent of the maximum dry density determined according to ASTM D 698.
    - c. Moisture content within 2 percent of optimum determined according to ASTM D 698.
- F. For trench excavations outside pavements, a Random Fill of suitable material may be used in the trench zone.



1. Fat clays (CH) may be used as trench zone backfill outside paved areas at the Contractor's option. If the required density is not achieved, the Contractor, at his option and at no additional cost to the Owner, may use lime stabilization to achieve compaction requirements or use a different suitable material.
2. Maximum 9-inch compacted lift thickness for clayey soils and maximum 12-inch lift thickness for granular soils.
3. Compact to a minimum of 90 percent of the maximum dry density determined according to ASTM D 698, or to same density as adjacent soils.
4. Moisture content as necessary to achieve density.

### **3.06 MANHOLES, JUNCTION BOXES AND OTHER PIPELINE STRUCTURES**

- A. Meet the requirements of adjoining utility installations for backfill of pipeline structures, as shown on the Plans.

### **3.07 FIELD QUALITY CONTROL**

- A. Quality Control
  1. The Engineer may sample and test backfill at:
    - a. Sources including borrow pits, production plants and Contractor's designated off-site stockpiles.
    - b. On-site stockpiles.
    - c. Materials placed in the Work.
  2. The Engineer may resample material at any stage of work or location if changes in characteristics are apparent.
- B. Production Verification Testing: The Owner's testing laboratory will provide verification testing on backfill materials, as directed by the Engineer. Samples may be taken at the source or at the production plant, as applicable.
- C. Provide excavation and Trench Safety Systems at locations and to depths required for testing and retesting during construction.
- D. Tests will be performed on a minimum of three different samples of each material type for plasticity characteristics, in accordance with ASTM D 4318, and for gradation characteristics, in accordance with Tex-101-E and Tex-110-E. Additional classification tests will be performed whenever there is a noticeable change in material gradation or plasticity.

- E. At least three tests for moisture-density relationships will be performed initially for backfill materials in accordance with ASTM D 698, and for cement stabilized sand in accordance with ASTM D 558. Additional moisture-density relationship tests will be performed whenever there is a noticeable change in material gradation or plasticity.
- F. In-place density tests of compacted pipe foundation, embedment and trench zone backfill soil materials will be performed according to ASTM D 1556, or ASTM D 2922 and ASTM D 3017, and at the following frequencies and conditions.
  - 1. A minimum of one test for every 100 linear feet measured along pipe for compacted embedment and for every 100 linear feet measured along pipe for compacted trench zone backfill material. Testing shall be performed for each lift thickness for different backfill material specified in Item 3.05.
  - 2. A minimum of three density tests for each full shift of Work when backfill is placed.
  - 3. Density tests will be distributed among the placement areas. Placement areas are: foundation, bedding, haunching, initial backfill and trench zone.
  - 4. The number of tests will 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 may be performed at various depths below the fill surface by pit excavation. Material in previously placed lifts may therefore be subject to acceptance/rejection.
  - 6. Two verification tests will be performed adjacent to in-place tests showing density less than the acceptance criteria. Placement will be rejected unless both verification tests show acceptable results.
  - 7. Re-compacted placement will be retested at the same frequency as the first test series, including verification tests.
- G. Recondition, re-compact, and retest at Contractor's expense if tests indicate Work does not meet specified compaction requirements. For Cement Stabilized Sand with nonconforming density, core and test for compressive strength at Contractor's expense.
- H. Acceptability of crushed rock compaction will be determined by inspection.

### **3.08 CLEAN-UP AND RESTORATION**

- A. Perform clean-up and restoration in and around construction zone in accordance with Section 01140 – Contractor's Use of Premises.

**3.09 PROTECTION OF THE WORK**

- A. Maintain excavation and embankment areas until start of subsequent work. Repair and re-compact slides, washouts, settlements, or areas with loss of density at no cost to the Owner
- B. Prevent erosion at all times. Do not allow water to pond in excavations.
- C. Distribute construction traffic evenly over compacted areas, where practical, to aid in obtaining uniform compaction. Protect exposed areas having high moisture content from wheel loads that cause rutting.
- D. Coordinate excavation within 15 feet of existing utilities with utility representative. Excavate by hand to locate existing utility, support utility with methods agreed upon by utility representative. All work shall be subsidiary to bid items in Section 00300 Bid Proposal. No additional cost to City.

**END OF SECTION**

**Section 02330****EMBANKMENT****1.0 GENERAL****1.01 SECTION INCLUDES**

- A Construction of embankments with excess excavated material and borrow.
- B References to Technical Specifications:
  - 1. Section 01200 – Measurement and Payment Procedures
  - 2. Section 01350 – Submittals
  - 3. Section 01760 – Project Record Documents
  - 4. Section 01570 – Trench Safety System
  - 5. Section 01450 – Testing Laboratory Services
  - 6. Section 01500 – Temporary Facilities and Controls
  - 7. Section 02255 – Bedding, Backfill and Embankment Material
  - 8. Section 02910 – Topsoil
  - 9. Section 01564 – Control of Ground Water and Surface Water
  - 10. Section 01720 – Field Surveying
  - 11. Section 02220 – Site Demolition
  - 12. Section 02200 – Site Preparation
  - 13. Section 01140 – Contractor’s Use of Premises
- C Referenced Standards:
  - 1. American Society for Testing and Materials (ASTM)
    - a. ASTM D 698, “Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort”
    - b. ASTM D 1556, “Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method”
    - c. ASTM D 2922, “Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)”
    - d. ASTM D 3017, “Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)”

**1.02 MEASUREMENT AND PAYMENT**

- A Unless indicated as a Bid Item, no separate payment will be made for Embankment under this Section. Include cost in Bid Items for which this Work is a component.
- B If embankment is included as a Bid Item, measurement will be based on the Units shown in Section 00300 – Bid Proposal and in accordance with Section 01200 – Measurement and Payment Procedures.

**1.03 SUBMITTALS**

- A Make Submittals required by this Section under the provisions of Section 01350 – Submittals.
- B Submit product quality, material sources, and field quality information in accordance with this Section.
- C Submit field red lines documenting location of embankments as installed, referenced to survey Control Points, under the provisions of Section 01760 – Project Record Documents, 1.04C. Include location of utilities and structures encountered or rerouted. Give horizontal dimensions, elevations, inverts and gradients.
- D Submit a Trench Safety Plan under the provisions of Section 01570 – Trench Safety System that included measures that establish compliance with the standard interpretation of the General Duty Clause, Section 5.(a)(1), of the Occupational Safety and Health Act of 1970 – 20 USC 654 which states, “Employers must shore or otherwise protect employees who walk/work at the base of an embankment from possible collapse.”

**1.04 TESTING**

- A Testing and analysis of product quality, material sources, or field quality shall be performed by an independent testing laboratory provided by the Owner under the provisions of Section 01450 – Testing Laboratory Services and as specified in this Section.

**1.05 PROTECTION OF PEOPLE AND PROPERTY**

- A Contractor shall conduct all construction operations under this Contract in conformance with the practices described in Section 01500 – Temporary Facilities and Controls.

**2.0 PRODUCTS****2.01 MATERIALS**

- A Contractor shall provide materials used as embedment, backfill, back-dressing, and embankment identified on the Plans in accordance with Section 02255 – Bedding, Backfill and Embankment Material.
- B Topsoil: Conform to requirements of Section 02910 – Topsoil.
- C Borrow Material: Conform to requirements of intended use. Take borrow material from sources approved by Engineer.

### **3.0 EXECUTION**

#### **3.01 EXAMINATION**

- A Verify borrow and excess excavated materials to be reused, are approved.
- B Verify removals, and clearing and grubbing operations, have been completed.
- C Verify backfill of new or relocated utilities and structures, below future grade, is complete.

#### **3.02 PREPARATION**

- A Employ a Trench Safety Plan as specified in Section 01570 – Trench Safety Systems.
- B Install and operate necessary dewatering and surface water control measures in accordance with requirements of Section 01564 – Control of Ground Water and Surface Water.
- C Identify required lines, levels, and datum. Coordinate with Section 01720 – Field Surveying.
- D Remove existing pavements and structures, including sidewalks and driveways, in conformance with requirements of Section 02220 – Site Demolition, as applicable.
- E Area shall be cleared and grubbed under the provisions of Section 02200 – Site Preparation prior to placing embankment or opening borrow source.
- F Strip and stockpile topsoil under the provisions of Section 02200 – Site Preparation.
- G Backfill test pits, or stump holes and other surface irregularities such as small swales with embankment materials and compact in proper lift depths according to the compaction requirements of this Section.
- H Areas of unsuitable material shall be removed, backfilled with embankment materials and compacted in proper lift depths according to the compaction requirements of this Section.
- I Upon discovery of unknown or badly deteriorated utilities, or concealed conditions, discontinue work. Notify Engineer and obtain instructions before proceeding in such areas.

#### **3.03 PLACEMENT AND COMPACTION**

- A Do not conduct placement operations during inclement weather or when existing ground or embankment materials exceed 3 percent of optimum moisture content. Contractor may manipulate wet material to facilitate drying, by disking or windrowing, at Contractor's expense.

- B Do not place embankment material until density and moisture content of previously placed material complies with specified requirements.
- C Scarify areas to receive embankment to a minimum depth of 4 inches to bond existing and new materials. Mix with first layer of embankment material.
- D Spread embankment material evenly, from dumped piles or windrows, into horizontal layers approximately parallel to finished grade. Place to meet specified compacted thickness. Break clods and lumps and mix materials by blading, harrowing, discing, or other approved method. Each layer shall extend across full width of embankment.
- E Each layer shall be homogeneous and contain uniform moisture content before compaction. Mix dissimilar abutting materials to prevent abrupt changes in composition of embankment.
- F Layers shall not exceed depth as indicated on the Plans.
- G Where shown on Plans for steep slopes, cut benches into slope and scarify before placing embankment. Place increasingly wide horizontal layers of specified depth, to the level of each bench.
- H Build embankment layers on back slopes, adjacent to existing roadbeds, to level of old roadbed. Scarify top of old roadbed to minimum depth of four inches and re-compact with next layer.
- I Construct to lines and grades shown on Plans.

### **3.04 COMPACTION REQUIREMENTS**

- A Maintain moisture content of embankment materials to attain required compaction density.
- B Compact to minimum densities shown on the Plans with a moisture content of optimum to 3 percent above optimum as determined by ASTM D 698.

### **3.05 TOLERANCES**

- A Top of compacted surface: Plus or minus  $\frac{1}{2}$  inch in cross section, or in 16 foot length.

### **3.06 FIELD QUALITY CONTROL**

- A Compaction testing will be performed in accordance with ASTM D 1556 or ASTM D 2922 and ASTM D 3017 under provisions of Section 01450 – Testing Laboratory Services.
- B A minimum of three tests will be taken for each 1,000 linear feet per lane of roadway or 500 square yards of embankment per lift.

- C If tests indicate work does not meet specified compaction requirements, recondition, re-compact, and retest at Contractor's expense.

### **3.07 CLEAN-UP AND RESTORATION**

- A Perform clean-up and restoration in and around construction zone in accordance with Section 01140 – Contractor's Use of Premises.
- B In unpaved areas, grade surface as a uniform slope from installed appurtenances to natural grade and stabilize as indicated on Plans.

### **3.08 PROTECTION OF THE WORK**

- A Maintain all embankment areas in good condition until completion of Work.
- B Repair and re-compact slides, washouts, settlements, areas with loss of density, or excavation damaged by Contractor's operations at no additional cost to Owner.
- C Distribute construction traffic evenly over compacted areas, where practical, to aid in obtaining uniform compaction. Protect exposed areas having high moisture content from wheel loads that cause rutting.

**END OF SECTION**



**Section 02335****SUBGRADE****1.0 GENERAL****1.01 SECTION INCLUDES**

- A. Foundation course of lime and Portland Cement stabilized in situ subgrade material.
- B. References to Technical Specifications:
  - 1. Section 01200 – Measurement and Payment Procedures
  - 2. Section 01350 – Submittals
  - 3. Section 01450 – Testing Laboratory Services
  - 4. Section 01500 – Temporary Facilities and Controls
  - 5. Section 01564 – Control of Ground Water and Surface Water
  - 6. Section 01720 – Field Surveying
  - 7. Section 01140 – Contractor’s Use of Premises
- C. Referenced Standards:
  - 1. American Society for Testing and Materials (ASTM)
    - a. ASTM D 4318, “Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils”
    - b. ASTM D 698, “Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort”
    - c. ASTM D 1556, “Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method”
    - d. ASTM D 2922, “Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)”
    - e. ASTM D 3017, “Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)”
    - f. ASTM C 150 - Standard Specification for Portland Cement.
    - g. ASTM D 558 - Standard Test Method for Moisture-Density Relations of Soil-Cement-Mixtures.

**1.02 MEASUREMENT AND PAYMENT**

- A. Measurement for subgrade is on a square yard basis. Separate payment will be made for each different required type and thickness of stabilized Subgrade. Limits of measurement shall match actual pavement replaced, but no greater than maximum pavement replacement limits shown on Drawings. Limits for measurement will be extended to include installed stabilized subgrade material that extends 2 foot beyond outside edge of pavement to be replaced, except where proposed pavement section

shares common longitudinal or transverse edge with existing pavement section. No payment will be made for stabilized subgrade in areas beyond these limits.

- B. Measurement for hydrated lime and quicklime is by the ton of 2,000 pounds dry-weight basis, determined by the area to be covered and the rate of application. Do not include cost of hydrated lime or quicklime in Bid Item for subgrade.
- C. Measurement for lime slurry is by the ton of 2,000 pounds of lime calculated on the percentage by weight of dry solids for the grade of slurry. Do not include cost of lime slurry in Bid Item for subgrade.
- D. Measurement for Portland Cement is by the ton of 2,000 pounds of dry weight basis. Do not include cost of Portland Cement in Bid Item for subgrade.
- E. Refer to Section 01200 – Measurement and Payment Procedures.

### **1.03 SUBMITTALS**

- A. Make Submittals required by this Section under the provisions of Section 01350 – Submittals.
- B. Submit certificates stating that hydrated lime, commercial lime slurry and quicklime complies with the requirements in this Section.
- C. Submit weight tickets, certified by supplier, with each bulk delivery of lime to Project Site.
- D. Submit manufacturer's description and characteristics for rotary speed mixer and compaction equipment for approval.

### **1.04 TESTING AND SAMPLING**

- A. Testing will be performed under provisions of Section 01450 – Testing Laboratory Services.
- B. Tests and analysis of soil materials will be performed in accordance with ASTM D 4318.
- C. Sampling and testing of lime slurry shall be in accordance with Tex-600-J.
- D. Sample mixtures of Portland Cement, hydrated lime or quicklime in slurry form will be tested to establish compliance with the requirements in this Section.
- E. Soil will be evaluated to establish percent of hydrated lime, quicklime, or lime slurry to be applied to subgrade material.
- F. Moisture-density relationship will be established on material sample from roadway, after stabilization, in accordance with ASTM D 698.

- G. Soil will be evaluated to establish ratio of cement to soil to obtain desired stability. Normal range is 6 percent to 10 percent by weight.
- H. The percentage of moisture in soil, at time of cement application, will be determined by ASTM D 558. Moisture will not be allowed to exceed quantity that will permit uniform, complete mixture of soil and cement during dry mixing operations nor specified optimum moisture content for soil cement mixture, as determined.

### **1.05 PROTECTION OF PEOPLE AND PROPERTY**

- A. Contractor shall conduct all construction operations under this Contract in conformance with the practices described in Section 01500 – Temporary Facilities and Controls.

### **1.06 DELIVERY, STORAGE, AND HANDLING**

- A. Bagged lime shall bear manufacturer's name, product identification, and certified weight. Bags varying more than 5 percent of certified weight may be rejected; average weight of 50 random bags in each shipment shall not be less than certified weight.
- B. Store lime in weatherproof enclosures. Protect lime from ground dampness.
- C. Quicklime can be dangerous; exercise extreme caution if used for the Work. Contractor shall become informed about recommended precautions in the handling, storage and use of quicklime.

## **2.0 PRODUCTS**

### **2.01 WATER**

- A. Water shall be clean; clear; and free from oil, acids, alkali, or organic matter.

### **2.02 LIME**

- A. Type A - Hydrated Lime: Dry material consisting essentially of calcium hydroxide or mixture of calcium hydroxide and an allowable percentage of calcium oxide and magnesium hydroxide.
- B. Type B - Lime Slurry: Liquid mixture consisting essentially of lime solids and water in slurry form. Water or liquid portion shall not contain dissolved material in sufficient quantity to be injurious or objectionable for purpose intended.
- C. Type C - Quicklime: Dry material consisting essentially of calcium oxide. Furnish quicklime in either of the following grades:

1. Grade DS: Pebble quicklime of a gradation suitable for use in the preparation of a slurry for wet placing.
2. Grade S: Finely-graded quicklime for use in the preparation of a slurry for wet placing. Do not use Grade S quicklime for dry placing. (So called "Blue Lime" is not acceptable.)

D. Lime shall conform to following requirements:

CHEMICAL COMPOSITION	TYPE		
	A	B	C
Active lime content, % by weight $\text{Ca(OH)}_2 + \text{CaO}$	90.0 min <sup>1</sup>	87.0 min <sup>2</sup>	-
Unhydrated lime content, % by weight CaO	5.0 max	-	87.0 min
Free water content, % by weight H <sub>2</sub> O	5.0 max	-	-
SIZING			
Wet Sieve, as % by weight residue retained:			
No. 6	0.2 max	0.2 max <sup>2</sup>	8.0 max <sup>3</sup>
No. 30	4.0 max	4.0 max <sup>2</sup>	-
Dry sieve, as % by weight residue retained:			
1-inch	-	-	0.0
3/4-inch	-	-	10.0 max

Notes:

<sup>1</sup> Maximum 5.0% by weight CaO shall be allowed in determining total active lime content.

<sup>2</sup> Maximum solids content of slurry.

<sup>3</sup> Total active lime content, as CaO, in material retained on the No. 6 sieve shall not exceed 2.0% by weight of original Type C lime.

E. Lime Slurry may be delivered to the Project Site as Commercial Lime Slurry, or may be prepared at the Project Site using Hydrated Lime or Quicklime. The slurry shall be free of liquids other than water and shall be of a consistency that can be handled and uniformly applied without difficulty.

### 2.03 PORTLAND CEMENT (ONLY WHEN DIRECTED BY ENGINEER)

A. ASTM C 150 Type I, bulk or sacked.

**2.04 SOIL**

- A. Provide soil consisting of approved material free from vegetation or other objectable matter encountered in existing roadbed.

**3.0 EXECUTION****3.01 EXAMINATION**

- A. Verify backfill of new or relocated utilities and structures below future grade is complete.
- B. Verify compacted subgrade is ready to support imposed loads.
- C. Verify subgrade lines and grades are correct.

**3.02 PREPARATION**

- A. Install and operate necessary dewatering and surface water control measures in accordance with requirements of Section 01564 – Control of Ground Water and Surface Water.
- B. Identify required lines, levels, and datum. Coordinate with Section 01720 – Field Surveying.
- C. Cut material to bottom of subgrade using an approved cutting and pulverizing machine meeting following requirements:
  - 1. Cutters accurately provide a smooth surface over entire width of cut to plane of secondary grade.
  - 2. Visible indication that cut is to proper depth.
- D. Alternatively, scarify or excavate to bottom of stabilized subgrade. Remove material or windrow to expose secondary grade. Correct wet or unstable material below secondary grade by scarifying, adding lime, and compacting. Obtain uniform stability.
- E. Upon discovery of unknown or badly deteriorated utilities, or concealed conditions, discontinue work. Notify Engineer and obtain instructions before proceeding in such areas.

**3.03 LIME SLURRY APPLICATION**

- A. Mix hydrated lime or quicklime with water to form a slurry of the solids content specified. Commercial lime slurry shall have dry solids content as specified. Conform to cautionary requirements in this Section, 1.06C, concerning use of quicklime.

- B. Apply slurry with a distributor truck equipped with an agitator to keep lime and water in a consistent mixture. Make successive passes over measured section of roadway to attain proper moisture and lime content. Limit spreading to an area where preliminary mixing operations can be completed on the same working day.

### **3.04 PRELIMINARY MIXING**

- A. Do not mix and place material when temperature is below 40 degrees F and falling. Base may be placed when temperature taken in shade and away from artificial heat is above 35 degrees F and rising.
- B. Use approved single-pass or multiple-pass rotary speed mixers to mix soil, lime, and water to required depth. Obtain a homogeneous friable mixture free of clods and lumps.
- C. Shape mixed subgrade to final lines and grades.
- D. Seal subgrade as a precaution against heavy rainfall by rolling lightly with light pneumatic rollers.
- E. Cure soil-lime material for 1 to 4 days. Keep subgrade moist during cure.

### **3.05 FINAL MIXING**

- A. Use approved single-pass or multiple-pass rotary speed mixers to uniformly mix cured soil and lime to required depth.
- B. Add water to bring moisture content of soil mixture to a minimum of optimum or above.
- C. Mix and pulverize until all material passes a 1 inch sieve; a minimum of 90 percent, excluding non-slaking fractions, passes a 3/4-inch sieve; and a minimum of 65 percent excluding non-slaking fractions passes a No. 4 sieve.
- D. Shape mixed subgrade to final lines and grades.
- E. Do not expose hydrated lime to open air for more than 6 hours during interval between application and mixing. Avoid excessive hydrated lime loss due to washing or blowing.

### **3.06 MIXING - PORTLAND CEMENT (ONLY WHEN DIRECTED BY ENGINEER)**

- A. Do not place and mix cement when temperature is below 40 degrees F and falling. Place Portland Cement base when temperature taken in shade and away from artificial heat is above 35 degrees F and rising.

- B. Spread cement uniformly on soil at rate specified by laboratory. When bulk cement spreader is used, position it by string lines or other approved method to ensure uniform distribution of cement. Apply cement only to area where operations can be continuous and completed in daylight, within 1 hour of application. Amount of moisture in soil at time of cement placement shall not exceed quantity that will permit uniform mixture of soil and cement during dry mixing operations. Do not exceed specified optimum moisture content for soil cement mixture.
- C. Do not allow equipment other than that used in spreading and mixing, to pass over freshly spread cement until it is mixed with soil.
- D. Dry mix cement with soil after cement application. Continue mixing until cement has been sufficiently blended with soil to prevent formation of cement balls when water is applied. Mixture of soil and cement that has not been compacted and finished shall not remain undisturbed for more than 30 minutes.
- E. Immediately after dry mixing is complete, uniformly apply water as necessary and incorporate it into mixture. Pressurized equipment must provide adequate supply to ensure continuous application of required amount of water to sections being processed within 3 hours of cement application. Ensure proper moisture distribution at all times. After last increment of water has been added, continue mixing until thorough and uniform mix has been obtained.
- F. Ensure percentage of moisture in mixture, based on dry weights, is within 2 percentage points of specified optimum moisture content prior to compaction. When uncompacted soil cement mixture is wetted by rain indicating that average moisture content exceeds tolerance given at time of final compaction, reconstruct entire section in accordance with this Section at no additional cost to City.

### **3.07 COMPACTION - LIME SUBGRADE**

- A. Aerate or sprinkle to attain optimum moisture content as determined by Testing Laboratory. Remove and reconstruct sections where average moisture content exceeds ranges specified at time of final compaction.
- B. Start compaction immediately after final mixing, unless approved by Engineer.
- C. Spread and compact in two or more approximately equal layers where total compacted thickness is to be greater than 8 inches.
- D. Compact with approved heavy pneumatic or vibrating rollers, or a combination of tamping rollers and light pneumatic rollers. Begin compaction at the bottom and continue until entire depth is uniformly compacted.
- E. Do not allow stabilized base to mix with underlying material. Correct irregularities or weak spots immediately by replacing material and re-compacting.

- F. Compact to following minimum densities at a moisture content of optimum to 3 percent above optimum as determined by ASTM D 698, unless otherwise indicated on the Plans:
  - 1. Areas to receive pavement without subsequent base course: Minimum density of 98 percent of maximum dry density.
  - 2. Areas to receive subsequent base course: Minimum density of 95 percent of maximum dry density.
- G. Seal with approved light pneumatic tired rollers: Prevent surface hair line cracking. Rework and re-compact at areas where hair line cracking develops.
- H. Contractor shall conduct operations to minimize elapsed time between mixing and compacting stabilized subgrade in order to take advantage of rapid initial set characteristics. Complete compaction within 2 hours of commencing compaction and not more than 6 hours after adding and mixing the last stabilizing agent.

### **3.08 COMPACTION - PORTLAND CEMENT SUBGRADE (ONLY WHEN DIRECTED BY ENGINEER)**

- A. Prior to beginning compaction, ensure mixture is in loose condition for its full depth. Uniformly compact the loose mixture to specified density, lines and grades.
- B. After soil and cement mixture is compacted, apply water uniformly as needed and mix thoroughly. Then reshape surface to required lines, grades and cross section and lightly scarify to loosen imprints left by compacting or shaping equipment.
- C. Roll resulting surface with pneumatic-tired roller and “skin” surface with power grader. Thoroughly compact mixture with pneumatic roller, adding small increments of moisture, as needed. When aggregate larger than No. 4 sieve is present in mixture, make one complete coverage of section with flat-wheel roller immediately after skinning operation. When approved by Project Manager, surface finishing methods may be varied from this procedure, provided dense uniform surface, free of surface compaction planes, is produced. Maintain moisture content of surface material at its specified optimum during finishing operations. Compact and finish surface within period not to exceed 2 hours, to produce smooth, closely knit surface, free of cracks, ridges, or loose material, conforming to crown, grade and line shown on Drawings within period not to exceed 2 hours.

### **3.09 CURING**

- A. Moist cure for a minimum of 3 days before placing base or surface course, or opening to traffic. Time may be adjusted as approved by Engineer. Subgrade may be opened to traffic after 2 days if adequate strength has been attained to prevent damage. Restrict traffic to light pneumatic rollers or vehicles weighing less than 10 tons.



- B. Keep subgrade surface damp by sprinkling. Roll with light pneumatic roller to keep surface knit together.
- C. Place base, surface, or seal course within 14 days after final mixing and compaction unless prior approval is obtained from Engineer.

### **3.10 TOLERANCES**

- A. Top of compacted surface: Plus or minus 1/4 inch in cross section or in 16 foot length.

### **3.11 FIELD QUALITY CONTROL**

- A. A minimum of three phenolphthalein test will be made at random locations per 1000 linear feet per lane of roadway or 500 square yards of base to determine in-place depth.
- B. Contractor may, at his own expense, request additional cores in the vicinity of cores indicating nonconforming in-place depths. If the average of the tests falls below the required depth, place and compact additional material at no cost to the Owner.
- C. Compaction Testing will be performed in accordance with ASTM D 1556 or ASTM D 2922 and ASTM D 3017 at random locations near depth determination tests. Three tests will be performed for each 1000 foot roadway section. Rework and re-compact areas that do not conform to compaction requirements at no cost to the Owner.

### **3.12 CLEAN-UP AND RESTORATION**

- A. Perform clean-up and restoration in and around construction zone in accordance with Section 01140 – Contractor’s Use of Premises.
- B. Fill test pits with new compacted lime stabilized subgrade.
- C. Completed surface shall be smooth and conform to typical section and established lines and grades.
- D. In unpaved areas, grade surface as a uniform slope from installed appurtenances to natural grade and stabilize as indicated on Plans.

### **3.13 PROTECTION OF THE WORK**

- A. Maintain stabilized Subgrade to lines and grades and in good condition until placement of base or surface course.
- B. Protect the asphalt membrane, if used, from being picked up by traffic.

- C. Repair settlements, areas with loss of density, or areas of subgrade damaged by Contractor's operations at no additional cost to Owner by replacing and re-compacting material to full depth.
  
- D. Distribute construction traffic evenly over compacted areas, where practical, to aid in obtaining uniform compaction. Protect exposed areas having high moisture content from wheel loads that cause rutting.

**END OF SECTION**

**Section 02370****GEOTEXTILE****1.0 GENERAL****1.01 SECTION INCLUDES**

- A Geotextile, also called filter fabric, in applications such as under a granular fill, as a pipe embedment wrap, around the exterior of a tunnel liner, or around the foundations of pipeline structures.
- B References to Technical Specifications:
  - 1. Section 01200 – Measurement and Payment Procedures
  - 2. Section 01350 – Submittals
- C Referenced Standards:
  - 1. American Society for Testing and Materials (ASTM)
    - a. ASTM D 4632, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles”
    - b. ASTM D 4533, “Standard Test Method for Trapezoid Tearing Strength of Geotextiles”
    - c. ASTM D 4833, “Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products”
    - d. ASTM D 3786, “Standard Test Method for Hydraulic Bursting strength of Textile Fabrics”
    - e. ASTM D 4751, “Standard Test Method for Determining Apparent Opening Size of a Geotextile”
    - f. ASTM D 4491, “Standard Test Method for Water Permeability of Geotextiles by Permittivity”
  - 2. American Association of State Highway and Transportation Officials (AASHTO)

**1.02 MEASUREMENT AND PAYMENT**

- A Unless indicated as a Bid Item, no separate payment will be made for work performed under this Section. Include cost in Bid Items for Work requiring geotextile.
- B If Geotextile is included as a Bid Item, measurement will be based on the Units shown in Section 00300 – Bid Proposal and in accordance with Section 01200 – Measurement and Payment Procedures.

**1.03 SUBMITTALS**

- A Make Submittals required by this Section under the provisions of Section 01350 – Submittals.
- B Submit the standard manufacturer's catalog sheets and other pertinent information, for approval, prior to installation.

- C Submit installation methods, as a part of the work plan for tunneling or for excavation and backfill for utilities. Obtain approval from Engineer for Geotextile material and the proposed installation method prior to use of the geotextile.

## 2.0 PRODUCTS

### 2.01 GEOTEXTILE

- A Provide a geotextile (filter fabric) designed for use in geotechnical applications which forms a permeable layer or media while retaining the soil matrix.
- B Use a fabric which meets the physical requirements for Class A Subsurface Drainage installation conditions as defined in AASHTO M288 and as specified in this Section, 2.02 "Properties".

### 2.02 PROPERTIES

- A Material: Non-woven, non-biodegradable, fabric consisting only of continuous chain polymer filaments or yarns, at least 85 percent by weight poly-olefins, polyesters or polyamide, formed into a dimensionally stable network.
- B Chemical Resistance: Inert to commonly encountered chemicals and hydrocarbons over a pH range of 3 to 12.
- C Physical Resistance: Resistant to mildew and rot, ultraviolet light exposure, insects and rodents.
- D Minimum Test Values:

PROPERTY	VALUE (MIN)	TEST METHOD
Grab strength	180 lbs	ASTM D 4632
Trapezoidal Tear Strength	50 lbs	ASTM D 4533
Puncture Strength	80 lbs	ASTM D 4833
Mullen Burst Strength	290 psi	ASTM D 3786
Apparent Opening Size <sup>(1)</sup>	0.25 mm	ASTM D 4751
Permittivity (sec <sup>-1</sup> )	0.2	ASTM D 4491

<sup>(1)</sup> Maximum average roll value

## 3.0 EXECUTION - Not used

END OF SECTION

**Section 02415****AUGERING PIPE OR CASING FOR SEWERS****1.0 GENERAL****1.01 SECTION INCLUDES**

- A Installation of pipe and casing for sanitary sewer by methods of augering.
- B References to Technical Specifications:
  - 1. Section 01570 – Trench Safety System
  - 2. Section 01200 – Measurement and Payment Procedures
  - 3. Section 01350 – Submittals
  - 4. Section 01563 – Control of Ground Water and Surface Water
  - 5. Section 01500 – Temporary Facilities and Controls
  - 6. Section 02530 – Gravity Sanitary Sewers
  - 7. Section 02430 – Tunnel Grout
  - 8. Section 02318 – Excavation and Backfill for Utilities
  - 9. Section 01140 – Contractor’s Use of Premises
- C Referenced Standards:
  - 1. American Railway Engineering Association (AREA) Manual for Railway Engineering
  - 2. American Association of State Highway and Transportation Officials (AASHTO)
  - 3. American Water Works Association (AWWA)
    - a. AWWA C200, Steel Water Pipe - 6 in. (150 mm) and Larger
- D Definitions:
  - 1. Dry Augering - installation of steel casing by excavating the soil at the advancing end of casing and transporting the spoil through the casing by an otherwise uncased auger, while advancing the casing by jacking at the same rate as the auger excavation progresses.
  - 2. Slurry Augering - installation of casing or sewer pipe by first drilling a small diameter pilot hole from auger pit to auger pit, followed by reaming the bore to full diameter by augering with slurry, and installing the casing or pipe by a pull-back or jacking method.
  - 3. Augered Pipe - the Contractor's installed water or sewer pipe in augered hole.
  - 4. Augered Casing with Pipe - the Contractor's installed water or sewer pipe in augered casing.

**1.02 MEASUREMENT AND PAYMENT**

- A Measurement for augered casing with sewer pipe will be on a linear foot basis measured from end to end of the casing.

- B Payment of augered casing with sewer pipe will be full compensation for all labor, equipment, casing, sewer pipe, materials and supervision for construction complete in place including dewatering, augering, joints, spoil removal, pipe installation, grouting, utility adjustments, testing, and cleanup, and other work necessary for construction as shown on the Plans and as specified.
- C Measurement of augered sewer pipe will be on a linear foot basis along the axis of the pipe from auger pit to auger pit.
- D Payment of augered sewer pipe will be full compensation for labor, pipe, equipment, materials, and supervision for construction complete in place including dewatering, jacking, utility adjustments, testing, cleanup, and other work necessary for construction as shown on the Plans and as specified.
- E No separate payment will be made for auger pits and other excavations under this section. Include cost of excavation, surface restoration, pavement repair, etc., for auger pits or observation pits in Sections related to the open-cut sewer installation portion of the Work. Include cost of trench safety for auger pits or observation pits in Section 01570 – Trench Safety Systems.
- F Refer to Section 01200 – Measurement and Payment Procedures.

### 1.03 SUBMITTALS

- A Review. Submittal shall be made in accordance with Section 01350 – Submittals. The Engineer will review submitted plans, details and data for compliance with specifications. Contractor shall not commence work on any items requiring pipe and casing augering work plan, or other submittal until the submittal have been reviewed and accepted by the Engineer. Such review by the Engineer shall not be construed in any way of relieving the Contractor of his responsibilities under the Contract, shall not be construed by the contractor as an endorsement by the Engineer that such methods are constructable or will work for the specific subsurface soils encountered. Structural designs and other engineered components shall be signed and sealed by a Professional Engineer registered in the State of Texas.
- B Pipe and Casing Augering Operation.
  - 1. Submit for review a Pipe and Casing Augering Work Plan with complete drawings and written description identifying details of the proposed method of construction and the sequence of operations to be performed during construction, as required. The drawings and descriptions shall be sufficiently detailed to demonstrate to the Engineer whether the proposed materials and procedures will meet the requirements of this Section.
  - 2. Depending on the Contractor's method of construction, the Pipe and Casing Augering Work Plan shall be submitted on the following items:
    - a. Arrangement drawings and technical specifications of the augering equipment and experience record of the Contractor.
    - b. Method of controlling line and grade of augering operation.

- c. Method of spoil and slurry removal, including surface storage and disposal.
  - d. Details of the pipe or casing installation.
  - e. Grouting techniques to be used for filling annular void between casing and sewer pipe, where required, and for filling over excavation, if any, including equipment, pumping and injection procedures, pressure grout types, and mixtures.
  - f. Location and construction of auger pits, including details for all required ground support installation not included in the Trench Safety Plan.
  - g. Groundwater control system per requirements in this section and in accordance with Section 01563 – Control of Ground Water and Surface Water, as required by construction method.
3. Casing and pipe fabrication drawings, including joint details.
- C Trench Safety
1. Shall be in accordance with Section 01570 – Trench Safety System.
  2. To the extent that excavation for pipe and casing augering involves work not covered by Contractor's Trench Safety Plan, the safety provisions of these excavations shall be addressed in the Pipe and Casing Augering Work Plan.
- D Quality Control Methods. At least 30 days prior to the start of augering, the Contractor shall submit a description of the quality control methods proposed for use in this operation to the Project Manager. The submittal shall include:
1. Supervision. Supervisory control to ensure that work is performed in accordance with the Plans and Specifications, and Pipe and Casing Augering Work Plan.
  2. Line & Grade. Procedures for surveying, controlling and checking line and grade, including field forms.
  3. Augering Observation and Monitoring. Procedures for preparing and submitting daily logs of augering operations, including field forms.
  4. Products and Materials. A plan for testing and submittal of test results to demonstrate compliance with the specification and Contractor's design criteria for permanent products, material and installations. The plan shall identify applicable standards and procedures for testing and acceptance.
  5. Monitoring Settlement. Submit a settlement Monitoring Plan if requested by the Engineer.

#### **1.04 PROTECTION OF PEOPLE AND PROPERTY**

- A Contractor shall conduct all construction operations under this Contract in conformance with the practices described in Section 01500 – Temporary Facilities and Controls.

**1.05 CRITERIA FOR DETERMINING INSTALLATION LOADS**

- A Pipes and casings shall be selected by the Contractor to carry overburden pressure and applicable surcharge and installation loads.
- B The criteria to be used for truck loading shall be HS-20 vehicle loading distributions in accordance with AASHTO.
- C The Contractor shall be responsible for the selection of the casing, pipe, and pipe joints to carry the thrust of the jacks or loads due to the pulling mechanism.
- D The Contractor shall select the diameter of the casing to meet the minimum dimensions defined in the Plans, and to permit practical installation (including skids, pipe spiders and shims, if applicable) and grouting, where required.

**2.0 PRODUCTS****2.01 MATERIALS**

- A Casing shall be provided where shown on Plans or indicated in Technical Specifications and be new, uncoated welded steel pipe, manufactured in accordance with AWWA C200. The design stress in the pipe wall shall be 50 percent of the minimum yield point of the steel or 18,000 psi, whichever is less, when subjected to the loading conditions. The design deflection to be used in determining wall thickness shall not exceed 3 percent of nominal casing pipe size.
- B Sewer pipe shall be provided in accordance with Section 02530 – Gravity Sanitary Sewers. The sewer pipe shall be selected by the Contractor and verified by the Contractor's engineer to safely withstand all service loads, including overburden pressures and surcharge loads together with all forces and pressures induced in pipe and joints during installation.
- C For grouting materials refer to Section 02430 – Tunnel Grout.
- D Where casings are required by Plans, casing insulator width 8 inches for pipe sizes 4 to 14 inches; 12 inches for pipe sizes 16 to 30 inches.
  - 1. For welded steel pipe 12 inches and smaller, use Pipeline Seal & Insulator Model PE, or approved equal.
  - 2. For other pipe materials, use Pipeline Seal & Insulator Model C8G-2 or approved equal for pipe sizes up to 12 inches.
  - 3. For all pipe sizes above 12 inches, use Pipeline Seal & Insulator Model C12G-2 or approved equal.
- E Casing End Seals: Provide Pipeline Seal & Insulator Model C or approved equal.

**3.0 EXECUTION**



**3.01 DRY AUGERING (CASING ONLY)**

- A Provide horizontal augering equipment of sufficient capacity for the diameter and length of the casing to be installed and the anticipated ground conditions.
- B Provide heavy-duty jacks of a capacity suitable for forcing the excavating auger and casing through the ground and a suitable jacking frame or backstop. Use operating jacks constructed so that even pressure is applied to all jacks used.
- C Provide steerable front section of casing to allow vertical grade adjustments. A water level or other means shall be provided to allow monitoring of the grade elevation of the auger casing.
- D Set casing to be jacked on guides, properly braced together, to support the section of pipe and direct it to proper line and grade. Place the whole jacking assembly so as to line up with the direction and grade of the pipe.
- E In unconsolidated soil formations, bentonite may be used to seal the voids outside the wall and furnish lubrication for the installation of casing. The use of water to assist in lubrication to facilitate the removal of spoil is permitted, however, water jetting of the soil is not allowed when jacking the casing.
- F Insofar as practical and depending on the character of the soil encountered during the augering operation, conduct operations without interruption to prevent the pipe from seizing up in the hole before the installation is complete.
- G Repair casing damaged in augering operations by method acceptable to the Engineer or remove and replace it.

**3.02 SLURRY AUGERING**

- A Provide horizontal boring equipment for drilling of pilot hole, slurry augering equipment for excavating the full-sized hole for casing or pipe installation.
- B Drill a small diameter pilot hole for the entire length of the augered pipe. Check the pilot hole for line and grade at the receiving end to determine if the larger diameter casing hole will comply with this Specification. The pilot hole shall be redrilled if the installed pipe would not meet the specified tolerances.
- C Auger the large-diameter hole by mechanical means for reaming the pilot hole. The diameter of the augered hole shall be not more than 1 inch greater than the outside diameter of the installed pipe measured from the barrel of the pipe. Place excavated material outside the working pit and dispose of it, as specified in Section 01500 – Temporary Facilities and Controls. Jetting is not permitted. Augered holes which do not meet the specified tolerances shall be grouted.
- D In unconsolidated soil formations, use a bentonite slurry to maintain a stable hole and furnish lubrication for the installation of the pipe. Install the pipe or casing in one

operation with the displacement of cuttings and slurry from the hole in potentially unstable soils to prevent casing and settlement of the ground surface.

- E Depending on the character of the soil encountered during the augering operation, conduct operations without interruption, insofar as practical, to prevent the pipe from seizing up in the hole before the installation is complete.
- F Repair casing or sewer pipe damaged in augering operations by method acceptable to the Engineer or remove and replace it.

### **3.03 AUGER PITS**

- A Contractor's Pipe and Casing Augering Work Plan shall identify the location, size, depth and layout, and ground support design of all augering and observation pits, as well as a schedule of dates that each pit is expected to be open.
- B Auger pits that are excavated as a part of open-cut sewer construction shall be in accordance with Section 02318 – Excavation and Backfill for Utilities.
- C Install sheeting, lining, shoring, and bracing required for the protection of the workmen and the public in accordance with Section 01570 – Trench Safety Systems.

### **3.04 PIPE IN CASING**

- A Pipes shall be installed in augered casings in accordance with this Section, as applicable.
- B Bottom of trench adjacent to each end of casing should be graded to provide firm, uniform, and continuous support for carrier pipe. If trench requires some backfill to establish final trench bottom grade, backfill material should be placed in 6-inch lifts and each layer properly compacted.
- C Install casing end seals in accordance with manufactures specifications.

### **3.05 SPACER AND INSULATOR INSTALLATION**

- A Casing spacers and/or insulators should be installed in accordance with manufacturer's instructions. Special care should be taken to ensure that all subcomponents are correctly assembled and evenly tightened, and that no damage occurs during tightening or carrier pipe insertion.
- B Spacing of spacers or insulators should ensure that carrier pipe is adequately supported throughout its length, particularly at ends, to offset settling and possible electrical shorting. End spacer must be within 6 inches of end of casing pipe, regardless of size of casing and carrier pipe or type of spacer used. Casing spacers are designed to withstand much greater loads than can be safely applied to most coatings. Therefore, spacing between spacers depends largely on load bearing capabilities of pipe coating and flexibility of pipe.

1. Spacing shall be as shown on Plans with maximum distance between spacers to be 10 feet for pipe sizes 4 to 14 inches and 8 feet for pipe sizes 16 to 30 inches.
  2. For ductile iron pipe, flanged pipe, or bell-and-spigot pipe, spacers should be installed within one foot on each side of bell or flange and one in center of joint when 18- to 20-foot-long joints are used.
  3. If casing or carrier pipe is angled, bent, or dented, spacing should be reduced.
- C Where metallic carrier pipe is to be placed in metallic casing, provide electric insulating type spacers to ensure no contact between carrier pipe and casing.

### **3.06 TOLERANCES**

- A Acceptance criteria for Augered Casing, as defined in this Section, 1.01D, shall be  $\pm 6$  inches in horizontal alignment from theoretical at any point between manholes, including the receiving end, and  $\pm 1\text{-}1/2$  inches in elevation from the theoretical.
- B Acceptance criteria for Augered Pipe, as defined in this Section, 1.01D, shall be  $\pm 6$  inches in horizontal alignment from theoretical at any point between manholes, including the receiving end, and  $\pm 1/8$  inch in elevation from the theoretical.
- C If a deviation exceeds these tolerances, the Contractor may be required to re-auger the casing or sewer pipe at no additional cost to the City, including any backfilling or grouting of the abandoned hole. Any redesign of the sewer and manholes made necessary by out-of-tolerance casing or sewer pipe shall be at the Contractor's expense and shall be signed by a Professional Engineer registered in the State of Texas. The installed pipe must be capable of meeting the design flow and velocities for a full pipe condition. Contractor is responsible for final selection of casing diameter to assure these tolerances.

### **3.07 FIELD QUALITY CONTROL**

- A Sewer pipes installed under this Section shall be tested under the provisions of the applicable Technical Specification for the type of sewer pipe installed.

### **3.08 CLEAN-UP AND RESTORATION**

- A Perform clean-up and restoration in and around construction zone in accordance with Section 01140 – Contractor's Use of Premises.

### **3.09 PROTECTION OF THE WORK**

- A Protect and maintain all pipe and casing augering in good condition until completion of Work.

END OF SECTION

**Section 02530****GRAVITY SANITARY SEWERS****1.0 GENERAL****1.01 SECTION INCLUDES**

- A Gravity sanitary sewers and appurtenances, including cleanouts, stacks, service connections, and reconnections.
  
- B References to Technical Specifications:
  - 1. Section 02415 – Augering Pipe or Casing for Sewers
  - 2. Section 01200 – Measurement and Payment Procedures
  - 3. Section 01350 – Submittals
  - 4. Section 01450 – Testing Laboratory Services
  - 5. Section 01500 – Temporary Facilities and Controls
  - 6. Section 01570 – Trench Safety System
  - 7. Section 02318 – Excavation and Backfill for Utilities
  - 8. Section 01564 – Control of Ground Water and Surface Water
  - 9. Section 02220 – Site Demolition
  - 10. Section 01140 - Contractor’s Use of Premises
  
- C Reference Standards:
  - 1. American Society for Testing and Materials (ASTM)
    - a. ASTM D 1784, “Standard Specification for Rigid Poly Vinyl Chloride (PVC) Compounds and Chlorinated Poly Vinyl Chloride (CPVC) Compounds”
    - b. ASTM F 477, “Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe”
    - c. ASTM D 3034, “Standard Specification for Type PSM Poly Vinyl Chloride (PVC) Sewer Pipe and Fittings”
    - d. ASTM F 679, “Standard Specification for Poly Vinyl Chloride (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings”
    - e. ASTM F 949, “Standard Specification for Poly Vinyl Chloride (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings”
    - f. ASTM D 794, “Standard Specification for Poly Vinyl Chloride (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter”
    - g. ASTM D 2241, “Standard Specification for Poly Vinyl Chloride (PVC) Pressure-Rated Pipe (SDR Series)”
    - h. ASTM D 3212, “Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals”
    - i. ASTM D 3139, “Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals”
    - j. ASTM D 2444, “Standard Test Method for Determination for the Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tup (Falling Weight)”

- k. ASTM F 714, "Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter"
- l. ASTM D 2657, "Standard Practice for Heat Fusion Joining and Polyolefin Pipe and Fittings"
- m. ASTM D 1248, "Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable"
- n. ASTM D 3350, "Standard Specification for Polyethylene Plastic Pipe and Fittings Materials"
- o. ASTM D 3681, "Standard Test Method for Chemical Resistance of Fiberglass (Glass-Fiber Reinforced Thermosetting-Resin) Pipe in a Deflected Condition"
- p. ASTM D 4161, "Standard Specification for Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Joints Using Flexible Elastomeric Seals"
- q. ASTM D 3262, "Standard Specification for Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe"
- r. ASTM D 3754, "Standard Specification for Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer and Industrial Pressure Pipe"
- s. ASTM D 618, "Standard Practice for Conditioning Plastics for Testing"
- t. ASTM C 828, "Standard Test Method for Low-Pressure Air Test of Vitrified Clay Pipe Lines"
- u. ASTM C 924, "Standard Practice for Testing Concrete Pipe Sewer Lines by Low-Pressure Air Test Method"
- v. ASTM F 1417, "Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air"
2. American Water Works Association (AWWA)
  - a. AWWA C 900 Polyvinyl Chloride (PVC) Pressure Pipe, 4" – 12" for Water Distribution
  - b. AWWA C 905 Polyvinyl Chloride (PVC) Water Transmission Pipe, Nominal Diameters, 14in. Through 36 in.
3. Plastic Pipe Institute (PPI)
  - a. PPI TR3, "Policies and Procedures for Developing Hydrostatic Design Basis (HDB), Pressure Design Basis (PDB), Strength Design Basis (SDB), and Minimum Required Strength (MRS) Ratings for Thermoplastic Piping Materials or Pipe"
4. Texas Commission on Environmental Quality (TCEQ)
5. Texas Administrative Code (TAC)

## 1.02 MEASUREMENT AND PAYMENT

- A Measurement of pipe installed at depths 8-feet and less by open cut method is on a linear foot basis, measured and complete in place. Measurement will be taken along the center line of the pipe from center line to center line of manholes, except for pipe in casing or augered installation.
- B Payment includes sewer pipe, excavation, bedding, backfill and special backfill, shoring, earthwork, connections to existing manholes and pipe, stacks, cleanouts,

accessories, inspection and testing. Depths beyond 8' will be paid by 2 vertical feet increments.

- C Refer to Section 02415 – Augering Pipe or Casing for Sewers for measurement and payment of augered sewer pipe.
- D Refer to Section 01200 – Measurement and Payment Procedures.

### **1.03 SUBMITTALS**

- A Make Submittals required by this Section under the provisions of Section 01350 – Submittals.
- B Submit inspection reports, testing reports, and video tape of television inspections as directed by Engineer.
- C Submit proposed methods, equipment, materials and sequence of operations for Gravity Sanitary Sewer construction. Plan operations to minimize disruption of utilities to occupied facilities or adjacent property.

### **1.04 QUALITY ASSURANCE**

- A Qualifications. Gravity Sanitary Sewer shall be watertight both in pipe-to-pipe joints and in pipe-to-manhole connections. Perform testing in accordance with this Section and Section 01450 – Testing Laboratory Services.
- B Regulatory Requirements.
  - 1. Install Gravity Sanitary Sewer to meet the minimum separation distance from any potable water line, as scheduled below. The separation distance is defined as the distance between the outside of the water pipe and the outside of the sewer pipe. When possible, install new Gravity Sanitary Sewers no closer to water lines than 9 feet in all directions. Where this separation distance cannot be achieved, new Gravity Sanitary Sewers shall be installed as specified in this Section.
  - 2. Make notification to the Engineer if water lines are uncovered during Gravity Sanitary Sewer installation where the minimum separation distance cannot be maintained.
  - 3. Lay Gravity Sanitary Sewers lines in straight alignment and grade.

### **1.05 PROTECTION OF PEOPLE AND PROPERTY**

- A Contractor shall conduct all construction operations under this Contract in conformance with the practices described in Section 01500 – Temporary Facilities and Controls.

### **1.06 PRODUCT DELIVERY, STORAGE AND HANDLING**

- A Inspect pipe and fittings upon arrival of materials at the Project Site.

- B Handle and store pipe materials and fittings to protect them from damage due to impact, shock, shear, or free fall. Do not drag pipe and fittings along the ground. Do not roll pipe unrestrained from delivery trucks.
- C Use mechanical means to move or handle pipe. Employ acceptable clamps, rope or slings around the outside barrel of pipe and fittings. Do not use hooks, bars, or other devices in contact with the interior surface of the pipe to lift or move lined pipe

**2.0 PRODUCTS**

**2.01 GASKET MATERIAL FOR USE IN POTENTIALLY CONTAMINATED AREAS**

- A Gravity Sanitary Sewer pipes to be installed in potentially contaminated areas, especially where free product is found near the elevation of the proposed sewer, shall have the following Gasket Material for the noted contaminants:

CONTAMINANT	GASKET MATERIAL REQUIRED
Petroleum (diesel, gasoline)	Nitrile Rubber
Other contaminants	As recommended by the pipe manufacturer

**2.02 POLYVINYL CHLORIDE (PVC) PIPE**

- A Use PVC compounds in the manufacture of pipe that contain no ingredient in an amount that has been demonstrated to migrate into water in quantities considered to be toxic.
- B Furnish PVC pressure pipe manufactured from Class 12454-A or Class 12454-B virgin PVC compounds as defined in ASTM D 1784. Use compounds qualifying for a rating of 4000 psi for water at 73.4° F per requirements of PPI TR3. Provide pipe which is homogeneous throughout, free of voids, cracks, inclusions, and other defects, uniform as commercially practical in color, density, and other physical properties. Deliver pipe with surfaces free from nicks and scratches with joining surfaces of spigots and joints free from gouges and imperfections which could cause leakage. All pipe used for gravity sanitary sewer shall be green.
- C Gaskets:
  - 1. Gaskets shall meet the requirements of ASTM F477. When no contaminant is identified, use elastomeric factory-installed gaskets to make joints flexible and watertight.
- D Lubricant for rubber-gasketed joints: Water soluble, non-toxic, non-objectionable in taste and odor imparted to fluid, non-supporting of bacteria growth, having no deteriorating effect on PVC or rubber gaskets.

- E PVC Gravity Sanitary Sewer pipe shall be green in color and shall be in accordance with the provisions in the following table:

WALL TYPE	MANUFACTURER	PRODUCT OPTIONS	ASTM DESIGNATION	SDR (MAX.)/ STIFFNESS (MIN.)	DIAMETER SIZE RANGE
Solid	J-M Pipe CertainTeed Can-Tex Carlton Diamond	Approved	D 3034	SDR 26 / PS 115	6" to 15"
		Approved	F 679	SDR 26 / PS 115	18" to 48"
		Approved	AWWA C900	DR 18 / N/A***	4" to 12"
		Approved	AWWA C905	DR 18 / N/A***	14" to 36"
Profile*	Contech A-2000**	Only when included in the Bid Schedule	F 949	N/A / 50 psi	12" to 36"
	ETI Ultra-Rib		F 794	N/A / 46 psi	12" to 48"
	Lamson Vylon		F 794	N/A / 46 psi	21" to 48"

\* Allowed to be used where there are no service taps.

\*\* Allowed to be used to a maximum depth of 10' only.

\*\*\*For water-sewer separation requirements unless specifically noted in Bid Schedule.

- F When solid wall PVC pipe 18 inches to 27 inches in diameter is required in SDR 26, provide pipe conforming to ASTM F 679, except provide wall thickness as required for SDR 26 and pipe strength of 115 psi.
- G For Gravity Sanitary Sewers up to 12 inch diameter crossing over waterlines, or crossing under waterlines with less than 2 feet separation, provide minimum 150 psi pressure-rated pipe conforming to ASTM D 2241 with suitable PVC adapter couplings.
- H Joints: Spigot and integral wall section bell with solid cross section elastometric or rubber ring gasket conforming to requirements of ASTM D 3212 and ASTM F 477, or ASTM D 3139 and ASTM F 477, shall be provided. Gaskets shall be factory-assembled and securely bonded in place to prevent displacement. The manufacturer shall test a sample from each batch conforming to requirements ASTM D 2444.
- I Fittings: Provide PVC gravity sanitary sewer bends, tee, or wye fittings for new sanitary sewer construction. PVC pipe fittings shall be full-bodied, either injection molded or factory fabricated. Saddle-type tees, wye fittings, or solvent welds are not acceptable.

**2.03 HIGH DENSITY POLYETHYLENE (HDPE) SOLID AND PROFILE WALL PIPE**

- A Provide HDPE pipe as follows and only when listed as a Bid Item:

WALL TYPE	MANUFACTURER	PRODUCT OPTIONS	ASTM DESIGNATION	PIPE STIFFNESS (MIN)	DIAMETER RANGE (INCHES)
Solid Wall	Drisco 1000 Drisco 8600 Quail Pipe	Approved	F 714	115 psi	8 to 10



	Poly Pipe Plexco				
--	---------------------	--	--	--	--

- B Solid wall pipe shall be produced with plain end construction for heat-joining (butt fusion) conforming to ASTM D 2657. Utilize controlled temperatures and pressures for joining to produce a fused leak-free joint.
- C Pipe and Fittings: High density, high molecular weight polyethylene pipe material meeting the requirements of Type III, Class C, Category 5, Grade P34, as defined in ASTM D1248. Material meeting the requirements of cell classification in accordance with ASTM D 3350 are also suitable for making pipe products under these specifications.
- D Gaskets:
  - 1. Use gaskets meeting requirement of ASTM F 477. Use gasket molded into a circular form or extruded to the proper section and then spliced into circular form. When no contaminant is identified, use gaskets of a properly cured, high-grade elastomeric compound. The basic polymer shall be natural rubber, synthetic elastomer, or a blend of both.
- E Lubricant. Use a lubricant for assembly of gasketed joints which has no detrimental effect on the gasket or on the pipe, in accordance with manufacturer's recommendations.
- F Furnish pipe and fittings that are homogeneous throughout and free from visible cracks, holes, foreign inclusions, or other injurious defects. Provide pipe as uniform as commercially practical in color, opacity, density, and other physical properties.

**2.04 CENTRIFUGALLY CAST FIBERGLASS PIPE**

- A Manufacturers
  - 1. Pre-approved manufacturer for centrifugally cast fiberglass pipe is Hobas Pipe USA, Inc.
- B Materials
  - 1. Resin Systems: The manufacturer shall use only polyester resin systems with a proven history of performance in this particular application. The historical data shall have been collected from applications of a composite material of similar construction and composition as the proposed product.
  - 2. Glass Reinforcements: The reinforcing glass fibers used to manufacture the components shall be of highest quality commercial grade glass filaments with binder and sizing compatible with impregnating resins.
  - 3. Fillers: Silica sand or other suitable materials may be used.
  - 4. Additives: Resin additives, such as pigments, dyes, and other coloring agents, if used, shall in no way be detrimental to the performance of the product nor shall they impair visual inspection of the finished products.
  - 5. Rubber Gaskets: Supply from an approved gasket manufacturer in accordance with ASTM F 477, when no contaminant is identified and suitable for the service intended. Gaskets shall either be affixed to the pipe by means of a

- suitable adhesive or shall be installed in such a manner so as to prevent the gasket from rolling out of the pre-cut groove in the pipe or sleeve coupling.
6. The internal liner resin shall be suitable for service as sewer pipe, and shall be highly resistant to exposure to sulfuric acid as produced by biological activity from hydrogen sulfide gases. Pipe shall meet or exceed requirements of ASTM D 3681.
- C Pipes
1. Furnish pipes in the diameters specified and within the tolerances specified below.
  2. Manufacture pipe by the centrifugal casting process to result in a dense, nonporous, corrosion-resistant, consistent composite structure to meet the operating conditions as shown on the Plans.
  3. Do not use stiffening ribs or rings.
- D Couplings: Unless otherwise specified, the pipe shall be field connected with fiberglass sleeve couplings that utilize elastomeric sealing gaskets as the sole means to maintain joint watertightness. The joints must meet the performance requirements of ASTM D 4161.
- E Fittings: Flanges, elbows, reducers, tees, and other fittings shall be capable of withstanding operating conditions when installed. They may be contact molded or manufactured from mitered sections of pipe joined by glass fiber reinforced overlays.
- F Manhole Connections: Provide a water stop flange (wall pipe) for connection to a cast-in-place manhole base or other structure.
- G Grout Ports: Provide grout ports in the wall of pipe when required. Provide plugs of 316 stainless steel or other corrosion-resistant material compatible with the pipe. Grout port plugs shall be designed and installed to meet the test pressure of the pipe.
- H Dimensions
1. Diameters: The actual outside diameter of the pipes shall be in accordance with Table 3 of ASTM D 3262 for Gravity Sanitary Sewers, or ASTM D 3754 for force mains.
  2. Lengths: The pipe standard length will be approximately 20 feet. A maximum of 10 percent of the lengths, excluding special order pipes, may be supplied in random lengths.
  3. Wall Thickness: The minimum average wall thickness shall be the stated design thickness. The minimum single point thickness shall not be less than 90 percent of the stated design thickness.
  4. End Squareness: Pipe ends shall be square to the pipe axis.
  5. Tolerance of Fittings: The tolerance of the angle of an elbow and the angle between the main and leg of a wye or tee shall be plus or minus 2 degrees. The tolerance on the laying length of a fitting shall be plus or minus 2 inches.
- I Stiffness Classes

1. Stiffness class of FRP pipe shall satisfy design requirements, but shall not be less than 46 psi, when used in direct bury operation; 36 psi, when installed within a primary tunnel liner.
2. Stiffness class of FRP in a pipe jacking operation shall be governed either by the ring deflection limitations or by a pipe design providing longitudinal strength required by the jacking method and shall satisfy design requirements stated below. Submit design calculations as required in Paragraph 1.05, Submittals.
  - a. Pipe stress calculations based on jacking loads shall be provided by the pipe supplier.
  - b. Ring deflection calculations shall conform to design requirements of 30 TAC Chapter 317.20 pertaining to flexible pipe used in Gravity Sanitary Sewers. The pipe deflection calculations shall ensure that predicted deflection will be less than 5 percent under long-term loading conditions (soil prism load) for the highest density of soil overburden and surcharge loads. Deflection on calculations shall be prepared using long-term (drained) values for soil parameters contained in the geotechnical investigation report for the Project, or other site-specific data obtained by the Contractor as approved by the Engineer.

#### J Testing

1. Pipes shall be tested in accordance with ASTM D 3262 or ASTM D 3754, as applicable, except that the factory hydrostatic pressure testing is not required.
2. Joints: Coupling joints shall be qualified per the tests of Section 7 of ASTM D 4161.

#### K Packaging, Handling, and Shipping

1. Packing, handling, and shipping should be done in accordance with the manufacturer's recommendations.

#### L Installation

1. Install pipe and fittings in accordance with requirements of this Section.
2. The manufacturer must supply a suitable qualified field service representative to be present periodically during the installation of pipe.
3. Pipe Bedding: Conform to requirements of Section 02318 – Excavation and Backfill for Utilities.
4. Pipe Handling: Use textile slings.
5. Jointing
  - a. Clean ends of pipe and coupling components.
  - b. Check pipe ends and couplings for damage. Correct any damage found.
  - c. Coupling grooves must be completely free of dirt.
  - d. Apply joint lubricant to pipe ends and rubber seals of coupling. Use only lubricants approved by the pipe manufacturer.
  - e. Use suitable auxiliary equipment, such as a wire rope puller, to pull joints together.

- f. Do not exceed forces recommended by the manufacturer for coupling pipe. If excessive force is required, remove coupling, determine source of problem, and correct it.
- g. In the process of jointing the pipe, do not allow the deflection angle to exceed the deflection permitted by the manufacturer.
6. If pressure grouting of the pipe is conducted as part of a pipe-jacked tunnel installation, seal the grout holes with liner resin to a thickness equal to the pipe liner thickness, or with a threaded plug for that purpose.
7. Tests: Conform to requirements of this Section.

## 2.05 INSPECTIONS

- A The Engineer reserves the right to inspect pipes or witness pipe manufacturing. Such inspection shall in no way relieve the manufacturer of the responsibilities to provide products that comply with the applicable standards and these Specifications.
- B Manufacturer's Notification to Customer. Should the Engineer wish to witness the manufacture of specific pipes, the manufacturer shall provide the Engineer with adequate advance notice of when and where the production of those specific pipes will take place.
- C Failure to Inspect. Approval of the products or tests is not implied by the Engineer's decision not to inspect the manufacturing, testing, or finished pipes.

## 2.06 TEST METHODS

- A Conditioning. Conditioning of samples prior to and during tests are subject to approval by the Engineer. When referee tests are required, condition the specimens in accordance with Procedure A in ASTM D 618 at 73.4 degrees F plus or minus 3.6 degrees F (23 degrees C plus or minus 2 degrees C) and 50 percent relative humidity plus or minus 5 percent relative humidity for not less than 40 hours prior to test. Conduct tests under the same conditions of temperature and humidity unless otherwise specified.
- B Flattening. Flatten three specimens of pipe, prepared in accordance with Paragraph 2.05A, in a suitable press until the internal diameter has been reduced to 40 percent of the original inside diameter of the pipe. The rate of loading shall be uniform and at 2-inches per minute. The test specimens, when examined under normal light and with the unaided eye, shall show no evidence of splitting, cracking, breaking, or separation of the pipe walls or bracing profiles.
- C Joint Tightness. Test for joint tightness in accordance with ASTM D 3212, except replace the shear load transfer bars and supports with 6 inch wide support blocks that can be either flat or contoured to conform to the pipe's outer contour.
- D Purpose of Tests. The flattening and the joint tightness tests are not intended to be routine quality control tests, but rather to qualify pipe to a specified level of performance.

**2.07 MARKING**

- A Mark each standard and random length of pipe in compliance with these Specifications with the following information:
  - 1. Pipe size
  - 2. Pipe class
  - 3. Production code
  - 4. Material designation

**3.0 EXECUTION****3.01 PREPARATION**

- A Employ a Trench Safety Plan as specified in Section 01570 – Trench Safety Systems.
- B Install and operate dewatering and surface water control measures in accordance with Section 01564 - Control of Ground Water and Surface Water.
- C Remove existing pavements and structures, including sidewalks and driveways, in conformance with requirements of Section 02220 – Site Demolition, as applicable.

**3.02 DIVERSION PUMPING**

- A Install and operate required bulkheads, plugs, piping, and diversion pumping equipment to maintain sewage flow and to prevent backup or overflow. Obtain approval for diversion pumping equipment and procedures from the Engineer.
- B Design piping, joints and accessories to withstand twice the maximum system pressure or 50 psi, whichever is greater.
- C No sewage shall be diverted into any area outside of the sanitary sewer.
- D In the event of accidental spill or overflow, immediately stop the overflow and take action to clean up and disinfect spillage. Promptly notify the Engineer so that required reporting can be made to the TCEQ and the Environmental Protection Agency by the Engineer.

**3.03 INSPECTION AND TESTING**

- A Acceptance testing of sanitary sewers including:
  - 1. Visual inspection of sewer pipes
  - 2. Mandrel testing for flexible sewer pipes.
  - 3. Leakage testing of sewer pipes.
  - 4. Leakage testing of manholes.
- B Performance Requirements:
  - 1. Gravity sanitary sewers are required to have a straight alignment and uniform grade between manholes.

2. Flexible pipe, including "semi-rigid" pipe, is required to show no more than 5 percent deflection. Test pipe no sooner than 30 days after backfilling of a line segment but prior to final acceptance using a standard mandrel to verify that installed pipe is within specified deflection tolerances.
3. Maximum allowable leakage for Infiltration or Exfiltration
  - a. The total exfiltration, as determined by a hydrostatic head test, shall not exceed 50 gallons per inch diameter per mile of pipe per 24 hours at a minimum test head of 2 feet above the crown of the pipe at the upstream manhole or 2 feet above the groundwater elevation, whichever is greater.
  - b. When pipes are installed more than 2 feet below the groundwater level, an infiltration test shall be used in lieu of the exfiltration test. The total infiltration shall not exceed 50 gallons per inch diameter per mile of pipe per 24 hours. Groundwater elevation must be at least 2 feet above the crown of the pipe at the upstream manhole.
  - c. Refer to Table 2530-1, Water Test Allowable Leakage, at the end of the Section, for measuring leakage in sewers. Perform leakage testing to verify that leakage criteria are met.
4. Perform air testing in accordance with requirements of this Section and the Texas Natural Resources Conservation Commission requirements. Refer to Table 02530-2, Time Allowed For Pressure Loss From 3.5 psig to 2.5 psig, Table 02530-3, Minimum Testing Times for Low Pressure Air Test, and Table 02530-4, Vacuum Test Time Table, at the end of this Section.

C Gravity Sanitary Sewer Quality Assurance:

1. Repair, correct, and retest manholes or sections of pipe which fail to meet specified requirements when tested.
2. Provide testing reports and video tape of television inspection as directed by Engineer.
3. Upon completion of tape reviews by Engineer, Contractor will be notified regarding final acceptance of the sewer segment.

D Sequencing and Scheduling:

1. Perform testing as work progresses. Schedule testing so that no more than 1000 linear feet of installed sewer remains untested at any one time.
2. Coordinate testing schedules with Engineer. Perform testing under observation of Engineer.

E Deflection Mandrel:

1. Mandrel Sizing. The rigid mandrel shall have an outside diameter (O.D.) equal to 95 percent of the inside diameter (I.D.) of the pipe. The inside diameter of the pipe, for the purpose of determining the outside diameter of the mandrel, shall be the average outside diameter minus two minimum wall thicknesses for O.D. controlled pipe and the average inside diameter for I.D. controlled pipe, dimensions shall be per appropriate standard. Statistical or other "tolerance packages" shall not be considered in mandrel sizing.
2. Mandrel Design. The rigid mandrel shall be constructed of a metal or a rigid plastic material that can withstand 200 psi without being deformed. The

mandrel shall have nine or more "runners" or "legs" as long as the total number of legs is an odd number. The barrel section of the mandrel shall have a length of at least 75 percent of the inside diameter of the pipe. The rigid mandrel shall not have adjustable or collapsible legs which would allow a reduction in mandrel diameter during testing. A proving ring shall be provided and used for modifying each size mandrel.

3. Proving Ring. Furnish a "proving ring" with each mandrel. Fabricate the ring of 1/2 inch thick, 3-inch-wide bar steel to a diameter 0.02 inches larger than approved mandrel diameter.
4. Mandrel Dimensions (5 percent allowance). Average inside diameter and minimum mandrel diameter are specified in Table 02530-5, Pipe vs. Mandrel Diameter, at the end of this Section. Mandrels for higher strength, thicker wall pipe or other pipe not listed in the table may be used when approved by the Engineer.

F Exfiltration Test:

1. Water Meter: Obtain a transient water meter from the City for use when water for testing will be taken from the City system. Conform to City requirements for water meter use.
2. Test Equipment:
  - a. Pipe plugs.
  - b. Pipe risers where the manhole cone is less than 2 feet above highest point in pipe or service lead.

G Infiltration Test:

1. Test Equipment:
  - a. Calibrated 90 degree V-notch weir.
  - b. Pipe plugs.

H Low Pressure Air Test:

1. Minimum Requirement for Equipment:
  - a. Control panel.
  - b. Low-pressure air supply connected to control panel.
  - c. Pneumatic plugs: Acceptable size for diameter of pipe to be tested; capable of withstanding internal test pressure without leaking or requiring external bracing.
  - d. Air hoses from control panel to:
    - 1) Air supply.
    - 2) Pneumatic plugs.
    - 3) Sealed line for pressuring.
    - 4) Sealed line for monitoring internal pressure.
2. Testing Pneumatic Plugs: Place a pneumatic plug in each end of a length of pipe on the ground. Pressurize plugs to 25 psig; then pressurize sealed pipe to 5 psig. Plugs are acceptable if they remain in place against the test pressure without external aids.

I Ground Water Determination:

1. Equipment: Pipe probe or small diameter casing for ground water elevation determination.
- J Visual Inspection:
1. Check pipe alignment visually by flashing a light between structures. Verify if alignment is true and no pipes are misplaced. In case of misalignment or damaged pipe, remove and re-lay or replace pipe segment.
- K Mandrel Testing:
1. Perform deflection testing on flexible and semi-rigid pipe to confirm pipe has no more than 5 percent deflection. Mandrel testing shall conform to ASTM D 3034. Perform testing no sooner than 30 days after backfilling of line segment, but prior to final acceptance testing of the line segment.
  2. Pull the approved mandrel by hand through sewer sections. Replace any section of sewer not passing the mandrel. Mandrel testing is not required for stubs.
  3. Retest repaired or replaced sewer sections.
- L Leakage Testing:
1. Test Options:
    - a. Test Gravity Sanitary Sewer pipes for leakage by either exfiltration or infiltration methods, as appropriate, or with low pressure air testing.
    - b. Test new or rehabilitated sanitary sewer manholes with water or low pressure air. Manholes tested with low pressure air shall undergo a physical inspection prior to testing.
    - c. Leakage testing shall be performed after backfilling of a line segment, and prior to tie-in of service connections.
    - d. If no installed piezometer is within 500 feet of the sewer segment, Contractor shall provide a temporary piezometer for this purpose.
  2. Compensating for Ground Water Pressure:
    - a. Where ground water exists, install a pipe nipple at the same time sewer line is placed. Use a 1/2-inch capped pipe nipple approximately 10 inches long. Make the installation through manhole wall on top of the sewer line where line enters manhole.
    - b. Immediately before performing line acceptance test, remove cap, clear pipe nipple with air pressure, and connect a clear plastic tube to nipple. Support tube vertically and allow water to rise in the tube. After water stops rising, measure height in feet of water over invert of the pipe. Divide this height by 2.3 feet/psi to determine the ground water pressure to be used in line testing.
  3. Exfiltration test:
    - a. Determine ground water elevation.
    - b. Plug sewer in downstream manhole.
    - c. Plug incoming pipes in upstream manhole.
    - d. Install riser pipe in outgoing pipe of upstream manhole if highest point in service lead (house service) is less than 2 feet below bottom of manhole cone.



- e. Fill sewer pipe and manhole or pipe riser, if used, with water to a point 2-1/2 feet above highest point in sewer pipe, house lead, or ground water table, whichever is highest.
  - f. Allow water to stabilize for one to two hours. Take water level reading to determine drop of water surface, in inches, over a one-hour period, and calculate water loss (1 inch of water in 4 feet diameter manhole equals 8.22 gallons) or measure the quantity of water required to keep water at same level. Loss shall not exceed that calculated from allowable leakage according to Table 02530-1 at the end of this Section.
4. Infiltration test: Ground water elevation must be not less than 2.0 feet above highest point of sewer pipe or service lead (house service).
- a. Determine ground water elevation.
  - b. Plug incoming pipes in upstream manhole.
  - c. Insert calibrated 90 degree V-notch weir in pipe on downstream manhole.
  - d. Allow water to rise and flow over weir until it stabilizes.
  - e. Take five readings of accumulated volume over a period of 2 hours and use average for infiltration. The average must not exceed that calculated for 2 hours from allowable leakage according to the Table 02530-1 at the end of this Section.
5. Low Air Pressure Test: When using this test conform to ASTM C 828, ASTM C 924, or ASTM F 1417, as applicable, with holding time not less than that listed in Table 02530-2.
- a. Air testing for sections of pipe shall be limited to lines less than 36-inch average inside diameter.
  - b. Lines 36-inch average inside diameter and larger shall be tested at each joint. The minimum time allowable for the pressure to drop from 3.5 pounds per square inch gauge to 2.5 pounds per square inch during a joint test shall be 10 seconds, regardless of pipe size.
  - c. For pipe sections less than 36-inch average inside diameter:
    - 1) Determine ground water level.
    - 2) Plug both ends of pipe. For concrete pipe, flood pipe and allow 2 hours to saturate concrete. Then drain and plug concrete pipe.
    - 3) After a manhole-to-manhole section of sanitary sewer main has been sliplined and prior to any service lines being connected to new liner, plug liner at each manhole with pneumatic plugs.
    - 4) Pressurize pipe to 4.0 psig. Increase pressure 1.0 psi for each 2.3 feet of ground water over highest point in system. Allow pressure to stabilize for 2 to 4 minutes. Adjust pressure to start at 3.5 psig (plus adjustment for ground water table). Refer to Table 02530-2 at the end of this Section.
    - 5) To determine air loss, measure the time interval for pressure to drop to 2.5 psig. The time must exceed that

listed in the Table 02530-2 at the end of this Section for pipe diameter and length. For sliplining, use diameter of carrier pipe.

6. Retest: Any section of pipe which fails to meet requirements shall be repaired and retested.

#### M Test Criteria Tables

1. Exfiltration and Infiltration Water Tests: Refer to Table 02530-1, Water Test Allowable Leakage, at the end of this Section.
2. Low Pressure Air Test:
  - a. Times in Table 02530-2, Time Allowed For Pressure Loss From 3.5 psig to 2.5 psig, at the end of this Section, are based on the equation from TCEQ Design Criteria for Sewerage Systems: 317.2(a)(4)(B).

$$T = 0.0850(D)(K)/(Q)$$

Where:

- |   |   |                                                                       |
|---|---|-----------------------------------------------------------------------|
| T | = | Time for pressure to drop 1.0 pounds per square inch gauge in seconds |
| K | = | 0.000419 DL, but not less than 1.0                                    |
| D | = | Average inside diameter in inches                                     |
| L | = | Length of line of same pipe size in feet                              |
| Q | = | Rate of loss, 0.0015 ft <sup>3</sup> /min./sq. ft. internal surface   |
- b. Since a K value of less than 1.0 shall not be used, there are minimum testing times for each pipe diameter as given in Table 02732-3, Minimum Testing Times for Low Pressure Air Test.

- Notes:
1. When two sizes of pipe are involved, the time shall be computed by the ratio of lengths involved.
  2. Line with a 27-inch average inside diameter and larger may be air tested at each joint.
  3. Lines with an average inside diameter greater than 36 inches must be air tested for leakage at each joint
  4. If the joint test is used, a visual inspection of the joint shall be performed immediately after testing.
  5. For joint test, the pipe is to be pressurized to 3.5 psi greater than the pressure exerted by groundwater above the pipe. Once the pressure has stabilized, the minimum times allowable for the pressure to drop from 3.5 pounds per square inch gauge to 2.5 pounds per square inch gauge shall be 10 seconds.

#### N Leakage Testing for Manholes

1. After completion of manhole construction, wall sealing, or rehabilitation, but prior to backfilling, test manholes for water tightness using hydrostatic or vacuum testing procedures.
2. Plug influent and effluent lines, including service lines, with suitably-sized pneumatic or mechanical plugs. Ensure plugs are properly rated for pressures required for test; follow manufacturer's safety and installation recommendations. Place plugs a minimum of 6 inches outside of manhole walls. Brace inverts to prevent lines from being dislodged if lines entering manhole have not been backfilled.
3. Vacuum testing:
  - a. Install vacuum tester head assembly at top access point of manhole and adjust for proper seal on straight top section of manhole structure. Following manufacturer's instructions and safety precautions, inflate sealing element to the recommended maximum inflation pressure; do not over-inflate.
  - b. Evacuate manhole with vacuum pump to 10 inches mercury (Hg), disconnect pump, and monitor vacuum for the time period specified in Table 02530-4, Vacuum Test Time Table.
  - c. If the drop in vacuum exceeds 1 inch Hg over the specified time period tabulated above, locate leaks, complete repairs necessary to seal manhole and repeat test procedure until satisfactory results are obtained.
4. Hydrostatic exfiltration testing shall be performed as follows:
  - a. Seal wastewater lines coming into the manhole with an internal pipe plug. Then fill the manhole with water and maintain it full for at least one hour.
  - b. The maximum leakage for hydrostatic testing shall be 0.025 gallons per foot diameter per foot of manhole depth per hour.
  - c. If water loss exceeds amount tabulated above, locate leaks, complete repairs necessary to seal manhole and repeat test procedure until satisfactory results are obtained.

### **3.04 BACKFILL**

- A Backfill and compact soil in accordance with Section 02318 – Excavation and Backfill for Utilities.
- B Backfill the trench in specified lifts only after pipe installation is approved by the Engineer.

### **3.05 CLEAN UP AND RESTORATION**

- A Perform clean up and restoration in and around construction zone in accordance with Section 01140 - Contractor's Use of Premises.

**3.06 PROTECTION OF THE WORK**

- A Maintain gravity sanitary sewer installations in good condition until completion of the work.

Table 02530-1  
WATER TEST ALLOWABLE LEAKAGE

DIAMETER OF RISER OR STACK IN INCHES	VOLUME PER INCH OF DEPTH		ALLOWANCE LEAKAGE*	
	INCH	GALLONS	PIPE SIZE IN INCHES	GALLONS/MINUTE PER 100 FT.
1	0.7854	.0034	6	0.0039
2	3.1416	.0136	8	0.0053
2.5	4.9087	.0212	10	0.0066
3	7.0686	.0306	12	0.0079
4	12.5664	.0306	15	0.0099
5	19.6350	.0544	18	0.0118
6	28.2743	.1224	21	0.0138
8	50.2655	.2176	24	0.0518
			27	0.0177
			30	0.0197
			36	0.0237
			42	0.0276
For other diameters, multiply square of diameters by value for 1" diameter			Equivalent to 50 gallons per inch inside diameter per mile per 24 hours	

- \* Allowable leakage rate shall be reduced to 10 gallons per inch of inside diameter per mile per 24 hours, when sewer is identified as located within the 25-year flood plain.

Table 02530-2  
ACCEPTANCE TESTING FOR SANITARY SEWERS

TIME ALLOWED FOR PRESSURE LOSS FROM 3.5 PSIG TO 2.5 PSIG														
Pipe Diam (in)	Min. Time (min:sec)	Length for Min. Time (ft)	Time for Longer Length (sec)	Specification Time for Length (L) Shown (min:sec)										
				100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft	450 ft	500 ft	550 ft	600 ft
6	5:40	398	0.8548	5:40	5:40	5:40	5:40	5:40	5:40	5:42	6:25	7:07	7:50	8:33
8	7:33	298	1.5196	7:33	7:33	7:33	7:33	7:36	8:52	10:08	11:24	12:40	13:36	15:12
10	9:27	239	2.3743	9:27	9:27	9:27	9:54	11:52	13:51	15:50	17:48	19:47	21:46	23:45
12	11:20	199	3.4190	11:20	11:20	11:20	14:15	17:06	19:57	22:48	25:39	28:30	31:20	34:11
15	14:10	159	5.3423	14:10	14:10	17:48	22:16	26:43	31:10	35:37	40:04	44:31	48:58	53:25
18	17:00	133	7.6928	17:00	19:14	25:39	32:03	38:28	44:52	51:17	57:42	64:06	70:31	76:56
21	19:50	114	10.4708	19:50	26:11	34:54	43:38	52:21	61:05	69:48	78:32	87:15	95:59	104:42
24	22:40	99	13.6762	22:48	34:11	45:35	56:59	68:23	79:47	91:10	102:34	113:58	125:22	136:46
27	25:30	88	17.3089	28:51	43:16	57:42	72:07	86:33	100:58	115:24	129:49	144:14	158:40	173:05
30	28:20	80	21.3690	35:37	53:37	71:14	89:02	106:51	124:39	142:28	160:16	178:05	195:53	213:41
33	31:10	72	25.8565	43:06	64:38	86:11	107:44	129:17	150:50	172:23	193:55	215:28	237:01	258:34

Table 02530-3  
MINIMUM TESTING TIMES FOR LOW PRESSURE AIR TEST

PIPE DIAMETER (INCHES)	MINIMUM TIME (SECONDS)	LENGTH FOR MINIMUM TIME (FEET)	TIME FOR LONGER LENGTH (SECONDS)
6	340	398	0.855 (L)
8	454	298	1.520 (L)
10	567	239	2.374 (L)
12	680	199	3.419 (L)
15	850	159	5.342 (L)
18	1020	133	7.693 (L)
21	1190	114	10.471 (L)
24	1360	100	13.676 (L)
27	1530	88	17.309 (L)
30	1700	80	21.369 (L)
33	1870	72	25.856 (L)

Table 02530-4  
VACUUM TEST TIME TABLE

DEPTH IN FEET	TIME IN SECONDS BY PIPE DIAMETER		
	48"	60"	72"
4	10	13	16
8	20	26	32
12	30	39	48
16	40	52	64
20	50	65	80
24	60	78	96
*	5.0	6.5	8.0

\*Add T times for each additional 2-foot depth.

(The values listed above have been extrapolated from ASTM C 924-85)

Table 02530-5  
PIPE VS. MANDREL DIAMETER

MATERIAL AND WALL CONSTRUCTION	NOMINAL SIZE (INCHES)	AVERAGE I.D. (INCHES)	MINIMUM MANDREL DIAMETER (INCHES)
PVC-Solid (SDR 26)	6	5.764	5.476
	8	7.715	7.329
	10	9.646	9.162
PVC-Solid (SDR 35)	12	11.737	11.150
	15	14.374	13.655
	18	17.629	16.748
	21	20.783	19.744
	24	23.381	22.120
	27	26.351	25.033
PVC-Profile (ASTM F 794)	12	11.740	11.153
	15	14.370	13.652
	18	17.650	16.768
	21	20.750	19.713
	24	23.500	22.325
	27	26.500	25.175
	30	29.500	28.025
	36	35.500	33.725
	42	41.500	39.425
HDPE-Profile	18	18.000	17.100
	21	21.000	19.950
	24	24.000	22.800
	27	27.000	25.650
	30	30.000	28.500
	36	36.000	34.200
	42	42.000	39.900
	48	48.000	45.600
	54	54.000	51.300
Fiberglass-Centrifugally Cast (Class SN 46)	12	12.85	11.822
	18	18.66	17.727
	20	20.68	19.646
	24	24.72	23.484
	30	30.68	29.146
	36	36.74	34.903
	42	42.70	40.565
	48	48.76	46.322
	54	54.82	52.079
60	60.38	57.361	

END OF SECTION

**Section 02531****SANITARY SEWER SERVICE LEADS OR RECONNECTIONS****1.0 GENERAL****1.01 SECTION INCLUDES**

- A Installation of service stubs on new sanitary sewers serving areas where sanitary sewer service did not previously exist.
- B Reconnection of existing service connections along parallel, replacement, or rehabilitated sanitary sewers.
- C References to Technical Specifications:
  - 1. Section 01350 – Submittals
  - 2. Section 01760 – Project Record Documents
  - 3. Section 01500 – Temporary Facilities and Controls
  - 4. Section 01570 – Trench Safety System
  - 5. Section 01564 – Control of Ground Water and Surface Water
  - 6. Section 02318 – Excavation and Backfill for Utilities
  - 7. Section 02530 – Gravity Sanitary Sewers
  - 8. Section 01140 – Contractor’s Use of Premises
- D Referenced Standards:
  - 1. American Society for Testing and Materials (ASTM)
    - a. ASTM D 1784, “Standard Specification for Rigid Poly Vinyl Chloride (PVC) Compounds and Chlorinated Poly Vinyl Chloride (CPVC) Compounds”
    - b. ASTM D 3034, “Standard Specification for Type PSM Poly Vinyl Chloride (PVC) Sewer Pipe and Fittings”
    - c. ASTM D 3212, “Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals”

**1.02 MEASUREMENT AND PAYMENT**

- A Measurement for single, near-side service leads is on a per each basis, complete in place.
- B Measurement for double, near-side service leads is on a per each basis, completed in place.
- C Measurement for single, far-side service leads is on a per each basis, complete in place.
- D Measurement for double, far-side service leads is on a per each basis, complete in place.



- E Payment for service leads includes service connections, couplings, clean-outs, adapters, disconnecting existing services, reconnecting new service, fittings, excavation, backfill, and testing.
- F Measurement for sanitary sewer stacks up to 3 vertical feet is on a per each basis, complete in place. Payment includes riser pipe, service connections, couplings, clean-outs, adapters, disconnecting existing services, reconnecting new service, fittings, excavation, backfill, and testing.
- G Measurement for extra depth sanitary sewer stacks greater than 3 vertical feet is on a vertical foot basis from the top of the receiving sewer to the invert of the service connection, measured and complete in place. Payment includes excavation, pipe, bedding, and backfill for that portion of the stack in excess of 3 feet.
- H Measurement for sanitary sewer service reconnections with stacks located within 5 feet of the sanitary sewer main centerline shall be per each reconnection, complete in place.
- I Measurement for sanitary sewer service reconnections without stacks located within 5 feet of the sanitary sewer main centerline shall be per each reconnection, complete in place.
- J Payment for sanitary sewer service reconnections includes include service connections, couplings, clean-outs, adapters disconnecting existing services, reconnecting new service, fittings, excavation, backfill, and testing.
- K Augered pipe for service leads will be paid as provided in Section 02415 – Augering Pipe or Casing for Sewer.
- L One or more connections discharging into a common point are considered one service connection. The Contractor shall not add service reconnections without approval of the Engineer. The Engineer may require reconnections to be moved or relocated to avoid having more than two single family units per reconnection.
- M Measurement for abandonment of service connection is on a per each basis. No additional payment will be made for abandonment of service connection unless excavation is required beyond new or replacement sewer or service lead trench zone. No separate payment will be made for excavation of sanitary sewer services within the new or replacement sewer trench.

### 1.03 SUBMITTALS

- A Make Submittals required by this Section under the provisions of Section 01350 – Submittals.
- B Submit product data for each pipe product, fitting, coupling and adapter.
- C Submit field red lines documenting location of sanitary sewer stubs and reconnections as installed, referenced to survey Control Points, under the provisions of Section 01760

– Project Record Documents, 1.04C. Include location of utilities and structures encountered or rerouted. Give horizontal dimensions, elevations, inverts and gradients. Record the exact distance from each service connection to the nearest downstream manhole.

#### **1.04 PROTECTION OF PEOPLE AND PROPERTY**

- A Contractor shall conduct all construction operations under this Contract in conformance with the practices described in Section 01500 – Temporary Facilities and Controls.

### **2.0 PRODUCTS**

#### **2.01 PVC SERVICE CONNECTION**

- A As stubouts, use PVC sewer pipe, 4-inch through 10-inch, conforming to ASTM D 1784 and ASTM D 3034, with a cell classification of 12454-B. The SDR (ratio of diameter to wall thickness) shall be 26 for pipe 10 inches in diameter or less.
- B PVC pipe shall be gasket jointed with gasket conforming to ASTM D3212.
- C Provide service connection pipe in sizes shown on the Plans. For reconnection of existing services, select service connection pipe diameter to match existing service diameter.
- D Provide a 6-inch service connection when more than one service discharges into a single pipe.
- E Connect service pipes to new parallel or replacement sewer mains with prefabricated, full-bodied tee or wye fittings conforming to specifications for the sewer main pipe material as specified in other Sections for all sewers up to 18 inches in diameter.
- F Where new sewers are installed using pipe augering or tunneling, or where the new sewer is greater than 18 inches in diameter, use Fowler “Inserta-Tee” to connect the service to the new sewer main.

#### **2.02 PIPE SADDLES**

- A Use pipe saddles only on rehabilitated sanitary sewer mains. Comply with Paragraph 2.01E for new parallel and replacement sanitary sewer mains.

**2.03 COUPLINGS AND ADAPTERS**

- A For connection between new PVC pipe stubout and existing service; 4-, 6-, or 8-inch diameter, use flexible adapter coupling consisting of a neoprene gasket and stainless steel shear ring, with 1/2-inch stainless steel band clamps:
1. Fernco Pipe Connectors, Inc., Series 1055 with shear ring SR-8;
  2. Band Seal by Mission Rubber Co., Inc.;
  3. Approved equal.
- B For connection between new PVC pipe stub out and new service, use rubber-gasketed adapter coupling:
1. GPK Products, Inc., IPS & Sewer Adapter.
  2. Approved Equal.

**2.04 STACKS**

- A Provide stacks for service connections wherever the crown of the sewer is 8 feet or more below finished grade.
- B Construct stacks of the same material as the sanitary sewer and as shown on the Plans.
- C Provide stacks of the same nominal diameter at the sanitary service line.

**2.05 CLEAN-OUTS**

- A Install clean-outs at property line on each service connection as shown in detail on the Plans.

**2.06 PLUGS AND CAPS**

- A Seal the upstream end of unconnected sewer service stubs with rubber gasketed plugs or caps of the same pipe type and size. Provide plugs or caps by GPK Products, Inc., or equal.

**3.0 EXECUTION****3.01 PERFORMANCE REQUIREMENTS**

- A Accurately field locate service connections, whether in service or not, as pipe laying progresses from downstream to upstream.
- B Properly disconnect existing connections from the sewer and reconnect to the new sewer, as described in this Section.
- C Reconnect service connections, including those that go to unoccupied or abandoned buildings, unless directed otherwise by the Engineer. Plug the service connection at the R.O.W. for vacant lots.

- D Connect services 8 inches in diameter and larger to the sewer by construction of a manhole.

### **3.02 PREPARATION**

- A Employ a Trench Safety Plan as specified in Section 01570 – Trench Safety System.
- B Install and operate necessary dewatering and surface water control measures in accordance with requirements of Section 01564 – Control of Ground Water and Surface Water.
- C Provide a minimum of 48 hours notice to customers whose sanitary sewer service will potentially be interrupted.
- D Schedule Work so that reconnection of service lines can be completed within 24 hours after disconnection.
- E Where sewers are existing, field locate existing service connections, whether in service or not. Use existing service locations for reconnection of service lines to new liner or new sanitary sewer main.
- F For new parallel and replacement sanitary sewer mains, complete testing and acceptance of downstream sewers as applicable.

### **3.03 EXCAVATION AND BACKFILL**

- A Excavate and backfill in accordance with Section 02318 – Excavation and Backfill for Utilities.

### **3.04 RECONNECTION ON NEW SEWER**

- A Install the new service connection on the new sanitary sewer main for each service connection.
- B Remove and replace cracked, offset or leaking service line for up to 5 feet, measured horizontally, from the centerline of the new sanitary sewer main.
- C Make up the connection between the new main and the existing service line using PVC sewer pipe and approved couplings, as shown on the Plans.
- D Test service connections before backfilling.
- E Embed the service connection and service line as specified for the new sanitary sewer main at this location, and as shown on the Plans. Place and compact trench zone backfill in compliance with Section 02318 – Excavation and Backfill for Utilities.

**3.05 INSTALLATION OF NEW SERVICE LEADS**

- A Install the new service connections on the new sanitary sewer main for each service connection. Provide the length of stub indicated on the Plans. Install plug or cap on the upstream end of the service stub as needed.
- B Test service connections before backfilling.
- C Embed the service connection and service line as specified for the new sanitary sewer main at this location, and as shown on the Plans. Place and compact trench zone backfill in compliance with Section 02318 – Excavation and Backfill for Utilities.

**3.06 FIELD QUALITY CONTROL**

- A Test service reconnections and service stubs. Follow applicable procedures given in Section 02530 – Gravity Sanitary Sewers.

**3.07 CLEAN-UP AND RESTORATION**

- A Perform clean-up and restoration in and around construction zone in accordance with Section 01140 – Contractor’s Use of Premises.

**3.08 PROTECTION OF THE WORK**

- A Protect and maintain all installations good condition until completion of Work.
- B Replace installations by Contractor's operations at no cost to Owner.
- C Do not allow sand, debris or runoff to enter sewer system.

END OF SECTION

**Section 02534****PVC PIPE****1.0 GENERAL****1.01 SECTION INCLUDES**

- A. Polyvinyl chloride pressure pipe for water distribution in nominal diameters 4 inches through 16 inches.
- B. Polyvinyl chloride sewer pipe for gravity sanitary sewers in nominal diameters 4 inches through 48 inches.
- C. Polyvinyl chloride pressure pipe for gravity sanitary sewers and force mains in nominal diameters 4 inches through 36 inches.
- D. References to Technical Specifications:
  - 1. Section 01350 – Submittals
  - 2. Section 02634 – Ductile Iron Pipe and Fittings
  - 3. Section 02533 – Sanitary Sewage Force Mains
  - 4. Section 02512 – Polyethylene Wrap
  - 5. Section 02510 – Water Mains
  - 6. Section 02530 – Gravity Sanitary Sewers
  - 7. Section 02731 – Sanitary Sewage Force Mains
  - 8. Section 02630 – Storm Sewers
  - 9. Section 02318 – Excavation and Backfill for Utilities
- E. Referenced Standards:
  - 1. American Water Works Association (AWWA)
    - a. AWWA C900 Polyvinyl Chloride (PVC) Pressure Pipe, 4” – 12” for Water Distribution.
    - b. AWWA C905 Polyvinyl Chloride (PVC) Water Transmission Pipe, Nominal Diameters, 14in. Through 36 in.
    - c. AWWA C110 Ductile-Iron and Gray Iron Fittings for Water.
  - 2. American Society for Testing and Materials (ASTM)
    - a. ASTM D 1784, “Standard Specification for Rigid Poly Vinyl Chloride (PVC) Compounds and Chlorinated Poly Vinyl Chloride (CPVC) Compounds”
    - b. ASTM F 477, “Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe”

- c. ASTM D 3139, “Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals”
  - d. ASTM D 3034, “Standard Specification for Type PSM Poly Vinyl Chloride (PVC) Sewer Pipe and Fittings”
  - e. ASTM F 949, “Standard Specification for Poly Vinyl Chloride (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings”
  - f. ASTM D 794, “Standard Specification for Poly Vinyl Chloride (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter”
  - g. ASTM F 679, “Standard Specification for Poly Vinyl Chloride (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings”
  - h. ASTM D 2241, “Standard Specification for Poly Vinyl Chloride (PVC) Pressure-Rated Pipe (SDR Series)”
  - i. ASTM D 3212, “Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals”
  - j. ASTM D 2444, “Standard Test Method for Determination for the Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tup (Falling Weight)”
  - k. ASTM D 1248, “Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable”
  - l. ASTM D 2321, “Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications”
3. American National Standards Institute (ANSI)
    - a. ANSI A21.10 Cast Iron and Ductile Iron Fittings, 2 thru 48 in./Water.
    - b. ANSI A21.11 Rubber Gasket Joints Cast and Ductile Iron Press Pipe.

## **1.02 MEASUREMENT AND PAYMENT**

- A. Unless indicated as a Bid Item, no separate payment will be made for PVC pipe under this Section. Include cost in Bid Items for Water Mains, Gravity Sanitary Sewer, and Sanitary Sewage Force Mains.

## **1.03 SUBMITTALS**

- A. Make Submittals required by this Section under the provisions of Section 01350 – Submittals.
- B. Submit Shop Drawings showing design of new pipe and fittings indicating alignment and grade, laying dimensions, fabrication, fittings, flanges, and special details.

**1.04 QUALITY CONTROL**

- A. Submit manufacturer's certifications that PVC pipe and fittings meet requirements of this Section and AWWA C900 or AWWA C905 for pressure pipe applications, or the appropriate ASTM standard specified for gravity sewer pipe.
- B. Submit manufacturer's certification that PVC pressure pipe has been hydrostatically tested at the factory in accordance with AWWA C900 or AWWA C905 and this Section.
- C. When foreign manufactured material is proposed for use, have material tested for conformance to applicable ASTM requirements by certified independent testing laboratory located in United States. Certification from any other source is not acceptable. Furnish copies of test reports to the Engineer for review. Cost of testing shall be borne by Contractor or Supplier.

**2.0 PRODUCTS****2.01 MATERIAL**

- A. Use PVC compounds in the manufacture of pipe that contain no ingredient in an amount that has been demonstrated to migrate into water in quantities considered to be toxic.
- B. Furnish PVC pressure pipe manufactured from Class 12454-A or Class 12454-B virgin PVC compounds as defined in ASTM D 1784. Use compounds qualifying for a rating of 4000 psi for water at 73.4 degrees F per requirements of PPI TR3. Provide pipe which is homogeneous throughout, free of voids, cracks, inclusions, and other defects, uniform as commercially practical in color, density, and other physical properties. Deliver pipe with surfaces free from nicks and scratches with joining surfaces of spigots and joints free from gouges and imperfections which could cause leakage.
- C. For PVC pressure pipe used for water mains, provide self-extinguishing PVC pipe that bears Underwriters' Laboratories mark of approval and is acceptable without penalty to Texas State Fire Insurance Committee for use in fire protection lines.
- D. Gaskets:
  - 1. Gaskets shall meet the requirements of ASTM F 477. Use elastomeric factory-installed gaskets to make joints flexible and watertight.
  - 2. Pipes to be installed in potentially contaminated areas, especially where free product is found near the elevation of the proposed sewer, shall have the following gasket materials for the noted contaminants.



CONTAMINANT	GASKET MATERIAL REQUIRED
Petroleum (diesel, gasoline)	Nitrile Rubber
Other contaminants	As recommended by the pipe manufacturer

- E. Lubricant for rubber-gasketed joints: Water soluble, non-toxic, non-objectionable in taste and odor imparted to fluid, non-supporting of bacteria growth, having no deteriorating effect on PVC or rubber gaskets.

## 2.02 WATER SERVICE PIPE

- A. Pipe 4-inch through 12-inch: AWWAC900, Class 150, DR 18; nominal 20-foot lengths; cast iron equivalent outside diameters.
- B. Pipe 16-inch: AWWA C905; Class 235; DR 18; nominal 20 foot lengths; cast iron equivalent outside diameter.
- C. Joints: ASTM D 3139; push-on type joints in integral bell or separate sleeve couplings. Do not use socket type or solvent weld type joints.
- D. Make curves and bends by deflecting the joints. Do not exceed maximum deflection recommended by the pipe manufacturer. Submit details of other methods of providing curves and bends for review by the Engineer.
- E. Hydrostatic Test: AWWA C900, AWWA C905, ANSI A21.10 (AWWA C110); at point of manufacture; submit manufacturer's written certification.

## 2.03 BENDS AND FITTINGS FOR PVC PRESSURE PIPE

- A. Bends and Fittings: ANSI A21.10, ductile iron; ANSI A21.11 single rubber gasket push-on type joint; minimum 150 psi pressure rating.
- B. Coatings and Linings: Conform to requirements of Section 02634 – Ductile Iron Pipe and Fittings.

## 2.04 GRAVITY SANITARY SEWER PIPE

- A. PVC gravity sanitary sewer pipe shall be in accordance with the provisions in the following table:

WALL TYPE	MANUFACTURER	PRODUCT OPTIONS	ASTM DESIGNATION	SDR (MAX.) / STIFFNESS (MIN.)	DIAMETER SIZE RANGE
Solid	J-M Pipe CertainTeed	Approved	D3034	SDR 26 / PS 115	6" to 15"
		Approved	F679	SDR 26 / PS 115	18" to 48"
	Can-Tex Carlton Diamond	Approved	AWWA C900	DR 18 / N/A***	4" to 12"
		Approved	AWWA C905	DR 18 / N/A***	14" to 36"
Profile*	Contech A-2000**	Only when included in the Bid Schedule	F949	N/A / 50 psi	12" to 36"
	ETI Ultra-Rib		F794	N/A / 46 psi	12" to 48"
	Lamson Vylon		F794	N/A / 46 psi	21" to 48"

\* Allowed to be used where there are no service taps.

\*\* Allowed to be used to maximum depth of 10' only.

\*\*\* For water-seer separation requirements unless specifically noted in Bid Schedule.

- B. When solid wall PVC pipe 18 inches to 27 inches in diameter is required in SDR 26, provide pipe conforming to ASTM F679, except provide wall thickness as required for SDR 26 and pipe strength of 115 psi.
- C. For sewers up to 12-inch-diameter crossing over waterlines, or crossing under waterlines with less than 2 feet separation, provide minimum 150 psi pressure-rated pipe conforming to ASTM D 2241 with suitable PVC adapter couplings.
- D. Joints: Spigot and integral wall section bell with solid cross section elastomeric or rubber ring gasket conforming to requirements of ASTM D 3212 and ASTM F 477.
- E. ASTM D 3139 and ASTM F 477 shall be provided. Gaskets shall be factory-assembled and securely bonded in place to prevent displacement. The manufacturer shall test a sample from each batch conforming to requirements ASTM D 2444.
- F. Fittings: Provide PVC gravity sewer sanitary bends, tee, or wye fittings for new sanitary sewer construction. PVC pipe fittings shall be full-bodied, either injection molded or factory fabricated. Saddle-type tee or wye fittings are not acceptable.

## 2.05 SANITARY SEWER FORCE MAIN PIPE

- A. Provide PVC pressure pipe conforming to the requirements for water service pipe, and conforming to the minimum working pressure rating specified in Section 02533 – Sanitary Sewage Force Mains.
- B. Acceptable pipe joints are integral bell-and-spigot, containing a bonded-in elastomeric sealing ring meeting the requirements of ASTM F 477. In designated areas requiring restrained joint pipe and fittings, use EBAA Iron Series 2000PV, Uniflange Series 1350 restrainer, or equal joint restraint device conforming to UNI-B-13, for PVC pipe 12-inch diameter and less.

- C. Fittings: Provide ductile iron fittings as per this Section, 2.03 “Bends and Fittings for PVC Pressure Pipe”, except furnish all fittings with one of the following internal linings:
1. Nominal 40 mils (35 mils minimum) virgin polyethylene complying with ASTM D 1248, heat fused to the interior surface of the fitting, as manufactured by American Cast Iron Pipe "Polybond", or U.S. Pipe "Polyline".
  2. Nominal 40 mils (35 mils minimum) polyurethane, Corro-pipe II by Madison Chemicals, Inc.
  3. Nominal 40 mils (35 mils minimum) ceramic epoxy, Protecto 401 by Enduron Protective Coatings.
- D. Exterior Protection: Provide polyethylene wrapping of ductile iron fittings as required by Section 02512 – Polyethylene Wrap.
- E. Hydrostatic Tests: Hydrostatically test pressure rated pipe in accordance with this Section, 2.02E.
- F. Manufacturers: Approved manufacturers of pressure rated, solid wall PVC pipe for sanitary sewer force mains are:
1. J & M Manufacturing Company, Inc.
  2. CertainTeed Corporation
  3. Diamond Plastics Corporation
  4. Carlon Company
  5. North American Pipe Corporation (NAPCO)

### **3.0 EXECUTION**

#### **3.01 PROTECTION**

- A. Store pipe under cover out of direct sunlight and protect from excessive heat or harmful chemicals in accordance with the manufacturer's recommendations.

#### **3.02 INSTALLATION**

- A. Conform to requirements of Section 02510 – Water Mains, Section 02530 – Gravity Sanitary Sewers, Section 02731 – Sanitary Sewage Force Mains, and Section 02630 – Storm Sewers.
- B. Install PVC pipe in accordance with Section 02318 – Excavation and Backfill for Utilities, ASTM D 2321, and manufacturer's recommendations.

- C. Water service pipe 12 inches in diameter and smaller: Installed to clear utility lines and have minimum 4 feet of cover below lowest property line grade of street, unless otherwise required by Plans.
- D. For water service, exclude use of PVC within 200 feet (along the public right-of-way) of underground storage tanks or in undeveloped commercial acreage. Underground storage tanks are primarily located on service stations but can exist at other commercial establishments.
- E. Avoid imposing strains that will overstress or buckle the pipe when lowering pipe into trench.
- F. Hand shovel pipe bedding under the pipe haunches and along the sides of the pipe barrel and compact to eliminate voids and ensure side support.

**END OF SECTION**

**Section 02542****CONCRETE MANHOLES AND ACCESSORIES****1.0 GENERAL****1.01 SECTION INCLUDES**

- A. Pre-Cast Concrete Manholes for sanitary.
- B. Pre-Cast and Cast-in-Place Manholes for storm sewer.
- C. Iron castings for manhole frames and covers, inlet frames and grates, catch basin frames and grates, meter vault frames and covers, adjustment rings and extensions.
- D. Ring grates.
- E. References to Technical Specifications:
  - 1. Section 01200 – Measurement and Payment Procedures
  - 2. Section 01350 – Submittals
  - 3. Section 01500 – Temporary Facilities and Controls
  - 4. Section 03300 – Cast-in-Place Concrete
  - 5. Section 02255 – Bedding, Backfill, and Embankment Materials
  - 6. Section 02318 – Excavation and Backfill for Utilities
  - 7. Section 02530 – Gravity Sanitary Sewers
  - 8. Section 01140 – Contractor’s Use of Premises
- F. Referenced Standards:
  - 1. American Society for Testing and Materials (ASTM)
    - a. ASTM C 478, “Standard Specification for Precast Reinforced Concrete Manhole Sections”
    - b. ASTM C 443, “Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets”
    - c. ASTM C 270, “Standard Specification for Mortar for Unit Masonry”
    - d. ASTM C 923, “Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals”
    - e. ASTM C 1107, “Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)”
    - f. ASTM A 48, “Standard Specification for Gray Iron Castings”
    - g. ASTM A 615, “Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement”
    - h. ASTM D 698, “Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort”

2. American Association of State Highway and Transportation Officials (AASHTO)
  3. American Water Works Association (AWWA)
  4. American Welding Society (AWS)
    - a. AWS D12.1, "Reinforcing Steel Welding Code"
  5. Texas Commission on Environmental Quality (TCEQ)
    - a. Chapter 217.55 "Minimum Clear Opening"
- G. Definitions:
1. Shallow Depth Manholes- manholes having a depth of 4 feet or less measured from the top of cover to sewer invert.
  2. Normal Depth Manholes- manholes having a depth of greater than 4 feet and up to 8 feet measured from top of cover to sewer invert.
  3. Extra Depth Manholes- manholes having a depth of greater than 8 feet measured from the top of cover to sewer invert.
  4. Corrosion Resistant Manholes- concrete manholes incorporating additional material, such as liners or coatings, which make them more resistant to corrosion than typical concrete manholes.
  5. Standard Manholes Drops- drops of up to 3 vertical feet measured from the invert of the T-fitting to the sewer invert.
  6. Extra Depth Manhole Drops- drops in excess of 3 vertical feet measured from the invert of the T-fitting to the sewer invert.

## **1.02 MEASUREMENT AND PAYMENT**

- A. Measurement for Normal Depth Manholes and/or Normal Depth Corrosion Resistant Manholes shall be per each.
- B. Measurement for Shallow Depth Manholes and/or Shallow Depth Corrosion Resistant Manholes shall be per each.
- C. Measurement for Extra Depth Manholes and/or Extra Depth Corrosion Resistant Manholes is on a vertical foot basis for each foot of depth greater than 8 feet.
- D. Payment for Manholes under this Section shall be for complete installation including riser, frames, grates, adjustment rings, stainless steel inflow preventers, cut-in work, covers, penetrations, other appurtenances, and be in accordance with Section 01200 – Measurement and Payment Procedures.

- E. Measurement for Standard Manhole Drops shall be per each.
- F. Measurement for Extra Depth Manhole Drops is on a vertical foot basis for each foot of Drop greater than 3 feet.
- G. Payment for Drops under this Section shall be for assembly components, encasement, other appurtenances, and be in accordance with Section 01200 – Measurement and Payment Procedures.
- H. Payment for Air Release Manhole with Valves and Fittings installed is on a unit price basis for each manhole with air release valves, fittings and appurtenances installed and in accordance with Section 01200 Measurement and Payment Procedures.

### 1.03 PERFORMANCE REQUIREMENTS

- A. Perform work needed to make manholes structurally sound, improve flow, prevent entrance of inflow or groundwater, prevent entrance of soil or debris, and provide protection against hydrogen sulfide gas attack.
- B. Manufacturer's Product Support.
  - 1. Through the Contractor, manufacturers of wall sealing or lining systems shall submit to Engineer for review and approval a detailed description of the proposed coating installation process. Describe surface preparation, independent laboratory test results, mix design procedures and method of controlling uniform thickness.
  - 2. A representative employed by the manufacturer and having technical training in epoxy or cementitious liner shall be named and available for consultation by telephone during business hours and on site upon 48 hours notice.
  - 3. Manufacturer's representative on concrete lining systems shall provide technical assistance to applicators to ensure proper usage of dispensing equipment and accurate proportions of admixtures.

### 1.04 SUBMITTALS

- A. Make Submittals required by this Section under the provisions of Section 01350 – Submittals.
- B. Submit proposed design mix and test data for each type and strength of concrete.
- C. Submit manufacturer's data and details of following items for approval:
  - 1. Frames, grates, rings, and covers.
  - 2. Materials to be used in fabricating drops.

3. Materials to be used for pipe connections at manhole walls.
  4. Materials to be used for stubs and stub plugs.
  5. Plugs to be used for sanitary sewer hydrostatic testing.
  6. Shop Drawings of manhole sections and base units and construction details, including reinforcement, jointing methods, materials and dimensions.
  7. Certification from manufacturer that precast manhole design is in full accordance with ASTM C 478 and design criteria as established in this Section, 2.03E, "Design Loading Criteria".
  8. Product data, materials and procedures for corrosion resistant liner and coatings, if required. For coating and resistant liner systems requiring 10-yr manufacturer warranty, submit specific coating system including product, thickness, and application for Engineer's approval.
  9. Manufacturer's data for pre-mix (bag) concrete, if used for channel inverts and benches.
- D. Installer Qualifications: Installers of liners and wall repair systems shall submit qualifications to Engineer at least 14 days prior to start of any material application. Submittal shall consist of:
1. Manufacturer's approved equipment list, by name and model number for application of product and contractor's equipment list showing approved equipment available for use in product application.
  2. List of contractor's personnel who have satisfactorily completed manufacturer's training in product application within previous two years. Include date of certification for each person.
- E. Provide Shop Drawings for fabrication and erection of casting assemblies. Include plans, elevations, sections and connection details. Show anchorage and accessory items. Include Setting Drawings for location and installation of castings and anchorage devices.

## **2.0 PRODUCTS**

### **2.01 MATERIALS**

- A. Concrete shall conform to requirements in Section 03300 - Cast-In Place Concrete.
- B. Minimum concrete compressive strength of 4000 psi.



- C. Reinforcing Steel shall conform to requirement in Section 03300 - Cast-In Place Concrete.
- D. Mortar shall conform to requirements of ASTM C 270, Type S using Portland cement.

## 2.02 PRECAST CONCRETE MANHOLES

- A. Use manhole sections and base sections conforming to ASTM C 478. Use base riser section with integral floors, unless shown otherwise. Provide adjustment rings which are standard components of the manufacturer of the manhole sections meeting material requirements of ASTM C 478. Mark date of manufacture and name or trademark of manufacturer on inside of barrel.
- B. Construct barrels for precast manholes from 48-inch diameter standard reinforced concrete manhole sections unless otherwise indicated on Plans. Use various lengths of manhole sections in combination to provide the correct height with the fewest joints. Wall sections shall be designed for depth as shown and loading conditions as described in this Section, 2.03E, "Design Load Criteria", but shall not be less than 5 inches thick. Base section shall have a minimum thickness of 12 inches under the invert.
- C. Provide cone tops to receive 30-inch cast iron frames and covers, unless indicated otherwise. Use tops designed to support an AASHTO H-20 loading.
- D. Where the Plans indicate that manholes larger than 48-inch diameter are required, precast base sections of the required diameter shall be provided with flat slab top precast sections used to transition to 48-inch diameter manhole access riser sections. Transition can be concentric or eccentric. The transition shall be located to provide a minimum of 7-foot head clearance from the top of bench to underside of transition.
- E. Design Loading Criteria: The manhole walls, transition slabs, cone tops, and manhole base slab shall be designed by the manufacturer to the requirements of ASTM C 478 for the depth as shown on Plans and the following design criteria:
  - 1. AASHTO H-20 loading applied to the manhole cover and transmitted down to the transition and base slabs.
  - 2. Unit soil weight of 120 pcf located above all portions of the manhole, including base slab projections.
  - 3. Lateral soil pressure based on saturated soil conditions producing an at-rest equivalent fluid pressure of 100 pcf, with soil pressure acting on empty manhole.
  - 4. Internal liquid pressure based on a unit weight of 63 pcf, with manhole filled with liquid from invert to cover, with no balancing external soil pressure.
  - 5. Dead load of manhole sections fully supported by the transition and base slabs.

6. Design additional reinforcing steel to transfer stresses at openings.
  7. The minimum clear distance between any two wall penetrations shall be 12 inches or half the diameter of the smaller penetration, whichever is greater.
- F. Form joints between sections with O-ring gaskets conforming to ASTM C 443.
- G. Do not incorporate manhole steps in manhole sections.
- H. Do not use brick masonry in construction of sanitary sewer manholes.

### **2.03 MISCELLANEOUS METALS**

- A. Provide cast-iron frames, grates, rings, covers, and stainless steel inflow preventers conforming to requirements of this Section and the City of Pearland Standard Construction Details.

### **2.04 DROPS**

- A. Drops shall conform to the same pipe material requirements used in the main pipe, unless otherwise indicated on the Plans.

### **2.05 PIPE CONNECTIONS**

- A. Use resilient connectors conforming to requirements of ASTM C 923. Metallic mechanical devices as defined in ASTM C 923 shall be made of the following materials:
1. External clamps:
    - a. Type 304 stainless steel.
  2. Internal, expandable clamps on standard manholes:
    - a. Type 304 stainless steel, 11 gage minimum.
  3. Internal, expandable clamps on corrosion-resistant manholes:
    - a. Type 316 stainless steel, 11 gage minimum.
    - b. Type 304 stainless steel, 11 gage minimum, coated with minimum 16 mm fusion-bonded epoxy conforming to AWWA C-213.
  4. All precast openings shall be fully circular, 360° openings.
- B. Where rigid joints between pipe and a cast-in-place manhole base are specified or shown on the Plans, use polyethylene-isoprene water-stop meeting the physical property requirements of ASTM C 923, Press-Seal WS Series, or equal.

- C. Storm sewer pipe connections:
  - 1. Connections acceptable for sanitary sewers.
  - 2. Line pipe grouted in place with mortar. Rehabilitate.

## **2.06 WALL CLEANING MATERIAL**

- A. Cleaners: Detergent or muriatic acid capable of removing dirt, grease, oil and other matter which would prevent a good bond of sealing material to wall. Refer to sealing material manufacturer's recommendations.

## **2.07 SEALANT MATERIALS**

- A. Sealing materials between precast concrete adjustment ring and manhole cover frame shall be Adeka Ultraseal P201, or approved equal.

## **2.08 WALL REPAIR MATERIALS**

- A. Hydraulic Cements: Use a blend of cement powders or hydraulic cement to stop active leaks in the manhole structure.
- B. Quickset Mortar: Use a quickset mortar to repair wide cracks, holes or disintegrated mortar.

## **2.09 CORROSION RESISTANT MANHOLE MATERIALS**

- A. Provide one of the following as indicated on the Plans:
  - 1. Precast cylindrical Portland cement concrete sanitary sewer manhole sections, base sections, and cone sections with one of the following factory applied internal coatings or approved equal:
    - a. NeoPoxy™ NPR-5300 Series "PureEpoxy" spray on epoxy liner and other required fillers/sealants per manufacturer's recommendations:
    - b. NeoPoxy NPR-3501 high tensile elongation epoxy elastomeric gout and sealant.
    - c. NeoPoxy NPR-5305 trowelable epoxy filler, grout and sealant,
    - d. Chemical and cementitious rapid set hydraulic grouts such as Strong-Plug, Strong-Seal QSR, Quadex Hyperform and Quadex Hydro-Plug, or other equivalents pre-approved by the engineer.

- e. NeoPoxy P-88 ultraviolet light resistant topcoat.
  - f. EMACO liner (contact City of Pearland Public Works Department for specific type).
  - g. Raven liner (contact City of Pearland Public Works Department for specific type).
  - h. SewperCoat 100% Calcium aluminate by Kerneos™ Aluminate Technologies.
2. Type I Coating: The manufacturer of these applied products shall provide a minimum 10-year material and labor warranty. A 10-year manufacturer warranty shall be applicable for the following sanitary sewer manholes:
    - a. Manholes that receive force main discharge.
    - b. Manholes within the lift/pump station site including last manhole before wet well.
    - c. Manholes with 5 feet diameter and larger or manholes that receive discharge from 15" or larger diameter gravity sewer.
    - d. Manholes as determined by City Engineer.
  3. Type II Coating: All other sanitary sewer manholes shall be coated with minimum 125 mil thick coating of products specified in Section 2.09.1.a-d, or approved equal.

## **2.10 BACKFILL MATERIALS**

- A. Backfill materials shall conform to the requirements of Section 02255 – Bedding, Backfill, and Embankment Materials.

## **2.11 NON-SHRINK GROUT**

- A. For non-shrink grout, use prepackaged, inorganic, flowable, non-gas-liberating, non-metallic, cement-based grout requiring only the addition of water. It shall meet the requirements of ASTM C 1107 and shall have a minimum 28-day compressive strength of 7000 psi.

**2.12 CASTINGS**

- A. Castings for frames, grates, rings and covers shall conform to City of Pearland Standard Construction Details and shall be ASTM A 48, Class 30. Provide locking covers if indicated on Plans.
- B. Castings shall be capable of withstanding the application of an AASHTO H-20 loading without permanent deformation.
- C. Fabricate castings to conform to the shapes, dimensions, and with wording or logos shown on the Plans.
- D. Castings shall be clean, free from blowholes and other surface imperfections. Cast holes in covers shall be clean and symmetrical, free of plugs.

**2.13 BEARING SURFACES**

- A. Machine bearing surfaces between covers or grates and their respective frames so that even bearing is provided for any position in which the casting may be seated in the frame.

**2.14 SPECIAL FRAMES AND COVERS**

- A. Where indicated on the Plans, provide watertight manhole frames and covers with a minimum of four bolts and a gasket designed to seal cover to frame. Supply watertight manhole covers and frames, Model R-1916 manufactured by Neenah Foundry Company, Model V-2420 by East Jordan Iron Works, or approval equal.
- B. Where personnel entry is anticipated, minimum clear openings of 30-inches is required.

**2.15 FABRICATED RING GRATES**

- A. Ring grates shall be fabricated from reinforcing steel conforming to ASTM A 615.
- B. Welds connecting the bars shall conform to AWS D12.1.

**2.16 INFLOW PREVENTERS**

- A. Provide stainless steel inflow preventers with air release vents on all sanitary sewer manholes.

### **3.0 EXECUTION**

#### **3.01 EXAMINATION**

- A. Verify lines and grades are correct.
- B. Determine if the subgrade, when scarified and re-compacted, can be compacted to 95 percent of maximum Standard Proctor Density according to ASTM D 698 prior to placement of foundation material and base section. If it cannot be compacted to that density, the subgrade shall be moisture conditioned until that density can be reached or shall be treated as an unstable subgrade.
- C. Do not build sanitary or storm sewer manholes in ditches, swales, or drainage paths unless approved by the Engineer.

#### **3.02 PLACEMENT OF PRECAST MANHOLES**

- A. Install precast manholes to conform to locations and dimensions shown on Plans.
- B. Place manholes at points of change of alignment, grade, size, pipe intersections, and end of sewer.

#### **3.03 MANHOLE BASE SECTIONS AND FOUNDATIONS**

- A. Place precast base on 12-inch-thick (minimum) foundation of cement stabilized sand or a concrete foundation slab. Compact cement-sand in accordance with requirements of Section 02318 – Excavation and Backfill for Utilities.
- B. Unstable Subgrade Treatment: When unstable subgrade is encountered, the subgrade will be examined by the Engineer to determine if the subgrade has heaved upwards after being excavated. If heaving has not occurred, the subgrade shall be over-excavated to allow for a 24-inch thick layer of crushed stone wrapped in filter fabric as the foundation material under the manhole base. If there is evidence of heaving, a pile-supported concrete foundation, as detailed on the Plans, shall be provided under the manhole base, when indicated by the Engineer.

#### **3.04 PRECAST MANHOLE SECTIONS**

- A. Install sections, joints, and gaskets in accordance with manufacturer's printed recommendations.
- B. Install precast or steel adjustment rings above tops of cones or flat-top sections as required to adjust the finished elevation and to support manhole frame.
- C. Seal any lifting holes with non-shrink grout.

- D. Where PVC liners are required, seal joints between sections in accordance with manufacturers recommendations.

### 3.05 PIPE CONNECTIONS AT MANHOLE

- A. Install approved resilient connectors at each pipe entering and exiting sanitary sewer manholes in accordance with manufacturer's instructions.
- B. Ensure that no concrete, cement stabilized sand, fill, or other rigid material is allowed to enter the space between the pipe and the edge of the wall opening at and around the resilient connector on either the interior or exterior of the manhole. If necessary, fill the space with a compressible material to guarantee the full flexibility provided by the resilient connector. All pipe openings shall be fully circular, 360° openings.
- C. Where a new manhole is to be constructed on an existing sewer, install precast manhole base with factory installed Fernco type connections and pipe stubouts at least two (2) feet outside manhole wall. Manhole shall be cut-in to existing pipe. No "horseshoe" or "dog house" type connections will be permitted.
- D. Do not construct joints on sanitary sewer pipe within wall sections of manholes. Use approved connection material.
- E. Construct pipe stubs with resilient connectors for future connections at locations and with material indicated on Plans. Install approved stub plugs at interior of manhole.
- F. Test connection for watertight seal before backfilling.

### 3.06 INVERTS FOR SANITARY SEWERS

- A. Construct invert channels to provide a smooth flow transition waterway with no disruption of flow at pipe-manhole connections. Conform to following criteria:
  - 1. Slope of invert bench: 1 inch per foot minimum; 1-1/2 inch per foot maximum.
  - 2. Depth of bench to invert:
    - Pipes smaller than 15-inches: one-half largest pipe diameter
    - Pipes 15 to 24-inches: three-fourths the largest pipe diameter
    - Pipes larger than 24-inches: equal to the largest pipe diameter
  - 3. Invert slope through manhole: 0.10-foot drop across manhole with smooth transition of invert through manhole, unless otherwise indicated on Plans.
- B. Form invert channels with class A concrete if not integral with manhole base. For direction changes of mains, construct channels tangent to mains with maximum possible radius of curvature. Provide curves for side inlets and smooth invert fillets for flow transition between pipe inverts.

**3.07 DROPS FOR SANITARY SEWERS**

- A. Construct Drops with same materials used in main pipe unless otherwise indicated on Plans or approved by the Engineer. Install a Drop when a sewer line enters a manhole higher than 30-inches above the invert of the manhole. All drops must be interior drops.
- B. Terminate encasement of blind drops a minimum of 5 inches below top of bell and not less than 12 inches above top of next lower bell. Install approved plug at bell.

**3.08 MANHOLE FRAME AND ADJUSTMENT RINGS**

- A. Combine precast concrete adjustment rings so that the elevation of the installed casting cover is 3/8 inch below the pavement surface. Seal between adjustment ring and the manhole top with non-shrink grout; do not use mortar between adjustment rings. Apply a latex-based bonding agent to concrete surfaces to be joined with non-shrink grout. Set the cast iron frame on the adjustment ring in a bed of approved sealant. The sealant bed shall consist of two beads of sealant, each bead having minimum dimensions of 1/2-inch and 3/4-inch wide.
- B. For manholes in unpaved areas, top of frame shall be set a minimum of 6 inches above existing ground line unless otherwise indicated on Plans. In unpaved areas, encase the manhole frame in mortar or non-shrink grout placed flush with the face of the manhole ring and the top edge of the frame. Provide a rounded corner around the perimeter.

**3.09 BACKFILL**

- A. Place and compact backfill materials in the area of excavation surrounding manholes in accordance with requirements of Section 02318 – Excavation and Backfill for Utilities. Use embedment zone backfill material, as specified for the adjacent utilities, from manhole foundation up to an elevation 12 inches over each pipe connected to the manhole. Provide trench zone backfill, as specified for the adjacent utilities, above the embedment zone backfill.
- B. Where rigid joints are used for connecting existing sewers to the manhole, backfill under the existing sewer up to the spring-line of the pipe with Class B concrete or flowable fill.

**3.10 MANHOLE WALL CLEANING**

- A. The floor and interior walls of the manhole shall be thoroughly cleaned and made free of all foreign materials including dirt, grit, roots, oils, grease, sludge, incompatible existing coatings, waxes, form release, curing compounds, efflorescence, sealers, salts, or other contaminants which may affect the performance and adhesion of the coating to the substrate.



1. High pressure water blasting with a minimum of 3,500 psi shall be used to clean free all foreign material within the manhole
  2. When grease and oil are present within the manhole, an approved detergent or muriatic acid shall be used integrally with the high pressure cleaning water.
  3. All materials resulting from the cleaning of the manhole shall be removed prior to application of the coating.
  4. All loose grout, ledges, steps and protruding ledges shall be removed to provide an even surface prior to application of coating.
- B. Prevent any foreign material from entering the adjoining pipes. Remove droppings of foreign and wall sealant materials before they harden on the bottom of the manhole.
- C. No separate pay shall be made for this item. Include cost for sealing in the unit price for manholes.
- D. Manufacturer's representative shall be available at all times on site to answer questions and approve manhole preparation work prior to lining.

### **3.11 MANHOLE WALL SEALING**

- A. Seal active leaks in the manhole structure by using non-shrink grout.
- B. Remove loose or defective wall material. Wipe or brush surface clean prior to the application of hydraulic cement
- C. Drill weep holes at bottom of manhole walls to relieve hydrostatic pressure to stop leaks. Plug pressure relief holes after leaks are stopped using hydraulic cement materials. Lead wool may also be used to plug large leaks.
- D. Repair wide cracks, or holes with quickset mortars. Follow manufacturer's application procedures.
- E. Shape manhole inverts before wall sealing work. Apply concrete to cleaned manhole benches as specified in Section 03300.
- F. After all active leaks have been stopped, clean and prepare walls for application of selected liner material.
- G. Properly apply the sealing compound to provide the minimum required uniform coating to the wall surface.
- H. Prevent any foreign material from entering the adjoining pipes. Remove droppings of foreign and wall sealant materials before they harden on the bottom of the manhole.

- I. Strictly follow product manufacturer's published technical specifications and recommendations for surface preparation, application and proportioning.

### **3.12 FIELD QUALITY CONTROL**

- A. Conduct leakage testing of manholes in accordance with requirements of Section 02530 – Gravity Sanitary Sewers. Vacuum test shall be completed prior to coating of the manhole.

### **3.13 INSPECTION**

- A. After manhole wall sealing has been completed, visually inspect the manhole in the presence of Engineer. Check for cleanliness and for elimination of active leaks.
- B. At completion of manhole construction, assist Engineer in verifying installation of minimum coating thickness of concrete liner. Test several points on the manhole wall. Repair verification points prior to final acceptance for payment.
- C. During application of corrosion resistant liner, a wet film thickness gauge, meeting ASTM D4414, shall be used. Measurements shall be taken, documented and attested by the Contractor for submission to the Owner.
- D. At completion of manhole construction, assist Engineer in inspection of installation.

### **3.14 TESTING**

- A. After the coating product(s) have set in accordance with manufacturer's instructions, all surfaces shall be inspected for holidays with high-voltage holiday detection equipment. Reference NACE RPO 188-99 for performing holiday detection. All detected holidays shall be marked and repaired by abrading the coating surface with grit disk paper or other hand tooling method. After abrading and cleaning, additional coating can be hand applied to the repair area. All touch-up/repair procedures shall follow the coating manufacturer's recommendations. Documentation on areas tested, results and repairs made shall be provided to Owner by Contractor.
- B. Visual inspection shall be made by the Project Engineer and/or Inspector. Any deficiencies in the finished coating shall be marked and repaired according to the procedures set forth herein by Contractor.

### **3.15 CLEAN-UP AND RESTORATION**

- A. Perform clean-up and restoration in and around construction zone in accordance with Section 01140 – Contractor's Use of Premises.

**3.16 PROTECTION OF THE WORK**

- A. Protect Manholes from damage until subsequent work has been accepted.
- B. Repair or replace damaged elements of Manholes at no additional cost to the Owner.
- C. In unpaved areas, provide positive drainage away from manhole frame to natural grade.

**END OF SECTION**

**Section 02603****FRAMES, GRATES, RINGS, AND COVERS****1.0 GENERAL****1.01 SECTION INCLUDES**

- A. Iron castings for manhole frames and covers, inlet frames and grates, catch basin frames and grates, meter vault frames and covers, adjustment rings and extensions.
- B. Ring grates.
- C. References to Technical Specifications:
  - 1. Section 01200 – Measurement and Payment Procedures
  - 2. Section 01350 - Submittals
- D. Referenced Standards:
  - 1. American Society for Testing and Materials (ASTM)
    - a. ASTM A 48, “Standard Specification for Gray Iron Castings”
    - b. ASTM A 615, “Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement”
    - c. ASTM C 270, “Standard Specification for Mortar for Unit Masonry”
  - 2. American Association of State Highway and Transportation Officials (AASHTO)
    - a. AASHTO M 306, “Drainage, Sewage, Utility, and Related Castings”
  - 3. American Welding Society (AWS)
    - a. AWS D12.1, “Reinforcing Steel Welding Code”
  - 4. Texas Commission on Environmental Quality (TCEQ)
    - a. Chapter 217.55 “Minimum Clear Opening”

**1.02 MEASUREMENT AND PAYMENT**

- A. Unless indicated as a Bid Item, no separate payment will be made for frames, grates, rings, covers, and seals under this Section. Include cost in Bid Items for which this Work is a component.
- B. If frames, grates, rings, covers, and seals are included as a Bid Items, measurement will be based on the Units shown in Section 00300 – Bid Proposal and in accordance with Section 01200 – Measurement and Payment Procedures.

**1.03 SUBMITTALS**

- A. Make Submittals required by this Section under the provisions of Section 01350 – Submittals.
- B. Provide copies of manufacturer's specifications, load tables, dimension diagrams, anchor details, and installation instructions. Manufacturer shall be East Jordan Iron Works, Inc. or as approved by public works.
- C. Provide Shop Drawings for fabrication and erection of casting assemblies. Include plans, elevations, sections and connection details. Show anchorage and accessory items. Include Setting Drawings for location and installation of castings and anchorage devices.

**2.0 PRODUCTS****2.01 CASTINGS**

- A. Castings for frames, grates, rings and covers shall conform to ASTM A 48, Class 35B and AASHTO M 306. Provide locking covers if indicated on Plans.
- B. Castings shall be capable of withstanding the application of an AASHTO H-20 loading without permanent deformation.
- C. Fabricate castings to conform to the shapes, dimensions, and with wording or logos shown on the Plans.
- D. Castings shall be 75% post-consumer recycled material, clean, free from blowholes and other surface imperfections. Cast holes in covers shall be clean and symmetrical, free of plugs.

**2.02 BEARING SURFACES**

- A. Machine bearing surfaces between covers or grates and their respective frames so that even bearing is provided for any position in which the casting may be seated in the frame.

**2.03 SPECIAL FRAMES AND COVERS**

- A. Where indicated on the Plans, provide stainless steel inflow preventers and watertight manhole frames and covers with a minimum of four bolts and a gasket designed to seal cover to frame. Supply watertight manhole Frames and Covers, Model R-1916 manufactured by Neenah Foundry Company, Model V-2420 by East Jordan Iron Works, or as approved by public works.
- B. Where personnel entry is anticipated, minimum clear opening of 30-inches is required.

**2.04 FABRICATED RING GRATES**

- A. Ring grates shall be fabricated from reinforcing steel conforming to ASTM A 615.
- B. Welds connecting the bars shall conform to AWS D12.1.

**2.05 MORTAR**

- A. Conform to requirements of ASTM C 270, Type S using Portland cement.

**3.0 EXECUTION**

**3.01 INSTALLATION**

- A. All installations that have an elevation difference between the final elevation of the manhole cover and the surrounding finished grade greater than 18 inches will be required to be hinged, lift assist gasketed ring and cover.
- B. Install castings according to approved Shop Drawings, instructions given in related Sections, and applicable directions from the manufacturer's printed materials.
- C. Set castings accurately at required locations to proper alignment and elevation. Keep castings plumb, level, true and free of rack. Measure location accurately from established lines and grades. Brace or anchor frames temporarily in formwork until permanently set.
- D. Ring grates shall be fabricated in accordance with Plans and shall be set in mortar in the mouth of the pipe bell.

**END OF SECTION**

**Section 02741****ASPHALTIC CONCRETE PAVEMENT****1.0 GENERAL****1.01 SECTION INCLUDES**

- A. Surface courses of compacted mixture of coarse and fine aggregates and asphaltic material.
- B. References to Technical Specifications:
  - 1. Section 01200 – Measurement and Payment Procedures
  - 2. Section 01350 - Submittals
  - 3. Section 01450 – Testing Laboratory Services
  - 4. Section 02742 – Prime Coat
  - 5. Section 02743 – Tack Coat
- C. Referenced Standards:
  - 1. American Society for Testing and Materials (ASTM)
    - a. ASTM C 33, “Standard Specification for Concrete Aggregates”
    - b. ASTM C 131, “Standard Test Methods for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine”
  - 2. Texas Department of Transportation (TxDOT)
    - a. Tex-106-E, “Calculating the Plasticity Index of Soils”
    - b. Tex-203-F, “Sand Equivalent Test”
    - c. Tex-126-E, “Molding, Testing, and Evaluating Bituminous Black Base Material”
    - d. Tex-204-F, “Design of Bituminous Mixtures”
    - e. Tex-208-F, “Test for Stabilometer Value of Bituminous Material”
    - f. Tex-207-F, “Determining Density of Compacted Bituminous Mixtures”
    - g. Tex-227-F, “Theoretical Maximum Specific Gravity of Bituminous Mixtures”
    - h. Standard Specifications for Construction and Maintenance of Highways, Streets and Bridges, 2004 Adoption
      - 1) Item 340, “Dense-Graded Hot-Mix Asphalt (Method)”

**1.02 MEASUREMENT AND PAYMENT**

- A. Measurement for asphaltic concrete pavement is on square yard basis. Separate measurement will be made for each different required thickness of pavement.
- B. Payment for asphaltic concrete pavement includes all labor and materials required to complete placement as indicated on Plans.
- C. Refer to Section 01200 – Measurement and Payment Procedures.
- D. Refer to this Section, 3.07 “Nonconforming Pavement” for unit price adjustments for deficient thickness.

**1.03 SUBMITTALS**

- A. Make Submittals required by this Section under the provisions of Section 01350 – Submittals.
- B. Submit certificates that asphaltic materials and aggregates meet requirements of this Section.
- C. Submit proposed design mix and test data for each type and strength of surface course in Work.
- D. Submit manufacturer's description and characteristics of mixing plant for approval.
- E. Submit manufacturer's description and characteristics of spreading and finishing machine for approval.

**1.04 TESTING**

- A. Testing and analysis of product quality, material sources, or field quality shall be performed by an independent testing laboratory provided by the Owner under the provisions of Section 01450 – Testing Laboratory Services and as specified in this Section.

**2.0 PRODUCTS****2.01 MATERIALS**

- A. Coarse Aggregate: Crushed stone or gravel or combination thereof, that is retained on No. 10 sieve, uniform in quality throughout and free from dirt, organic or other injurious matter occurring either free or as coating on aggregate. Aggregate shall conform to ASTM C 33 except for gradation. Furnish rock or gravel with Los Angeles



abrasion loss not to exceed 40 percent by weight when tested in accordance with ASTM C 131.

- B. Fine Aggregate: Sand or stone screenings or combination of both passing No. 10 sieve. Aggregate shall conform to ASTM C 33 except for gradation. Use sand composed of sound, durable stone particles free from loams or other injurious foreign matter. Furnish screenings of same or similar material as specified for coarse aggregate. Plasticity index of that part of fine aggregate passing No. 40 sieve shall be not more than 6 when tested by Tex-106-E. Sand equivalent shall have a minimum value of 45 when tested by Tex-203-F.
- C. Composite Aggregate: Conform to the grading limits of TxDOT Item 340 for the paving type indicated on the Plans.
- D. Asphaltic Material: Moisture-free homogeneous material which will not foam when heated to 347° F, meeting following requirements:

<b>VISCOSITY GRADE</b>				
<b>TEST</b>	<b>AC-10</b>		<b>AC-20</b>	
	<b>MIN.</b>	<b>MAX.</b>	<b>MIN.</b>	<b>MAX.</b>
Viscosity, 140° stokes	1000	±200	2000	±400
Viscosity, 275° stokes	1.9	-	2.5	-
Penetration, 77°, 100 g, 5 sec.	85	-	55	-
Flash Point, C.O.C., F.	450	-	450	-
Solubility in trichloroethylene, percent	99.0	-	99.0	-
Tests on residues from thin film oven tests:				
Viscosity, 140° stokes	-	3000	-	6000
Ductility, 77°, 5 cms per min., cms	70	-	50	-
Spot tests	Negative for all grades			

1. Material shall not be cracked.
2. The Engineer will designate grade of asphalt to use after design tests have been made. Use only one grade of asphalt after grade is determined by test design for project.

## **2.02 EQUIPMENT**

- A. Mixing Plant: Weight-batching or drum mix plant with capacity for producing continuously mixtures meeting specifications. Plant shall have satisfactory conveyors, power units, aggregate handling equipment, hot aggregate screens and bins, and dust

collectors. Provide equipment to supply materials adequately in accordance with rated capacity of plant and produce finished material within specified tolerances. Following equipment is essential:

1. Cold aggregate bins and proportioning device.
  2. Dryer.
  3. Screens.
  4. Aggregate weight box and batching scales.
  5. Mixer.
  6. Asphalt storage and heating devices.
  7. Asphalt measuring devices.
  8. Truck scales.
- B. Bins: Separate aggregate into minimum of four bins to produce consistently uniform grading and asphalt content in completed mix.

### 2.03 MIXES

- A. Employ and pay certified testing laboratory to prepare design mixes. Test in accordance with Tex-126-E or Tex-204-F and Tex-208-F.
- B. Density and Stability Requirements:

PERCENT DENSITY		PERCENT OPTIMUM	HVEEM STABILITY PERCENT NOT LESS THAN
MIN.	MAX.		
95	99	97	35

- C. Proportions for Asphaltic Material: As specified in TxDOT Item 340 for the paving type shown on the Plans.

## 3.0 EXECUTION

### 3.01 EXAMINATION

- A. Verify compacted base course is ready to support imposed loads.
- B. Verify lines and grades are correct.

### 3.02 PREPARATION

- A. Prime Coat: If indicated on the Plans, apply a prime coat conforming to requirements of Section 02742 – Prime Coat. Do not apply a tack coat until primed base has cured to satisfaction of the Engineer.

- B. Tack Coat: Conform to requirements of Section 02743 – Tack Coat. Where the mixture will adhere to the surface on which it is to be placed without use of a tack coat, tack coat may be eliminated if approved by the Engineer.
- C. Do not use cutback asphalt during the period of April 16 to September 15.

### 3.03 PLACEMENT

- A. Do not place asphaltic mixture in rain or when air temperature is below 50° F and falling. Mixture may be placed when air temperature taken in shade and away from artificial heat is above 40 F and rising.
- B. Haul prepared and heated asphaltic concrete mixture to the project in tight vehicles previously cleaned of foreign material. Mixture shall be at temperature between 250° F and 325° F when laid.
- C. Spread material into place with approved mechanical spreading and finishing machine of screening or tamping type. Use track-mounted finish machine to place base course directly on earth subgrade.
- D. Surface Course Material: Surface course 2 inches or less in thickness may be spread in one lift. Spread all lifts in such manner that, when compacted, finished course will be smooth, of uniform density, and will be to section, line and grade as shown. Coincide construction joints on surface courses with lime lines, or as directed by the Engineer.
- E. Place courses as nearly continuously as possible. Pass roller over unprotected ends of freshly laid mixture only when mixture has cooled. When work is resumed, cut back laid material to produce slightly beveled edge for full thickness of course. Remove old material which has been cut away and lay new mix against fresh cut.
- F. When new asphalt is laid against existing or old asphalt mat, existing or old asphalt shall be saw cut full depth to provide straight smooth joint.
- G. In restricted areas where use of paver is impractical, spread and finish asphalt by mechanical compactor. Use wood or steel forms, rigidly supported to assure correct grade and cross section. Carefully place materials to avoid segregation of mix. Do not broadcast material. Remove any lumps that do not break down readily. Place asphalt courses in same sequence as if placed by machine.

### 3.04 COMPACTION

- A. Begin rolling while pavement is still hot and as soon as it will bear roller without undue displacement or hair cracking. Keep wheels properly moistened with water to prevent adhesion of surface mixture. Do not use excessive water.

- B. Compress surface thoroughly and uniformly, first with power-driven, 3-wheel, or tandem rollers weighing from 8 to 10 tons. Obtain subsequent compression by starting at side and rolling longitudinally toward center of pavement, overlapping on successive trips by at least one-half width of rear wheels. Make alternate trips slightly different in length. Continue rolling until no further compression can be obtained and all rolling marks are eliminated. Complete all rolling before mixture temperature drops below 175 F.
- C. Use tandem roller for final rolling. Double coverage with approved pneumatic roller on asphaltic concrete surface is acceptable after flat wheel and tandem rolling has been completed.
- D. Along walls, curbs, headers and similar structures, and in all locations not accessible to rollers, compact mixture thoroughly with lightly oiled tamps.
- E. Compact binder course and surface course to density not less than 93 percent of the maximum possible density of voidless mixture composed of same materials in like proportions.

### 3.05 TOLERANCES

- A. Furnish templates for checking surface in finished sections. Maximum deflection of templates, when supported at center, shall not exceed 1/8 inch.
- B. Completed surface, when tested with 10-foot straightedge laid parallel to center line of pavement, shall show no deviation in excess of 1/8 inch in 10 feet. Correct any surface not meeting this requirement.

### 3.06 FIELD QUALITY CONTROL

- A. At the direction of the Engineer, minimum of one core may be taken at random locations per 1,000 feet per lane of roadway or 500 square yards of asphalt concrete pavement to determine in-place depth and density.
- B. In-place density will be determined in accordance with Tex-207-F and Tex-227-F from cores or sections of asphaltic base located near each core. Other methods of determining in-place density, which correlate satisfactorily with results obtained from roadway specimens, may be used when approved by the Engineer.
- C. Contractor may, at his own expense, request three additional cores in vicinity of cores indicating nonconforming in-place depths. In-place depth at these locations shall be average depth of four cores.
- D. Fill cores and density test sections with new compacted asphaltic concrete pavement.

**3.07 NONCONFORMING PAVEMENT**

- A. Recompact pavement sections not meeting specified densities or replace them with new asphaltic concrete material. Replace with new material sections of surface course pavement not meeting surface test requirements or having unacceptable surface texture. Patch asphalt pavement sections in accordance with procedures established by Asphalt Institute.
- B. Remove and replace areas of asphaltic concrete pavement found by cores to be deficient in thickness by more than 10 percent at no cost to Owner. Use new asphaltic concrete pavement of thickness shown on Plans.
- C. Areas of asphaltic concrete pavement found by cores to be deficient in thickness by less than 10 percent shall be remedied at the Owner's direction by one of the following methods:
  - 1. Remove and replace using new asphaltic concrete pavement of thickness shown on Plans and in accordance with the requirements of this Section at no cost to Owner.
  - 2. Reduce the Unit Price by the ratio of the average thickness (as determined by cores) to the thickness required.
- D. No adjustments will be made for excess thickness.

**3.08 PROTECTION OF THE WORK**

- A. Do not open pavement to traffic until 12 hours after completion of rolling, or as shown on Plans.
- B. Maintain asphaltic concrete pavement in good condition until completion of Work.
- C. Repair defects immediately by replacing asphaltic concrete pavement to full depth at no cost to Owner.

**END OF SECTION**

**Section 02980****PAVEMENT REPAIR****1.0 GENERAL****1.01 SECTION INCLUDES**

- A Repairing streets, highways, driveways, sidewalks, and other pavements that have been cut, broken, or otherwise damaged during construction.
- B Repairing areas of failed paving in preparation for resurfacing.
- C References to Technical Specifications:
  - 1. Section 01200 – Measurement and Payment Procedures
  - 2. Section 01350 – Submittals
  - 3. Section 01500 – Temporary Facilities and Controls
  - 4. Section 02335 – Subgrade
  - 5. Section 02710 – Base Course for Pavement
  - 6. Section 02330 – Embankment
  - 7. Section 01140 – Contractor’s Use of Premises

**1.02 MEASUREMENT AND PAYMENT**

- A Unless indicated as a Bid Item, no separate payment will be made for pavement repair under this section. Include cost in Bid Items for which this Work is a component.
- B If pavement repair is included as a Bid Item, measurement is on a square yard basis. as follows:
  - 1. Trench width plus 48 inches for utilities.
  - 2. Trench width plus 10 feet for structures.
  - 3. As marked in field for failed paving.
- C If provisions of this Section, 3.01D, require the limits of pavement repairs to be increased, then the payment limits shall be increased to the same extent.
- D No payment will be made for work outside payment limits, in areas that are not specifically called out as pay items and are incidental to the work or in areas removed for Contractor's convenience.
- E Refer to Section 01200 - Measurement and Payment Procedures.

**1.03 SUBMITTALS**

- A Make submittals required by this section under the provisions of Section 01350 – Submittals.

**1.04 PROTECTION OF PEOPLE AND PROPERTY**

- A Contractor shall conduct all construction operations under this Contract in conformance with the practices described in Section 01500 – Temporary Facilities and Controls.

**2.0 PRODUCTS****2.01 MATERIALS**

- A Provide materials of the same character as existing materials encountered in a cross section of the area to be repaired, or as approved by the Engineer.
- B Subgrade: Provide on site soil stabilized with lime, lime fly ash, etc., as required by the testing laboratory under the provisions of Section 02335 – Subgrade.
- C Base: Provide new base material as required by applicable portions of Section 02710 – Base Course for Pavement.
- D Pavement: Provide new paving materials as required by Technical Specifications of applicable surface course treatments.

**3.0 EXECUTION****3.01 EXAMINATION**

- A Verify backfill is complete before repairing pavement over installed utilities or structures.
- B Verify remaining subgrade is ready to support imposed loads before repairing areas of failed paving.

**3.02 PREPARATION**

- A For installation of utilities and utility appurtenances, saw cut and remove pavement (including base material for asphalt paving) 24 inches beyond the width of excavation, unless otherwise indicated on Plans.
- B For installation of structures, saw cut and remove pavement (including base material for asphalt paving) 5 feet beyond the width of excavation, unless otherwise indicated on Plans.
- C For repair of areas of failed paving, saw cut and remove pavement (including base material for asphalt paving) where indicated in the field or as directed by Engineer. Remove subgrade that is soft and yielding, or to depth as directed by Engineer.
- D If removed pavement is greater than one-half of pavement lane width, or within 18 inches of a longitudinal joint, on concrete pavement, replace pavement for full lane width or to nearest longitudinal joint as approved by the Engineer.

- E Protect edges of existing pavement to remain from damage during removals, utility placement, backfill, and paving operations. For concrete pavement, leave and protect minimum of 18 inches of undisturbed subgrade on each side of trench to support replacement slab.

### **3.03 EXAMINATION :**

- A Verify backfill is complete before repairing pavement over installed utilities or structures.
- B Verify remaining subgrade is ready to support imposed loads before repairing areas of failed paving.

### **3.04 INSTALLATION**

- A Replace subgrade with material specified in this Section, 2.01B. Place and compact under the provisions of Section 02330 – Embankment for areas under future paving to match lines and grade of surrounding subgrade.
- B Replace base course with material specified in this Section, 2.01C. Place and compact under the provisions of Section 02710 – Base Course for Pavement to match lines and grade of surrounding base course.
- C Replace pavement with material specified in this Section, 2.01D, and according to the Technical Specifications of the particular surface course treatment so that a smooth, hard, well cemented surface, conforming to the lines and grade of the surround pavement is secured
- D For concrete pavement, install size and length of reinforcing steel and pavement thickness indicated on Plans. Place types and spacing of joints to match existing or as indicated on Plans.
- E Where existing pavement consists of concrete pavement with asphaltic surfacing, resurface with minimum 2-inch depth asphaltic pavement.
- F Repair state highway crossings in accordance with highway department permit and within 1 week after utility work is installed.

### **3.05 CLEAN-UP AND RESTORATION**

- A Perform clean-up and restoration in and around construction zone in accordance with Section 01140 – Contractor's Use of Premises.

### **3.06 PROTECTION OF THE WORK**

- A Protect and maintain all pavement in good condition until completion of Work.
- B Replace pavement damaged by Contractor's operations at no cost to Owner.

END OF SECTION