2023-2026 Review Cycle
General Requirements and Standard Construction Specifications
Redlines

March 2, 2026

SECTION 01422

REFERENCE STANDARDS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Section includes general quality assurance as related to reference standards and a list of references.

1.02 QUALITY ASSURANCE

A. For Products or workmanship specified by association, trade, or Federal standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.

B. Conform to reference standard by date of issue current on the date as stated in the General Conditions.

C. Request clarification from Project Manager before proceeding should specified reference standards conflict with Contract documents.

1.03 SCHEDULE OF REFERENCES

A. AASHTO American Association of State Highway and Transportation Officials

B. ACI American Concrete Institute

~~B.~~C. ACPA American Concrete Pipe Association

~~C.~~D. AGC Associated General Contractors of America

~~D.~~E. AI Asphalt Institute Research

~~E.~~F. AITC American Institute of Timber Construction

~~F.~~G. AISC American Institute of Steel Construction

~~G.~~H. AISI American Iron and Steel Institute

~~H.~~I. ASME American Society of Mechanical Engineers

~~I.~~J. AMPP The Association for Materials Protection and Performance

~~J.~~K. ANSI American National Standards Institute

~~K.~~L. APA Engineered Wood Association

~~L.~~M. API American Petroleum Institute

~~M.~~N. AREMA American Railway Engineering and Maintenance-of-Way- Association

~~N.~~O. ASTM American Society for Testing and Materials International

~~O.~~P. AWPA American Wood Protection Association

~~P.~~Q. AWS American Welding Society

~~Q.~~R. AWWA American Water Works Association

~~R.~~S. COH City of Houston

T. CLFMI Chain Link Fence Manufacturers Institute

~~S.~~U. CRD Corps of Engineers Research and Development

V. CRSI Concrete Reinforcing Steel Institute

~~T.~~W. DIPRA Ductile Iron Pipe Research Association

X. EJMA Expansion Joint Manufacturers Association

~~U.~~Y. EPA Environmental Protection Agency

~~V.~~Z. FS Federal Standardization Documents

~~W.~~AA. ICEA Insulated Cable Engineers Association

~~X.~~BB. IEEE Institute of Electrical and Electronics Engineers

CC. ISA International Society of Arboriculture

~~Y.~~DD. ISO Petroleum and Natural Gas Industries

~~Z.~~EE. MIL Military Specifications

FF. NACE International ~~-~~National Association of Corrosion Engineers

~~AA.~~GG. NCPI National Clay Pipe Institute

HH. NEMA National Electrical Manufacturers' Association

~~BB.~~II. NEC/NFPA 70 National Electrical Code

JJ. NFPA National Fire Protection Association

KK. NIOSH National Institute of Occupational Safety and Health

~~CC.~~LL. NPCA National Precast Concrete Association

~~DD.~~MM. OSHA Occupational Safety and Health Administration

~~EE.~~NN. PCA Portland Cement Association

~~FF.~~OO. PCI Precast/Prestressed Concrete Institute

~~GG.~~PP. PPI Plastic Pipes Institute

~~HH.~~QQ. SDI Steel Deck Institute

~~II.~~RR. SSPC Society for Protective Coatings

~~JJ.~~SS. TAC Texas Administrative Code

TT. TxDOT Texas Department of Transportation

~~KK.~~UU. HSC Texas Health and Safety Code

~~LL.~~VV. UL Underwriters' Laboratories, Inc.

~~MM.~~WW. UNI-BELL PVC Pipe Association

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

SECTION 01570

STORM WATER POLLUTION PREVENTION CONTROL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Implementation of Storm Water Pollution Prevention Plans (SWP3) described in Section 01410 - TPDES Requirement.

B. Installation, maintenance and removal, of storm water pollution prevention structures: diversion dikes, interceptor dikes, diversion swales, interceptor swales, down spout extenders, pipe slope drains, paved flumes and level spreaders. Structures are used during construction and prior to final development of the site.

C. Filter Fabric Barriers:

1. Type 1: Temporary filter fabric barrier for erosion and sediment control in non-channelized flow areas.

2. Type 2: Temporary reinforced filter fabric barrier for erosion and sediment control in channelized flow areas.

D. Hay Bale Fence.

E. Drop Inlet Basket

F. Inlet Sediment Traps

G. Brush Berm

H. Sand Bag Barrier

I. Bagged Gravel Barrier

J. Sediment Basin

K. Inlet Protection Barrier

1.02 RELATED SECTIONS

A. Document 00410 – Bid Form

B. Section 01270 – Measurement and Payment

C. Section 01330 – Submittal Procedures

D. Section 01410 – TPDES Requirements

E. Section 01504 - Temporary Facilities and Controls

F. Section 01562 - Tree and Plant Protection

G. Section 01575 - Stabilized Construction Access

H. Section 01576 - Waste Material Disposal

I. Section 02233 - Clearing and Grubbing

J. Section 02315 - Roadway Excavation

K. Section 02317 - Excavation and Backfill for Utilities

L. Section 02320 - Utility Backfill Materials

M. Section 02505 - High Density Polyethylene (HDPE) Solid and Profile Wall Pipe

N. Section 02506 - Polyvinyl Chloride Pipe

~~N.~~O. Section 02510 – Polypropylene (PP) Corrugated Wall Pipe

~~O.~~P. Section 02642 - Corrugated Metal Pipe

~~P.~~Q. Section 03315 - Concrete for Utility Construction

1.03 MEASUREMENT AND PAYMENT

A. UNIT PRICES

1. Payment for filter fabric barrier is on a linear foot basis measured between limits of beginning and ending of stakes.

2. Payment for reinforced filter fabric barrier is on a linear foot basis measured between limits of beginning and ending of stakes.

3. Payment for drop inlet baskets is on a unit price basis for each drop inlet basket.

4. Payment for storm inlet sediment traps is on a unit price basis for each storm inlet sediment trap.

5. Payment for storm water pollution prevention structures is on a lump sum basis for the project. Earthen structures with outlet and piping include diversion dikes, interceptor dikes, diversion swales, interceptor swales, and excavated earth-outlet sediment trap, embankment earth-outlet sediment trap, down spout extenders, pipe slope drains, paved flumes, stone outlet sediment trap, and level spreaders.

6. Payment for hay bale barrier, if included in Document 00410 - Bid Form, is on a linear foot of accepted bale barriers, if not include in cost of storm water pollution prevention structures.

7. Payment for brush berm, if included in Document 00410 - Bid Form, is on a linear foot of accepted brush berm, if not include in cost of storm water pollution prevention structures.

8. Payment for sandbag barrier, if included in Document 00410 - Bid Form, is on a linear foot basis measured between limits of beginning and ending of sandbags, if not include in cost of storm water pollution prevention structures.

9. Payment for bagged gravel barrier, if included in Document 00410 - Bid Form, is on a linear foot basis measured between limits of beginning and ending of bagged gravel barrier, if not include in cost of storm water pollution prevention controls.

10. Payment for inlet protection barriers, if included in Document 00410 - Bid Form, is on a linear foot basis measured along outside face of inlet protection barrier, if not include in cost of storm water pollution prevention structures.

11. Repair or replacement of any storm water pollution prevention component is incidental to the individual bid items, regardless of cause of damage.

~~10.~~12. Refer to Section 01270 - Measurement and Payment for unit price procedures.

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

1.04 REFERENCE STANDARDS

A. ASTM

1. A 36 - Standard Specification for Carbon Structural Steel.

2. D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600kN-m/m3)).

3. D3786 - Standard Test Method for Hydraulic Bursting Strength for knitted Goods and Nonwoven Fabrics.

4. D 4355 - Standard Test Method for Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus).

5. D 4491 - Standard Test Methods for Water Permeability of Geotextiles by Permittivity.

6. D 4632 - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.

7. D 4833 - Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.

8. D 6382 - Standard Practice for Dynamic Mechanical Analysis and Thermogravimetry of Roofing and Waterproofing Membrane Material.

B. Storm Water Management Handbook for Construction Activities prepared by City of Houston, Harris County and Harris County Flood Control District.

1.05 SYSTEM DESCRIPTIONS

A. Filter Fabric Barrier Type 1 and Type 2: Install to allow surface or channel runoff percolation through fabric in sheet-flow manner and to retain and accumulate sediment. Maintain Filter Fabric Barriers to remain in proper position and configuration at all times.

B. Hay Bale Fence: Install to allow surface runoff percolation through hay in sheet-flow manner and to retain and accumulate sediment. Maintain Hay Bale Fence to remain in proper position and configuration at all times.

C. Interceptor Dikes and Swales: Construct to direct surface or channel runoff around the project area or runoff from project area into sediment traps.

D. Drop Inlet Baskets: Install to allow runoff percolation through the basket and to retain and accumulate sediment. Clean accumulation of sediment to prevent clogging and backups.

E. Sediment Traps: Construct to pool surface runoff from construction area to allow sediment to settle onto the bottom of trap.

F. Sand Bags: Are used during construction activities in unstabilized minor swales, ditches, or streambeds when the contributing drainage area is no greater than 2 acres. It is also sediment barrier for stage one Inlet.

G. Bagged Gravel Barrier: Are used during construction activities in unstabilized minor swales, ditches, or streambeds when the contributing drainage area is no greater than 2 acres. It is also sediment barrier for stage two Inlet.

H. Drop Inlet Insert Basket: Is a temporary barrier placed within a storm drain inlet (Lower Portion of Stage I and Upper Portion of Stage II Inlets) consisting of a filter fabric supported by a metal frame~~-~~work to prevent sediment and other pollutants from entering convey system.

I. Brush Berm: Brush Berm is constructed at the perimeter of a distribute site within the developing area.

1.06 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

B. Submit manufacturer's literature for product specifications and installation instructions.

C. Submit manufacturer’s catalog sheets and other product data for~~on~~ geotextile or filter fabrics, outlet pipe, perforated riser and connectors.

D. Submit proposed methods, equipment, materials, and sequence of operations for storm~~-~~ water pollution prevention structures.

E. Submit shop drawings for Drop Inlet Baskets.

PART 2 PRODUCTS

2.01 CONCRETE

A. Concrete: Class B in accordance with Section 03315 - Concrete for Utility Construction or as shown on the Drawings.

2.02 AGREGATE MATERIALS

A. Use poorly graded cobbles with diameter greater than 3 inches and less than 5 inches.

B. Provide gravel lining in accordance with Section 2320 - Utility Backfill Materials or as shown on the drawings.

C. Provide clean cobbles and gravel consisting of crushed concrete or stone. Use clean, hard crushed concrete or stone free from adherent coatings, salt, alkali, dirt, clay, loam, shale, soft or flaky materials, or organic matter.

D. Sediment Pump Pit Aggregate: Use nominal 2-inch diameter river gravel.

2.03 PIPE

A. High Density Polyethylene (HDPE) culvert pipe, Polypropylene (PP), or PVC sewer pipe in accordance with Section 02505~~-~~ High Density Polyethylene (HDPE) Solid and Profile Wall Pipe and Section 02506 Polyvinyl Chloride Pipe or as shown on the Drawings.

B. Inlet Pipes: Galvanized steel pipe in accordance with Section 02642 Corrugated Metal Pipe or as shown on the Drawings.

C. Standpipe for Sediment Pump Pits: Galvanized round culvert pipe or round PVC pipe, minimum of 12-inch and a maximum of 24-inch diameter, perforate at 6 to 12 inch centers around circumference.

2.04 GEOTEXTILE FILTER FABRIC

A. Woven or nonwoven geotextile filter fabric made of either polypropylene, polyethylene, ethylene, or polyamide material, in continuous rolls of longest practical length.

B. Grab Strength: -100 psi in any principal direction (ASTM D-4632), Mullen burst strength >200 psi (ASTM D-3786), and equivalent opening size between 50 and 140.

C. Furnish ultraviolet inhibitors and stabilizers for minimum 6 months of expected usable construction life at temperature range of 0 degrees F to 120 degrees F.

D. Mirafi, Inc., Synthetic Industries, or equivalent.

2.05 BARRIER

A. Wire Barrier: Woven galvanized steel wire, 14 gauge by 6-inch square mesh spacing, minimum 24--inch roll or sheet width of longest practical length.

B. Barrier Stakes: Nominal 2-inch by ~~2 inch~~2-inch moisture-resistant treated wood or steel posts (min. of 1.25 lbs. per linear foot and Brinell Hardness greater than 140) with safety caps on top length as required for minimum 8 inch bury and full height of filter fabric.

2.06 SANDBAGS

A. Provide woven material made of polypropylene, polyethylene, or polyamide material.

1. Minimum unit weight of four ounces per square yard.

2. Minimum grab strength of 100 lbs in any principal direction (ASTM D4632)

3. Mullen burst strength exceeding 300 lbs (ASTM D4833).

4. Ultraviolet stability exceeding 70 percent. After 500 hours of exposure (ASTM 4355).

5. Size: Length:18 to 24 inches. Width: 12 to 18 inches. Thickness: 6 to 8 inches. Weight: Approximately 40 to 50 pounds not to exceed 75 pounds.

2.07 BAGGED GRAVEL BARRIER

A. Minimum unit weight of four ounces per square yard.

B. Minimum grab strength of 100 lbs in any principal direction (ASTM D4632)

C. Mullen burst strength exceeding 300 lbs (ASTM D4833).

D. Ultraviolet stability exceeding 70 percent. After 500 hours of exposure (ASTM 4355).

E. Size: Length:18 to 24 inches. Width: 12 to 18 inches. Thickness: 6 to 8 inches. Weight: Approximately 40 to 50 pounds not to exceed 75 pounds.

2.08 DROP INLET BASKET

A. Provide steel frame members in accordance with ASTM A36.

B. Construct top frame of basket with two short sides of 2-inch by 2-inch and single long side of 1-inch by 1-inch, 1/8-inch angle iron. Construct basket hangers of 2 inch by 1/4-inch iron bars. Construct bottom frame of 1-inch by ~~1/4 inch~~1/4-inch iron bar or 1/4-inch plate with center 3 inches removed. Use minimum 1/4-inch diameter iron rods or equivalent for sides of inlet basket.

C. Weld minimum of 14 rods in place between top frame/basket hanger and bottom frame. Exact dimensions for top frame and insert basket will be determined based on dimensions of type of inlet being protected.

2.09 HAY BALE

A. Hay: Standard-baled agricultural hay bound by wire, nylon, or polypropylene rope. Do not use jute or cotton binding.

B. Hay Bale Stakes (applicable where bales are on soil): No. 3 (3/8 diameter) reinforcing bars, deformed or smooth at Contractor's option, length as required for minimum 18 inch bury and full height bales.

PART 3 EXECUTION

3.01 PREPARATION, INSTALLATION AND MAINTEINANCE

A. Provide erosion and sediment control structures at locations shown on the Drawings.

B. Do not clear, grub or rough cut until erosion and sediment control systems are in place unless approved by Project Manager to allow installation of erosion and sediment control systems, soil testing and surveying.

C. Maintain existing erosion and sediment control systems located within project site until acceptance of Project or until directed by Project Manager to remove and discard existing system.

D. Regularly inspect and repair or replace damaged components of erosion and sediment control structures. Unless otherwise directed, maintain erosion and sediment control structure until project area stabilization is accepted. Redress and replace granular fill at outlets as needed to replenish depleted granular fill. Remove erosion and sediment control structures promptly when directed by Project Manager. Dispose of materials in accordance with Section 01576 - Waste Material Disposal.

E. Remove and dispose sediment deposits at the designated spoil site for the Project. If a project spoil site is not designated on Drawings, dispose of sediment off site at approved location in accordance with Section 01576 - Waste Material Disposal.

F. Unless otherwise shown on the Drawings, compact embankments, excavations, and trenches in accordance with Section 02315 - Roadway Excavation or Section - 02317 Excavation and Backfill for Utilities.

G. Prohibit equipment and vehicles from maneuvering on areas outside of dedicated right of way and easements for construction. Immediately repair damage caused by construction traffic to erosion and sediment control structures.

H. Protect existing trees and plants in accordance with Section 01562 - Tree and Plant Protection.

3.02 SEDIMENT TRAPS

A. Install sediment traps so that surface runoff shall percolate through system in sheet flow fashion and allow retention and accumulation of sediment.

B. Inspect sediment traps after each rainfall, daily during periods of prolonged rainfall, and at a minimum once each week. Repair or replace damaged sections immediately.

C. Use fill material for embankment in accordance with Section 02320 - Utility Backfill Materials.

D. Excavation length and height shall be as specified on Drawings. Use side slopes of 2:1 or flatter.

E. Stone outlet sediment traps:

1. Maintain minimum of 6 inches between top of core material and top of stone outlet, minimum of 4 inches between bottom of core material and existing ground and minimum of 1 foot between top of stone outlet and top of embankment.

2. Embed cobbles minimum of 4 inches into existing ground for stone outlet. Core shall be minimum of 1 foot in height and in width and wrapped in triple layer of geotextile filter fabric.

F. Sediment Basin with Pipe Outlet Construction Methods: Install outlet pipe and riser as shown on the Drawings.

G. Remove sediment deposits when design basin volume is reduced by 1/3 ~~one-third~~ or sediment level is 1~~one~~ foot below principal spillway crest, whichever is less.

3.03 FILTER FABRIC BARRIER CONSTRUCTION METHODS

A. Fence Type 1: Filter Fabric: Barrier

1. Install stakes 3 feet on center maximum and firmly embed minimum 8 inches in soil. If filter fabric is factory preassembled with support netting, then maximum support spacing is 8 feet. Install wood stakes at a slight angle toward the source of anticipated runoff.

2. Trench in the toe of the fence lines so the downward face of the trenches is flat and perpendicular to direction of flow. V-trench configuration as shown on Drawings may also be used.

3. Lay fabric along edges of trenches in longest practical continuous runs to minimize joints. Make joints only at a support post. Splice with minimum 6-inch overlap and seal securely.

4. Staple filter fabric to stakes at maximum 3 inches on center. Extend fabric minimum 18 inches and maximum 36 inches above natural ground.

5. Backfill and compact trench.

B. Barrier Type 2: Reinforced Filter Fabric Barrier

1. Layout barrier same as for Type 1.

2. Install stakes at 6 feet on center maximum and at each joint in wire fence, firmly embedded 1-foot minimum, and inclined it as for Type 1.

3. Tie wire fence to stakes with wire at 6 inches on center maximum. Overlap joints minimum one bay of mesh.

4. Install trench same as for Type 1.

5. Fasten filter fabric wire fence with tie wires at 3 inches on center maximum.

6. Layout fabric same as for Type 1. Fasten to wire fence with wire ties at 3 inches on center maximum and, if applicable, to stakes above top of wire fence it as for Type 1.

7. Backfill and compact trench.

8. Attach filter fabric to wooden fence stakes spaced a maximum of 6 feet apart or steel fence stakes spaced a maximum of 8 feet apart and embedded a minimum of 12 inches. Install stakes at a slight angle toward source of anticipated runoff.

9. Trench in toe of filter fabric barrier with spade or mechanical trencher so that downward face of trench is flat and perpendicular to direction of flow. A V-trench configuration may also be used. Lay filter fabric along edges of trench. Backfill and compact trench upon completion of Construction.

10. Filter fabric fence shall have a minimum height of 18 inches and a maximum height of 36 inches above natural ground.

11. Cut length of fence to minimize use of joints. When joints are necessary, splice fabric together only at support post with minimum 6~~-~~-inch overlap and seal securely.

12. When used in swales, ditches or diversions, elevation of barrier at top of filter fabric at flow line location in channel shall be lower than bottom elevation of filter fabric at ends of barrier or top of bank, whichever is less, in order to keep storm water discharge in channel from overtopping bank.

C. Triangular Filter Fabric Barrier Construction Methods

1. Attach filter fabric to wire fencing, 18 inches on each side. Provide a fabric cover and skirt with continuous wrapping of fabric. Skirt should form continuous extension of fabric on upstream side of fence.

2. Secure triangular fabric filter barrier in place using one of the following methods:

   a. Toe-in skirt 6 inches with mechanically compacted material

   b. Weight down skirt with continuous layer of 3-inch to 5-inch graded rock or

   c. Trench-in entire structure 4 inches.

3. Anchor triangular fabric filter barrier structure and skirt securely in place using 6-inch wire staples on 2-foot centers on both edges and on skirt, or staked using 18-inch by 3/8-inch diameter re-bar with tee ends.

4. Lap fabric filter material by 6 inches to cover segment joints. Fasten joints with galvanized shoat rings.

3.04 DIKE AND SWALE

A. Unless otherwise indicated, maintain minimum dike height of 18 inches, measured from cleared ground at up slope toe to top of dike. Maintain side slopes of 2:1 or flatter.

B. Dike and Swale Stabilization: When shown on the Drawings, place gravel lining 3 inches thick and compacted into the soil or 6 inches thick if truck crossing is expected. Extend gravel lining across bottom and up both sides of swale minimum height of 8 inches vertically, above bottom. Gravel lining on dike side shall extend up the up slope side of dike a minimum height of 8 inches, measured vertically from interface of existing or graded ground and up slope toe of dike, as shown on Drawings.

C. Divert flow from dikes and swales to sediment basins, stabilized outlets, or sediment trapping devices of types and at locations shown on Drawings. Grade dikes and swales as shown on Drawings, or, if not specified, provide positive drainage with maximum grade of 1 percent to outlet or basin.

D. Clear in accordance with Section 2233 - Clearing and Grubbing Compact embankments in accordance with Section 2315 - Roadway Excavation.

E. Carry out excavation for swale construction so that erosion and water pollution is minimal. Minimum depth shall be 1 ~~foot~~foot, and bottom width shall be 4 feet, with level swale bottom. Excavation slopes shall be 2:1 or flatter. Clear, grub and strip excavation area of vegetation and root material.

3.05 DOWN SPOUT EXTENDER

A. Down spout extender shall have slope of approximately 1 percent. Use pipe diameter of 4 inches or as shown on the Drawings. Place pipe in accordance with Section 02317 – Excavation and Backfill for Utilities.

3.06 PIPE SLOPE DRAIN

A. Compact soil around and under drain entrance section to top of embankment in lifts appropriately sized for method of compaction utilized.

B. Inlet pipe shall have slope of 1 percent or greater. Use pipe diameter as shown on the Drawings.

C. Top of embankment over inlet pipe and embankments directing water to pipe shall be at least 1 foot higher at all points than top of inlet pipe.

D. Pipe shall be secured with hold-down grommets spaced 10 feet on centers.

E. Place riprap apron with a depth equal to pipe diameter with 2:1 side slopes.

3.07 PAVED FLUME

A. Compact soil around and under the entrance section to top of the embankment in lifts appropriately sized for method of compaction utilized.

B. Construct subgrade to required elevations. Remove and replace soft sections and unsuitable material. Compact subgrade thoroughly and shape to a smooth, uniform surface.

C. Construct permanent paved flumes in accordance with Drawings.

D. Remove sediment from riprap apron when sediment has accumulated to depth of one foot.

3.08 LEVEL SPREADER

A. Construct level spreader on undisturbed soil and not on fill. Ensure that spreader lip is level for uniform spreading of storm runoff.

B. Maintain at required depth, grade, and cross section as specified on Drawings. Remove sediment deposits as well as projections or other irregularities which will impede normal flow.

3.09 INLET PROTECTION BARRIER

A. Place sandbags for Stage I, Bagged gravel for Stage II and filter fabric barriers at locations shown on the SWP3. Maintain to allow minimal inlet in flow restrictions-/-blockage during storm events.

3.10 DROP INLET BASKET CONSTRUCTION METHODS

A. Fit inlet insert basket into inlet without gaps around insert at locations shown on the SWP3.

B. Support for inlet insert basket shall consist of fabricated metal as shown on Drawings.

C. Push down and form filter fabric to shape of basket. Use sheet of fabric large enough to be supported by basket frame when holding sediment and extend at least 6 inches past frame. Place inlet grates over basket/frame to serve as fabric anchor.

D. Remove sediment deposit after each storm event and whenever accumulation exceeds 1-inch depth during weekly inspections.

3.11 HAY BALE FENCE CONSTRUCTION METHODS

A. Place bales in row with ends tightly abutting adjacent bales. Place bales with bindings parallel to ground surface.

B. Embed bale in soil a minimum of 4 inches.

C. Securely anchor bales in place with Hay Bale Stakes driven through bales a minimum of 18-inches into ground. Angle first stake in each bale toward previously laid bale to force bales together.

D. Fill gaps between bales with straw to prevent water from channeling between bales. Wedge carefully in order not to separate bales.

E. Replace with new hay bale fence every two months or as required by Project Manager.

3.12 BRUSH BERM CONSTRUCTION METHODS

A. Construct brush berm along contour lines by hand placing method. Do not use machine placement of brush berm.

B. Use woody brush and branches having diameter less than 2-inches with 6- inches overlap. Avoid incorporation of annual weeds and soil into brush berm.

C. Use minimum height of 18-inches measured from top of existing ground at upslope toe to top of berm. Top width shall be 24 inches minimum and side slopes shall be 2:1 or flatter.

D. Embed brush berm into soil a minimum of 4-inches and anchor using wire, nylon or polypropylene rope across berm with a minimum tension of 50 pounds. Tie rope securely to 18-inch x 3/8-inch diameter rebar stakes driven into ground on 4-foot centers on both sides of berm.

3.13 STREET AND SIDEWALK CLEANING

A. Keep areas clean of construction debris and mud carried by construction vehicles and equipment. If necessary, install stabilized construction exits at construction, staging, storage, and disposal areas, following Section 01575- Stabilized Construction Access.

B. In lieu of or in addition to stabilized construction exits, shovel or sweep pavements as required to keep areas clean. Do not ~~water~~hose or sweep debris and mud off street into adjacent areas, except, hose sidewalks during off-peak hours, after sweeping.

3.14 WASTE COLLECTION AREAS

A. Prevent water runoff from passing through waste collection areas, and prevent water runoff from waste collection areas migrating outside collection areas.

3.15 EQUIPMENT MAINTENANCE AND REPAIR

A. Confine maintenance and repair of construction machinery and equipment to areas specifically designated for that purpose, so fuels, lubricants, solvents, and other potential pollutants are not washed directly into receiving streams or storm water conveyance systems. Provide these areas with adequate waste disposal receptacles for liquid and solid waste. Clean and inspect maintenance areas daily.

B. Where designated equipment maintenance areas are not feasible, take precautions during each individual repair or maintenance operation to prevent potential pollutants from washing into streams or conveyance systems. Provide temporary waste disposal receptacles.

3.16 VEHICLE/ EQUIPMENT WASHING AREAS

A. Install wash area (stabilized with coarse aggregate) adjacent to stabilized construction access, as required to prevent mud and dirt run-off. Release wash water into drainage swales or inlets protected by erosion and sediment controls. Build wash areas following Section 01575- Stabilized Construction Access. Install gravel or rock base beneath wash areas.

B. Wash vehicles only at designated wash areas. Do not wash vehicles such as concrete delivery trucks or dump trucks and other construction equipment at locations where runoff flows directly into waterways or storm water conveyance systems.

C. Locate wash areas to spread out and evaporate or infiltrate wash water directly into ground, or collect runoff in temporary holding or seepage basins.

3.17 WATER RUNOFF AND EROSION CONTROL

A. Control surface water, runoff, subsurface water, and water from excavations and structures to prevent damage to the Work, the site, or adjoining properties. Follow environment requirements.

B. Control fill, grading and ditching to direct water away from excavations, pits, tunnels, and other construction areas, and to direct drainage to proper runoff courses to prevent erosion, sedimentation or damage.

C. Provide, operate, and maintain equipment and facilities of adequate size to control surface water.

D. Retain existing drainage patterns external to the site by constructing temporary earth berms, sedimentation basins, retaining areas, and temporary ground cover as required to control conditions.

E. Plan and execute construction and earth work to control surface drainage from cuts and fills, and from borrow and waste disposal areas, to prevent erosion and sedimentation.

1. Hold area of bare soil exposed at one time to a minimum.

2. Provide temporary controls such as berms, dikes, and drains.

F. Construct fill and waste areas by selective placement to eliminate surface silts or clays which will erode.

G. Inspect earthwork periodically to detect start of erosion. Immediately apply corrective measures as required to control erosion.

H. Dispose of sediments offsite, not in or adjacent to waterways or floodplains, nor allow sediments to flush into streams or drainage ways. Assume responsibility for offsite disposal location.

I. Unless otherwise indicated, compact embankments, excavations, and trenches by mechanically blading, tamping, and rolling soil in maximum of 8- inch layers. Provide compaction density at minimum 90 percent Standard Proctor ASTM D-698-78 density. Make at least 1~~one~~ test per 500 cubic yards of embankment.

J. Prohibit equipment and vehicles from maneuver on areas outside of dedicated rights-of-way and easements for construction. Immediately repair damage to erosion and sedimentation control systems caused by construction traffic.

K. Do not damage existing trees intended to remain.

3.18 REMOVAL OF CONTROLS

A. Remove erosion and sediment controls when the site is finally stabilized or as directed by Project Manager.

B. Dispose of sediments and waste products following Section 01504 - Temporary Facilities and Controls.

END OF SECTION

SECTION 01740

SITE RESTORATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Restoration of site affected by the Work in public or private property, including pavement, esplanades, sidewalks, driveways, fences, lawns and landscaping.

1.02 RELATED SECTIONS

A. Section 01110 – Summary of Work

B. Section 01270 – Measurement and Payment

C. Section 01330 – Submittal Procedures

D. Section 01562 – Tree and Plant Protection

E. Section 01576 – Waste Material Disposal

F. Section 02514 – Disinfection of Water Lines

G. Section 02921 – Hydro Mulch Seeding

H. Section 02922 – Sodding

I. Section 02951 – Pavement Repair and Restoration

J. Section 02400 – Tunnel Shafts

K. Section 02445 - Jack and Bore/Jack and Mine/Pilot Tube Guided Boring Tunnels

~~I.~~L. Section 02511 – Water Lines

M. Section 02517 – Water Line in Tunnels

~~J.~~N. Section 02531 – Gravity Sanitary Sewers

1.03 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. ~~Payment~~ Measurement and payment for restoration of a Project site disturbed by utility construction ~~operations~~ is on a linear foot basis measured along the utility alignment for open-cut utility construction. ~~Measurement will be as provided for corresponding utility in each Specification section.~~ No separate payment will be made for branch pipes, valves, and~~,~~ other associated work for utilities. Measurement and payment for restoration with multiple utilities within the same right-of-way or easement will be on a linear foot basis for only one utility.

2. Measurement and payment for Site Restoration of a project site disturbed by small diameter waterline (SDWL) construction including appurtenances (less than or equal to 20-inch diameter) is on a linear foot basis irrespective of method of construction. No separate payment will be made for branch pipes, valves, and other associated work. When SDWLs are installed by open cut with multiple utilities, measurement and payment for restoration with multiple utilities within the same right-of-way or easement will be on a linear foot basis for only one utility.

3. No separate payment for Site Restoration will be made for trenchless utility construction except for small diameter waterline as indicated under section 1.03 A.2. Site Restoration for all other utility construction is incidental to the work for the corresponding trenchless utility construction unless:

    a. The item is indicated in Document 00410B separately as “Site Restoration for trenchless installation”, includes the type of utility being installed, and is approved by the Project Manager~~.~~

4. For measurement and payment for disturbance within tunnel shaft construction areas, refer to Section 02400 – Tunnel Shafts.

~~2.~~5. No separate payment will be made for Site Restoration for ~~f~~Facility or ~~r~~Roadway ~~projects c~~Construction. Include cost in the surface improvements associated with the ~~f~~Facility or ~~r~~Roadway ~~c~~Construction.

~~3.~~6. Payment includes required ~~s~~Site ~~r~~Restoration within the right-of-way or easement, regardless of size or type of pipe, method of construction, paved or unpaved areas or thickness and width of pavement.

~~4.~~7. No separate payment will be made for ~~s~~Site ~~r~~Restoration for service connections under this Section. Include cost in appropriate utility section.

8. Mailboxes

    a. Standard mailboxes: No separate payment made for removing, relocating and providing temporary/permanent mailboxes for residences and businesses impacted by construction activities during and after the completion of the construction. Include cost of this work, and cost of coordination with United States Postal Service and property owners in appropriate facility or Roadway Construction.

~~a.~~b. Customized mailboxes, including but not limited to decorative and brick mailboxes: No separate payment made for removing and salvaging decorative and brick mailboxes and providing temporary/permanent standard mailboxes for residences and businesses impacted by construction activities during and after the completion of the construction. Include cost of this work, and cost of coordination with United States Postal Service and property owners in appropriate facility or Roadway Construction.

~~5.~~9. Refer to Section 01270 – Measurement and Payment for Unit Price procedures.

B. Stipulated Price (Lump Sum) Contracts. If Contract is Stipulated Price Contract, include payment for work under this section in total Stipulated Price.

1.04 DEFINITIONS

A. Facility Construction: The improvement to the utility infrastructure located within the fenced boundary of a public works water, wastewater, or storm water facility, excluding distribution and collection utilities located within the public right-of-way or easement adjacent to the public right-of-way. This includes but is not limited to water/wastewater treatment plants, pump stations, lift stations, and water storage tanks.

~~A.~~B. Phase: Locations identified on the plans and listed in Section 01110 – Summary of Work under Work Sequence.

C. Roadway Construction: The improvement to the finished surface in the public-right of-way with or without underground utility improvements which includes but is not limited to pavement, sidewalk, and bicycle facility.

~~B.~~D. Site Restoration: Replacement or reconstruction of Site Improvements located in rights-of-way, easements, public property, and private property affected or altered by the Work.

~~C.~~E. Site Improvement: Includes pavement, curbs and gutters, esplanades, sidewalks, driveways, fences, lawns, irrigation systems, landscaping, mailboxes and other improvements in existence at the Project site before commencement of construction operations.

1.05 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

B. Schedule of testing, service connections, abandonment, backfill, and ~~s~~Site ~~r~~Restoration.

C. Sample of notices to residents outlining their responsibility for maintenance of ~~s~~Site ~~i~~Improvements adjacent to the Project that are not disturbed by construction operations

1.06 SCHEDULING

A. Schedule testing, service connections, abandonment, backfill and ~~s~~Site ~~r~~Restoration immediately following completion of pipe laying work or paving within each block or line segment.

B. Phased Construction:

1. Commencement of subsequent Phase will follow scheduling of ~~s~~Site ~~r~~Restoration of prior Phase. Limit work to a maximum of two Phases of the ~~p~~Project.

C. Construction of Projects with no Phases listed in Section 01110 - Summary of Work:

1. Complete ~~s~~Site ~~r~~Restoration prior to disturbing over 50% of total ~~p~~Project linear feet or 2,000 linear feet, whichever is greater, of right-of-way or easement.

2. Limit work to a maximum of 50% of total ~~p~~Project linear feet or 2,000 linear feet, whichever is greater, of right-of-way and easement. Commence work in additional right-of-way or easement after completion of ~~s~~Site ~~r~~Restoration.

PART 2 PRODUCTS

2.01 MATERIALS

A. Pavement, Sidewalks and Driveways: Materials specified in Section 02951 - Pavement Repair and Resurfacing.

B. Seeding and Sodding: Sod specified in Section 02922 - Sodding and Seed specified in Section 02921 - Hydromulch Seeding.

C. Trees, Shrubs and Plantings: Conform to requirements of Section 01562 – Tree and Plant Protection.

PART 3 EXECUTION

3.01 PREPARATORY WORK

A. Provide cleanup and restoration crews to work closely behind pipe laying and ~~r~~Roadway ~~c~~Construction crews, and where necessary, during testing, service restoration, abandonment, backfill and surface restoration.

B. Water Lines: Unless otherwise approved by Project Manager, comply with the following:

1. Once Project Manager approves work within a Phase, immediately begin preparatory work for disinfection effort.

2. No later than three days after completing disinfection preparatory work, submit to City appropriate request for disinfection.

3. If City fails to perform initial disinfection of lines in accordance with Section 02514 - Disinfection of Water Lines, within seven days from submission of appropriate request, and if approved by Project Manager, pipe laying operations may continue beyond approved limits until the City responds.

4. Immediately after transfer of services, begin abandonment of old water lines and ~~s~~Site ~~r~~Restoration.

C. Wastewater Lines:

1. Once Project Manager approves work within a Line Segment, immediately begin preparatory work for testing effort.

2. No later than three days after completing preparatory work for testing, initiate testing work.

3. Immediately after transfer of service connections, begin abandonment of old wastewater lines, and ~~s~~Site ~~r~~Restoration.

D. ~~Street Construction and Paving Projects~~ Storm Sewer Lines

1. Once Project Manager approves work within a Line Segment or block, immediately begin preparatory work for testing effort.

2. No later than three days after completing preparatory work for testing, initiate testing work.

3. Immediately after testing begin ~~s~~Site ~~r~~Restoration.

E. ~~Street Construction and Paving Projects~~ Street Paving Work

1. Once Project Manager approves work within a block, immediately begin preparatory work for sidewalk construction, sodding and hydromulching and tree planting.

2. No later than seven days after completing preparatory work, initiate construction.

3.02 CLEANING

A. Remove debris and trash to maintain a clean and orderly site in accordance with requirements of General Conditions and Section 01576 - Waste Material Disposal.

3.03 LANDSCAPING AND FENCES

A. Seeding and Sodding.

1. Remove construction debris and level area with bank sand so that new grass surface matches level of existing grass and maintains pre- construction drainage patterns. Level and fill minor ruts or depressions caused by construction operations with bank sand, where grass is still viable.

2. Restore previously existing turfed areas with sod and fertilize in accordance with Section 02922 - Sodding. Sod to match existing turf.

3. Restore unpaved areas not requiring sodding with hydromulch seeding conforming to Section 02921 - Hydromulch Seeding.

B. Trees, Shrubbery and Plants.

1. Remove and replant trees, shrubs, and plants in accordance with requirements of Section 01562 – Tree and Plant Protection.

C. Fence Replacement.

1. Replace removed or damaged fencing to equal or better condition than existed prior to construction, including concrete footings and mow strips. Provide new wood posts, top and bottom railing and panels. Metal fencing material, not damaged by the Work, may be reused.

2. Remove and dispose of damaged or substandard material.

3.04 MAILBOXES

A. Coordinate relocation of the existing mailboxes and/or installation of the temporary mailboxes with the United States Postal Service station serving the project area, and the homes and businesses prior to starting construction.

B. Contractor shall provide notification and ample time to homes and businesses in advance of construction for the relocation/removal of the customized mailboxes by the property owners. Property owner’s failure to relocate/remove the customized mailboxes does not relieve the contractor from removing and salvaging such mailboxes in accordance with Article 1.03.A.6.b of this Section and proceeding with the proposed improvements in timely manner.

C. Upon the completion of the proposed improvements, install standard mailboxes at original or appropriate location approved by the United States Postal Services, home and business owner, or Project Manager.

D. Contractor may use the existing standard mailbox material if it is in a good condition and is approved by the Project Manager or property owner. In case the existing mailbox material is not in satisfactory condition to the City, then Contractor shall provide mailbox with new material in accordance with ~~the~~ Article 1.03.A.6 of this Section.

~~3.04~~3.05 MAINTENANCE

A. Maintain shrubs, plantings, sodded areas and seeded areas.

B. Replace shrubs, plantings and seeded or sodded areas that fail to become established.

C. Refer to Section 01562 - Tree and Plant Protection, Section 02921 - Hydromulch Seeding and Section 02922 - Sodding for maintenance requirements.

END OF SECTION

SECTION 02081

CAST-IN-PLACE CONCRETE MANHOLES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Cast-in-place concrete manholes for sanitary sewers, water lines and storm sewers, including box sewers.

B. Pile-supported concrete foundation used for unstable subgrade treatment for manhole base.

1.02 ~~REALTED~~RELATED SECTIONS

A. Section 01270 – Measurement and Payment

B. Section 01330 – Submittal Procedures

C. Section 02090 – Frames, Grates, Rings, and Covers

D. Section 02317 – Excavation and Backfill for Utilities

E. Section 02321 – Cement Stabilized Sand

F. Section 02533 – Acceptance Testing for Sanitary Sewers

G. Section 02911 – Topsoil

H. Section 02921 – Hydro Mulch Seeding

I. Section 02922 – Sodding

J. Section 03315 – Concrete for Utility Construction

K. Section 04061 – Mortar

1.03 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. Payment for manholes is on a unit price basis for each manhole installed.

2. Payment for Type C manhole with BB inlet top is on a unit price basis for each.

3. Payment for pile-supported concrete foundation used for unstable subgrade treatment for manhole base is on a unit price basis for each foundation installed.

4. Refer to Section 01270 - Measurement and Payment for unit price procedures.

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

1.04 REFERENCES

A. ASME B 16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.

B. ASTM A 307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 psi Tensile Strength.

C. ASTM A 1107 – Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures and Corrugated Steel Drainage Pipes.~~ASTM C 270 - Standard Specification for Mortar for Unit Mason~~

D. ASTM C 478 - Precast Reinforced Concrete Manhole Sections.

E. ASTM C 890 – Standard Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures.

~~B.~~F. ASTM C 913 - Standard Specification for Precast Concrete Water and Wastewater Structure.

~~C.~~G. ASTM C 923 - Standard Specifications for Resilient Connectors Between Reinforced Concrete Manhole Structures and Pipes.

~~D. ASTM C 990 - Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.~~

H. ASTM C 1107 - Standard Specification for Packaged Dry, Hydraulic - Cement Grout (Non-shrink).

~~E.~~I. ASTM C 1821 – Standard Practice for Installation of Underground Circular Precast Concrete Manhole Structures.

~~F.~~J. ASTM D 698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft3 (600 kN-m/m3)).

~~G.~~K. ASTM D 2665 - Standard Specification for Poly Vinyl Chloride (PVC) Plastic Drain, Waste and Vent Pipe, and Fittings.

~~H.~~L. ASTM D 2996 - Standard Specification for Filament-wound Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.

~~I.~~M. ASTM D 2997 - Standard Specification for Centrifugally Cast Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.

~~J. ASTM F 2306 – Standard Specification for 12 to 60 in. [300 to 1500 mm] Annular Corrugated Profile – Wall Polyethylene (PE) Pipe and Fittings for Gravity-Flow Storm Sewer and Subsurface Drainage Applications.~~

~~K.~~N. ASTM F 2510 – Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures and Corrugated Dual- and Triple-Wall Polyethylene and Polypropylene Pipes.

O. AWWA C 213 - Fusion-Bonded Epoxy Coatings and Linings for Steel Water Pipe and Fittings.

P. AASHTO HL-93 Design Live Loading Loads as Referred to in AASHTO LRFD Bridge Design Specifications.

~~L.~~Q. OSHA Occupational Safety and Health Standards.

1.05 DEFINITIONS

A. Resilient Connectors - Flexible connectors consisting of a natural or synthetic rubber material and resilient seal that can be deformed or deflected up to a certain hydrostatic head pressure without leakage or rupture.

~~1.05~~1.06 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

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 drop connections.
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. Installation instructions for forms.

D. Submit structural design calculations, signed and sealed by a licensed Engineer.

PART 2 PRODUCTS

2.01 CONCRETE

A. Conform to requirements of Section 03315 - Concrete for Utility Construction.

B. Provide Class A concrete with minimum compressive strength of 4,000 psi unless otherwise indicated on Drawings.

C. Design Loading Criteria: Manhole walls, transition slabs, cone tops, and manhole base slab shall be designed~~, by manufacturer,~~ to requirements of ASTM C 478, ASTM C 890, and/or ASTM C 913 for depth as shown on Drawings and to resist following loads.

1. AASHTO HL-93 design live loading loads as referred to in AASHTO LRFD Bridge Design Specifications applied to manhole cover and transmitted down to transition and base slabs.

2. Unit soil weight of 120 pcf located above portions of manhole, including base slab projections.

3. Lateral soil pressure based on saturated soil conditions producing an at-rest equivalent fluid pressure of 100 pcf.

4. Internal liquid pressure based on unit weight of 63 pcf.

5. Dead load of manhole sections fully supported by transition and base slabs.

D. Design: Manhole walls, transition slabs, cone tops, and manhole base slab shall be designed according to requirements of ASTM C 478, ASTM C 890 and/or ASTM C 913 and following:

1. Design additional reinforcing steel to transfer stresses at openings. Area of steel to be no less than shown on Drawings.

2. Wall loading conditions:

a. Saturated soil pressure acting on empty manhole.

b. Manhole filled with liquid to a halfway depth as measured from invert to cover, with no balancing external soil pressure.

3. Minimum clear distance between two wall penetrations shall be 12-inches or half diameter of smaller penetration, whichever is greater

2.02 REINFORCING STEEL

A. Conform to requirements of Section 03315 - Concrete for Utility Construction.

2.03 MORTAR

A. Conform to requirements of Section 04061 - Mortar

2.04 MISCELLANEOUS METALS

A. Provide cast-iron frames, grates, rings, and covers conforming to requirements of Section 02090 - Frames, Grates, Rings, and Covers.

2.05 DROP CONNECTIONS AND STUBS

A. Provide drop connections and stubs conforming to same pipe material requirements used in main pipe, unless otherwise indicated on Drawings.

2.06 PIPE CONNECTIONS

A. Sanitary Sewers.

1. Provide resilient connectors conforming to requirements of ASTM C 923. Use the following materials for metallic mechanical devices as defined in ASTM C 923:

a. External clamps: Type 304 stainless steel

b. Internal, expandable clamps on Standard manholes: Type 304 stainless steel, 11 gauge minimum

c. Internal, expandable clamps on corrosion-resistant manholes:

(1) Type 316 stainless steel, 11 gauge minimum

(2) Type 304 stainless steel, 11 gauge minimum, coated with minimum 16 mil fusion-bonded epoxy conforming to AWWA C213

2. Where rigid joints between pipe and cast-in-place manhole base are specified or shown on Drawings, provide polyethylene-isoprene waterstop meeting physical property requirements of ASTM C 923, such as Pres-Seal WS Series, or approved equal.

B. Storm Sewers: ~~Connections of concrete pipe to manhole will be set in flexible joint sealant conforming to ASTM C 990, placed in the middle of the manhole wall and covering the lower 1/3rd of the opening. Use non-shrink grout for storm sewer pipe connections to concrete manholes, unless otherwise shown on Drawings. Grout pipe penetration in place on both inside and outside of manhole.~~

1. For watertight connections provide Resilient Connectors in accordance with ASTM C 923, ASTM A 1107 or ASTM F 2510 as applicable for pipe material.

2. For soil-tight connections, provide the following:

a. Rigid (concrete) pipe to manhole connections: Grouted in accordance with ASTM C 1821.

b. Flexible pipe to manhole connections: Resilient connectors in accordance with ASTM C 923, ASTM A 1107 or ASTM F 2510 as applicable for pipe material.

3. If no connection type is specified in Contract documents, a soil-tight connection shall be provided.

~~B.~~C. Water Lines

1. Where smooth exterior pipes, i.e., steel, ductile iron, or PVC pipes are connected to manhole base or barrel, seal space between pipe and manhole wall with assembly consisting of rubber gasket or links mechanically compressed to form a watertight barrier. Assemblies: Press-Wedge, Pres-Seal, Thunderline, Link-Seals, or approved equal. See Drawings for placement of assembly in manhole sections.

2. When connecting concrete or cement mortar coated steel pipes, or as option for connecting exterior pipes to manhole base or barrel, space between pipe and manhole wall may be sealed with an assembly consisting of a stainless steel power sleeve, stainless steel take-up clamp and a rubber gasket. Take-up clamp: Minimum of 9/16 inch wide. Provide PSX positive seal gasket system by Press-Seal Gasket Corporation or approved equal.

2.07 SEALANT MATERIALS

A. Provide sealing materials between precast concrete adjustment ring and manhole cover frame, such as Adeka Ultraseal P 201, or approved equal.

B. Provide external sealing material from Canusa Wrapid Seal manhole encapsulation system, or approved equal.

C. Butyl Sealant: Provide Press-Seal EZ Stick, or equal, for HDPE rings.

2.08 CORROSION-RESISTANT MANHOLE MATERIALS

A. Where corrosion-resistant manholes are indicated on the Drawings, refer to City of Houston Approved Product List for liner and/or coating materials.

2.09 BACKFILL MATERIALS

A. Conform to the requirements of Section 02317 - Excavation and Backfill for Utilities.

2.10 NON-SHRINK GROUT

A. Provide prepackaged, inorganic, flowable, non-gas-liberating, non-metallic, cement-based non-shrink grout requiring only addition of water.

B. Provide grout meeting requirements of ASTM C 1107 and having minimum 28-day compressive strength of 7,000 psi.

2.11 VENT PIPES

A. Provide external vent pipes for manholes where indicated on Drawings.

B. Buried Vent Pipes: Provide 3-inch or 4-inch PVC DWV pipe conforming to ASTM D 2665. Alternatively, provide FRP pipe as specified for vent outlet assembly.

C. Vent Outlet Assembly: Provide vent outlet assembly as shown on Drawings, constructed of following specified materials:

1. FRP Pipe: Provide filament-wound FRP conforming to ASTM D 2996 or centrifugally cast FRP conforming to ASTM D 2997. Seal cut ends in accordance with manufacturer's recommendations.

2. Joints and Fittings: Provide epoxy- bodied fittings and join pipe to fittings with epoxy adhesive, according to pipe manufacturer's instructions.

3. Flanges: Provide socket-flange fittings for epoxy adhesive bonding to pipe ends where shown on Drawings. Meet bolt pattern and dimensions for ASME B 16.1, 125-pound flanges. Use Type 304 stainless steel or hot-dip zinc coated, conforming to ASTM A 307, Class A or B flange bolts.

4. Coating: Provide 2-component, aliphatic polyurethane coating, using primer or tie coat recommended by manufacturer. Provide two or more coats to yield dry film thickness of at least 3 mils. Provide Amershield, Tnemec 74, or approved equal. Project Manager selects color from manufacturer's standard colors.

2.12 MANHOLE LADDER FOR WATERLINE MANHOLES

A. Manhole Ladder: Fiberglass with 300-lb rating at appropriate length; conform to requirements of Occupational Safety and Health Standards (OSHA), U.S. Department of Labor except where shown on Drawings.

1. Use components, including rungs, made of fiberglass, fabricated with nylon or aluminum rivets and/or epoxy. Apply non-skid coating to ladder rungs. Mount ladder using manufacturer's recommended hardware.

2. Provide ladder as manufactured by Saf-Rail or approved equal. Locate ladder as shown on Drawings.

3. Fiberglass: Premium type polyester resin, reinforced with fiberglass; constructed to provide complete wetting of glass by resin; resistant to rot, fungi, bacterial growth and adverse effects of acids, alkalis and residential and industrial waste; yellow in color.

4. Provide approved petroleum-based tape encapsulating bolts in access manhole.

2.13 PROHIBITED MATERIALS

A. Use of brick masonry is prohibited for construction of manholes, including adjustment of manholes to grade.

B. For Storm Water manholes, use of mortar is prohibited for pipe to manhole connections.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify lines and grades are correct.

B. Determine if subgrade, when scarified and recompacted, can be compacted to 95 percent of maximum Standard Proctor Density at ±3 percent optimum moisture content according to ASTM D 698 prior to placement of material and base section. If it does not meet the moisture-density requirement, condition the subgrade until the required moisture-density requirement is met or treat as an unstable subgrade.

C. Do not build manholes in ditches, swales, or drainage paths unless approved by Project Manager.

3.02 MANHOLES

A. Construct manholes to dimensions shown on Drawings. Commence construction as soon as possible after pipes are laid. On monolithic sewers, construct manholes at same time sewer is being constructed.

B. Unstable Subgrade Treatment: When unstable subgrade is encountered, notify Project Manager for examination of subgrade to determine if subgrade has heaved upwards after being excavated. When heaving has not occurred, over-excavate subgrade to allow for 24-inch-thick layer of crushed stone wrapped in filter fabric as foundation material under manhole base. When there is evidence of heaving, provide pile-supported concrete foundation, as detailed on Drawings, under manhole base.

C. Cast manhole foundations and walls monolithically. Use cold joint with approved waterstop when manhole flow line depth exceeds 12 feet. No other joints will be allowed unless shown on Drawings. Wrap cold joints with external sealing material, minimum 6-inch ~~with~~widthe.

D. For concrete containing micro silica admixtures, place, finish, and cure concrete for manholes following procedures in Section 03315 - Concrete for Utility Construction.

E. Top of manhole elevations shown on Drawings are approximate, based on current pavement and natural ground conditions as determined from elevations measured on 50-foot spacing. No additional payment will be made if final elevation of manhole ring and cover is higher or lower due to requirements of finished grade or replaced pavement surface.

F. For water lines place concrete for manhole base on 12-inches~~"~~ thick (minimum) foundation of cement stabilized sand. Compact cement stabilized sand in accordance with requirements of 02321 – Cement Stabilized Sand.

G. For manholes located over large diameter water lines, place base on a foundation of cement stabilized sand extending from bottom of manhole to bottom of trench. Manhole base is to be a minimum of 12-inches above water line.

3.03 PIPE CONNECTIONS

A. Sanitary Sewer and Water Line Manholes:

1. Install approved resilient connectors at each pipe entering and exiting water line and sanitary sewer manholes in accordance with manufacturer's instructions. See article 2.06 for approved connection materials.

B. Storm Sewer Manholes:

~~2.~~1. Install connections at each pipe entering and exiting manholes in accordance with manufacturer's instructions and specifications. See article 2.06 for connection material requirements. When pipe to manhole connections are to be grouted, all voids are to be completely filled with grout and grouted on both sides inside and outside of manhole.~~Storm sewer connections of concrete pipe to manhole will be set in flexible joint sealant conforming to ASTM C 990, placed in the middle of the manhole wall and covering the lower 1/3rd of the opening. Grout pipe penetrations both inside and outside of manhole.~~

~~B.~~C. Ensure no concrete, cement stabilized sand, fill, or other solid material is allowed to enter space between pipe and edge of wall opening at and around resilient connector on interior or exterior of manhole. When necessary, fill space with compressible material to ensure resilient connector will maintain full flexibility where evidence of reduced flexibility is encountered.

~~C.~~D. Where new manhole is to be constructed on existing sewer, a rigid joint pipe may be used. Install waterstop gasket around existing pipe at center of cast-in-place wall. Join ends of split waterstop material at pipe spring line using adhesive recommended and supplied by waterstop manufacturer.

~~D.~~E. Do not construct joints on sanitary sewer pipe within wall sections of manholes. Use approved connection material.

~~E.~~F. Construct pipe stubs with ~~r~~Resilient ~~c~~Connectors for future connections at locations and with material indicated on Drawings. Install approved stub plugs at interior of manhole.

~~F.~~G. Test connection for watertight seal before backfilling.

3.04 INVERTS FOR SANITARY SEWERS

A. Construct inverted channels to provide smooth flow transition waterway with no disruption of flow at pipe-manhole connections. Conform to the 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:

a. Pipes smaller than 15-inches: one-half of largest pipe diameter.

b. Pipes 15 to 24 inches: three-fourths of largest pipe diameter.

c. Pipes larger than 24-inches: equal to largest pipe diameter.

3. Invert slope through manhole: 0.10 foot drop across manhole with smooth transition of flow at pipe-manhole connections. Conform to following criteria.

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.

3.05 INVERTS FOR STORM SEWERS

A. When precast, square or rectangular structures are used for sewer manholes, construct invert channels to provide 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; 1-½ inches per foot maximum.

2. Depth of bench to invert: 1/2~~one half~~ of 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 drawings.

B. Form invert channels with concrete, after all connections have been made.

1. Use 5 sack premix (bag) concrete or Class A concrete for inverts, with minimum compressive strength of 4,000 psi.

3.06 DROP CONNECTIONS FOR SANITARY SEWERS

A. Backfill drop assembly with crushed stone wrapped in filter fabric, cement-stabilized sand, or Class A concrete to form solid mass. Extend cement stabilized sand or concrete encasement minimum of 4-inches outside bells.

B. Install connection when sewer line enters manhole higher than 24-inches above invert of manhole.

3.07 STUBS FOR FUTURE CONNECTIONS

A. In manholes where future connections are indicated on Drawings, install resilient connectors and pipe stubs with approved watertight plugs.

3.08 ADJUSTMENT RINGS AND FRAME

A. Combine precast concrete or HDPE adjustment rings so elevation of installed casting cover matches pavement surface. Seal between concrete adjustment ring and precast top section with non-shrink grout; do not use mortar between adjustment rings. Apply latex-based bonding agent to precast concrete surfaces to be joined with non-shrink grout. Set cast iron frame on adjustment ring in a bed of approved sealant material. Install a sealant bed consisting of two beads of sealant, each bead having minimum dimensions of 1/2-inch and 1/2-inch wide.

B. Wrap manhole frame and adjustment rings with external sealing material, minimum 3-inches beyond joint between ring and frame, and ring and precast section.

C. For manholes in unpaved areas, set top of frame minimum of 6-inches above existing ground line unless otherwise indicated on Drawings. Encase manhole frame in mortar or non-shrink grout placed flush with face of manhole ring and top edge of frame. Provide rounded corner around perimeter.

3.09 BACKFILL

A. After concrete obtains adequate strength, place and compact backfill materials in area of excavation surrounding manholes in accordance with requirements of Section 02317 - Excavation and Backfill for Utilities. Use embedment zone backfill material for adjacent utilities, as shown in City of Houston Standard Details over each pipe connected to manhole. Provide trench zone backfill, as specified for adjacent utilities, above embedment zone backfill.

B. Where rigid joints are used for connecting existing sewers to manhole, backfill under existing sewer up to spring~~-~~line of pipe with Class B concrete or flowable fill.

C. In unpaved areas, provide positive drainage away from manhole frame to natural grade.

D. Provide minimum of 4-inches of topsoil conforming to requirements of Section 02911 - Topsoil.

E. Seed in accordance with Section 02921 - Hydro Mulch Seeding, or sod disturbed areas in accordance with Section 02922 - Sodding.

3.10 FIELD QUALITY CONTROL

A. Conduct leakage testing of Sanitary Sewer manholes in accordance with requirements of Section 02533 - Acceptance Testing for Sanitary Sewers.

3.11 PROTECTION

A. Protect manholes from damage until subsequent work has been accepted. Repair or replace damaged elements of manholes at no additional cost to City.

END OF SECTION

SECTION 02082

PRECAST CONCRETE MANHOLES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Precast concrete manholes for sanitary sewers, storm sewers, and water lines. Manhole bases may be round or square.

B. Precast concrete sanitary sewer manholes with PVC liner where corrosion resistant manholes are specifically indicated in Drawings.

C. Pile-supported concrete foundation used for unstable subgrade treatment for manhole base.

1.02 ~~REALTED~~RELATED SECTIONS

A. Section 01270 - Measurement and Payment

B. Section 01330 - Submittal Procedures

C. Section 01630 - Product Substitution Procedures

D. Section 02090 - Frames, Grates, Rings, and Covers

E. Section 02317 - Excavation and Backfill for Utilities

F. Section 02321 - Cement Stabilized Sand

G. Section 02533 - Acceptance Testing for Sanitary Sewers

H. Section 02911 – Topsoil

I. Section 02921 - Hydro Mulch Seeding

J. Section 02922 – Sodding

K. Section 03315 - Concrete for Utility Construction

L. Section 04061 - Mortar

1.03 MEASUREMENT AND PAYMENT

A. Unit Prices

1. Payment for normal depth manholes, up to 8 feet deep, is on a unit price basis for each manhole installed. Manhole depth is measured from top of cover to sewer invert. Air release manhole depth is measured from top of cover to inside base for air release or vacuum release manholes. Manholes for water lines are measured from top of cover to inside base of manhole.

2. Payment for shallow depth manholes is on a unit price basis for each manhole installed. Shallow manholes have a depth of 5 feet or less measured from top of cover to sewer invert.

3. Payment for extra depth manholes is on a unit price basis per vertical foot for each foot of depth greater than 8 feet. Sewer manhole depth is measured from top of cover to sewer invert. Air release manhole depth is measured from top of cover to inside base for air release or vacuum release manholes. Manholes for water lines are measured from top of cover to inside base of manhole.

4. Payment for normal depth corrosion resistant manholes is on a unit price basis for each manhole installed.

5. Payment for standard manhole drops is on a unit price basis for each drop installed. Standard manhole drops include both internal and external drops.

6. Payment for watertight manholes, including external vent pipe and/or wraps, are on a unit price basis for each.

7. Payment for air-release manhole with valves and fittings installed is on a unit price basis for each manhole with air-release valves and fittings installed.

8. Payment for pile-supported concrete foundation used for unstable subgrade treatment for manhole base is on a unit price basis for each foundation installed.

9. Pay estimates for partial payments will be made as measured above according to the following schedule for sanitary sewer manholes:

   a. Estimate for 90 percent payment will be authorized when the manhole is completely installed and surrounding soil backfilled.

   b. Estimate for 100 percent payment will be authorized when manhole has been tested as specified in Section 02533 - Acceptance Testing for Sanitary Sewers.

10. Refer to Section 01270 - Measurement and Payment for unit price procedures

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

1.04 REFERENCES

A. ASME B 16.1 – Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250

B. ASTM A 307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 psi Tensile Strength

~~B.~~C. ASTM A 1107 – Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures and Corrugated Steel Drainage Pipes

~~C. ASTM A 615 - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement~~

D. ASTM C 443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.

E. ASTM C 478 - Standard Specification for Circular Precast Reinforced Concrete Manhole Sections

F. ASTM C 890 - Standard Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures.

G. ASTM C 913 – Standard Specification for Precast Concrete Water and Wastewater Structures.

H. ASTM C 923 - Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals

I. ASTM C 990 – Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants

J. ASTM C 1107 - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)

K. ASTM C 1821 - Standard Practice for Installation of Underground Circular Precast Concrete Manhole Structures

L. ASTM C 1837 - Standard Specification for Production of Dry Cast Concrete Used for Manufacturing Pipe, Box, and Precast Structures

M. ASTM C 1889 – Standard Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Utility, Water, and Wastewater Structures Using AASHTO LRFD Design

N. ASTM D 698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft3 (600kN-m/m3))

O. ASTM D 2665 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste and Vent Pipe and Fittings

P. ASTM D 2996 - Standard Specification for Filament-Wound “Fiberglass” (Glass-Fiber- Reinforced Thermosetting-Resin) Pipe

Q. ASTM D 2997 - Standard Specification for Centrifugally Cast “Fiberglass” (Glass-Fiber- Reinforced Thermosetting Resin) Pipe

~~R. ASTM F 2306 – Standard Specification for 12 to 60 in. [300 to 1500 mm] Annular Corrugated Profile-Wall Polyethylene (PE) Pipe and Fittings for Gravity-Flow Storm Sewer and Subsurface Drainage Applications.~~

~~S.~~R. ASTM F 2510 – Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures and Corrugated Dual- and Triple-Wall Polyethylene and Polypropylene Pipes.

~~T.~~S. AWWA C 213 - Fusion Bonded Epoxy Coatings and Linings for Steel Water Pipe and Fittings

T. ~~American Association of State Highway and Transportation Officials~~ (AASHTO M-306 Section 5 Loading)

U. AASHTO HL-93 design live loading loads as referred to in AASHTO LRFD Bridge Design.

V. Texas Department of Transportation (TxDOT) – Item 465 “Junction Boxes, Manholes, and inlets”

~~V.~~W. Occupational Safety and Health Standards (OSHA).

1.05 DEFINITIONS

A. Resilient Connectors - Flexible connectors consisting of a natural or synthetic rubber material and resilient seal that can be deformed or deflected up to a certain hydrostatic head pressure without leakage or rupture.

~~1.05~~1.06 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

B. Submit manufacturer's data and details of following items for approval:

1. Shop drawings of manhole sections, base units and construction details, including reinforcement, jointing methods, materials, and dimensions.

2. Summary of criteria used in manhole design including, as minimum, material properties, loadings, load combinations, and dimensions assumed. Include certification from manufacturer that precast manhole design is in full accordance with ASTM C 478 and/or ASTM C 890 and design criteria as established in Paragraph 2.01E of this Specification.

3. Frames, grates, rings, and covers.

4. Materials to be used in fabricating drop connections.

5. Materials to be used for pipe connections at manhole walls.

6. Materials to be used for stubs and stub plugs, if required.

7. Materials and procedures for corrosion-resistant liner and coatings, if required.

8. Plugs to be used for sanitary sewer hydrostatic testing.

9. Manufacturer's data for pre-mix (bag) concrete, if used for channel inverts and benches.

C. Seal submittal drawings by Professional Engineer registered in State of Texas.

PART 2 PRODUCTS

2.01 PRECAST CONCRETE MANHOLES

A. Provide machine-made manhole sections, base sections, and related components conforming to ASTM C 478 and/or ASTM C 913. Provide base riser section with integral floors, unless shown otherwise. Provide adjustment rings which are standard components of manufacturer of manhole sections. Mark date of manufacture and name or trademark of manufacturer on inside of barrel.

B. Construct risers and reduced risers for precast manholes from standard reinforced concrete manhole sections of diameter indicated on Drawings. Use various lengths of manhole sections in combination to provide correct height with fewest joints.

C. Minimum Thickness Requirements for Riser Walls and Bases:

1. Sanitary Sewer and Waterline Manholes

a. Design Wall sections for depth and loading conditions in paragraph 2.01.F, with minimum thickness of 5 inches.

b. Base sections shall have a minimum thickness of 12 inches under invert.

2. Storm Sewer Manholes

a. Design riser sections, base and base slabs for depth and loading conditions in Paragraph 2.01.F, with minimum thicknesses according to precast storm water manhole standard details. Minimum base thickness specified in the precast storm water manhole details excludes benching and invert material thickness.

D. Provide tops to support cast iron casting meeting AASHTO M-306 Section 5 loading, and receive manhole frame and~~&~~ covers, as indicated on Drawings.

E. Transition Slabs:

1. Sanitary Sewer & Waterline Manholes:

a. Where manholes larger than 48-inch diameter are indicated on Drawings, provide precast base sections with flat slab top precast sections used to transition to 48-inch diameter manhole access riser sections. Transition can be concentric or eccentric unless otherwise shown on Drawings. Locate transition to provide minimum of 7-foot head clearance from base to underside of transition unless otherwise approved by Project Manager.

2. Storm Sewer Manholes:

a. Where manholes larger than 48-inch diameter are indicated on Drawings, provide precast base sections with flat slab top precast sections used to transition to 48-inch or 60-inch diameter manhole access riser sections. Transition can be concentric or eccentric unless otherwise shown on Drawings.

F. Design Loading Criteria: Manhole walls, transition slabs, cone tops, and manhole base slab shall be designed, by manufacturer, to requirements of ASTM C 890, and/or ASTM C 1889 for depth as shown on Drawings and to resist following loads.

1. AASHTO HL-93 design live loading loads as referred to in AASHTO LRFD Bridge Design Specifications applied to manhole cover and transmitted down to transition and base slabs.

2. Unit soil weight of 120 pcf located above portions of manhole, including base slab projections.

3. Lateral soil pressure based on saturated soil conditions producing an at-rest equivalent fluid pressure of 100 pcf.

4. Internal liquid pressure based on unit weight of 63 pcf.

5. Dead load of manhole sections fully supported by transition and base slabs.

G. Design: Manhole walls, transition slabs, cone tops, and manhole base slab shall be designed according to requirements of ASTM C 478, and/or ASTM C 913 and following:

1. Design additional reinforcing steel to transfer stresses at openings. Area of steel to be no less than shown on Drawings.

2. Wall loading conditions:

a. Saturated soil pressure acting on empty manhole.

b. Manhole filled with liquid to a halfway depth as measured from invert to cover, with no balancing external soil pressure.

3. Wall Penetrations:

a. Sanitary Sewer and Waterline Manholes:

(1) Minimum clear distance between two wall penetrations shall be 12 inches or half diameter of smaller penetration, whichever is greater.

b. Storm Sewer Manholes:

(1) Minimum clear distance between two wall penetrations shall be 6 inches or the base units wall thickness, whichever is greater. Clear distance shall be measured along the inside wall arc of manhole.

(2) When ~~r~~Resilient ~~c~~Connectors are specified in the contract documents, minimum clear distance between wall penetrations shall be 12 inches. Minimum clear distance is to be verified with resilient connector manufacturer before fabricator's engineering design of manhole.

(3) All bases and risers may have cast or cored round wall penetrations. Wall penetrations shall not extend into the slabs or walls. Wall penetrations shall not ~~to~~ be within a distance less than the wall thickness, or a minimum of 6 inches, from the joint above or below.

(4) Only box bases and box risers may have thin wall panels (KO) that are round and do not extend into the slab, into walls, or within 6" of the joint above or below. KO dimensions to conform to requirements on standard details.

(5) For box manholes, wall penetrations at corners are prohibited.

(6) For rigid pipe, cut hole in thin wall panel (KO) 4" max, 2" min larger than pipe OD.

(7) For flexible pipe, consult ~~boot/seal~~ Resilient Connectors manufacturer's specification for placement tolerance and hole size.

H. Provide vertical joints between sections with gaskets conforming to ASTM C 443 and/or ASTM C 990.

I. When base is cast monolithic with portion of vertical section, extend reinforcing in vertical section into base.

J. Precast Concrete Base: Supply suitable cutouts, knockouts or holes to receive pipe and connections. Lowest edge of holes or cutouts: For water line manhole, no less than 6 inches above inside surface of floor of base. For storm sewer manholes, refer to requirements set by standard details.

K. Lifting Hole, Marking and Storage and Shipment for Storm~~Strom~~ Water Manholes Only:

1. Lifting Holes: Provide no more than 4 lifting holes in each section for precast units. Lifting holes may be cast, cut into fresh concrete after form removal, or drilled. Provide lifting holes large enough for adequate lifting devices based on the size and weight of the section. The maximum hole diameter is 3 inches. at the inside surface of the wall and 4 inches. at the outside surface. Cut no more than 5 inches. in any direction of reinforcement per layer for lifting holes. Repair spalled areas around lifting holes.

2. Marking. Clearly mark each precast manhole with the following information:

   a. Name or trademark of fabricator and plant location

   b. Product designation

   c. ASTM designation (if applicable)

   d. Date of manufacturing; and

   e. Designated fabricator's approval stamp

3. Storage and Shipment: Store Precast units on a level surface. Do not ship precast units until design strength requirements have been met.

L. Third-Party Certification Requirement:

1. Precast concrete manufacturers supplying precast concrete products shall maintain active certification from an accepted third-party quality control program at the time of manufacture.

~~1.~~2. Accepted third-party quality control programs are the National Precast Concrete Association (NPCA) Plant Certification Program and the American Concrete Pipe Association (ACPA) Q-Cast Program

3. Copies of certificates demonstrating compliance with the above third-party plant certification requirements shall be furnished upon the first delivery to the project. Certifications shall be resubmitted annually thereafter or upon request by the Project Manager.

2.02 CONCRETE

A. Manholes

1. Sanitary Sewer and Waterline Manholes

a. Conform to requirements of Section 03315 - Concrete for Utility Construction or ASTM C 1837.

2. Storm Sewer Manholes

a. Conform to concrete material requirements of TxDOT Specification Item 465 "Junction Boxes, Manholes and Inlets".

b. Cure precast manholes in accordance with ASTM C 478.

B. Channel Inverts

1. Sanitary Sewer and Waterline Manholes

a. Use 5 sack premix (bag) concrete or Class A concrete for inverts not integrally formed with manhole base, with minimum compressive strength of 4,000 psi.

2. Storm Sewer Manholes

a. Conform to concrete material requirements of TxDOT Specification Item 465 "Junction Boxes, Manholes and Inlets".

C. Cement Stabilized Sand Foundation: Provide cement stabilized sand foundation under base section in lieu of foundation slab, as shown on Drawings, conforming to requirements of Section 02321 - Cement Stabilized Sand.

D. Concrete Foundation: Provide Class A concrete with minimum compressive strength of 4,000 psi for concrete foundation slab under manhole base section where indicated on Drawings.

2.03 REINFORCING STEEL

A. Conform to requirements of Section 03315 - Concrete for Utility Construction.

2.04 MORTAR

A. Conform to requirements of Section 04061 - Mortar.

2.05 MISCELLANEOUS METALS

A. Provide cast-iron frames, rings, and covers conforming to requirements of Section 02090 - Frames, Grates, Rings and Covers.

2.06 DROP CONNECTIONS AND STUBS

A. Provide drop connections and stubs conforming to same pipe material requirements used in main pipe, unless otherwise indicated on Drawings.

2.07 PIPE CONNECTIONS TO MANHOLE

A. Sanitary Sewer Connections

1. Provide ~~r~~Resilient ~~c~~Connectors conforming to requirements of ASTM C 923. Use the following materials for metallic mechanical devices as defined in ASTM C 923:

a. External clamps: Type 304 stainless steel.

b. Internal, expandable clamps on standard manholes: Type 304 stainless steel, 11 gauge minimum.

c. Internal, expandable clamps on corrosion-resistant manholes:

(1) Type 316 stainless steel, 11 gauge minimum.

(2) Type 304 stainless steel, 11 gauge minimum, coated with minimum 16 mil fusion-bonded epoxy conforming to AWWA C 213.

2. Where rigid joints between pipe and cast-in-place manhole base are specified or shown on Drawings, provide polyethylene-isoprene water-stop meeting physical property requirements of ASTM C 923, such as Press-Seal WS Series, or approved equal.

B. Storm Sewer Connections

1. For watertight connections ~~P~~provide ~~watertight connections~~~~r~~Resilient Connectors in accordance with ASTM C 923, ASTM A 1107 ~~and~~ or ASTM F 2510 as applicable for ~~flexible~~ pipe material.

2. For soil-tight connections, provide the following:

a. Rigid (concrete) pipe to manhole connections: ~~are to be g~~Grouted in ~~according~~ accordance with ~~to~~ ASTM C 1821.

b. Flexible pipe to manhole connections: Resilient Connectors in accordance with ASTM C 923, ASTM A 1107 or ASTM F 2510 as applicable for pipe material.

3. If no connection type is specified in Contract documents, a soil-tight connection shall be provided.

C. Water Line Connections

1. Where smooth exterior pipes, i.e., steel, ductile iron, or PVC pipes are connected to manhole base or barrel, seal space between pipe and manhole wall with assembly consisting of rubber gasket or links mechanically compressed to form a watertight barrier. Assemblies: Press-Wedge, Res-Seal, Thunderline Link-Seal, or approved equal. See Drawings for placement of assembly in manhole sections.

2. When connecting concrete or cement mortar coated steel pipes, or as option for connecting smooth exterior pipes to manhole base or barrel, space between pipe and manhole wall may be sealed with an assembly consisting of a stainless-steel power sleeve, stainless steel take-up clamp and a rubber gasket. Take-up clamp: Minimum of 9/16 inch wide. Provide PSX positive seal gasket system by Press-Seal Gasket Corporation or approved equal.

2.08 SEALANT MATERIALS

A. Approved products in accordance with Section 01630 - Product Substitution Procedures.

B. Sealing material between precast concrete adjustment ring and manhole, between each adjustment ring, and between adjustment ring and manhole cover frame shall be a hydrophilic elastic sealant, which adheres to both concrete and metal, or approved equal.

C. Provide approved external sealing material from Canusa Wrapid Seal manhole encapsulation system, or approved equal.

D. Provide Butyl Sealant: Provide Press-Seal EZ Stick, or equal, for HDPE rings.

2.09 CORROSION RESISTANT MANHOLE MATERIALS

A. Where corrosion-resistant manholes are indicated on Drawings, refer to City of Houston Approved Product List for liner and/or coating materials.

2.10 BACKFILL MATERIALS

A. Conform to requirements of Section 02317 - Excavation and Backfill for Utilities.

2.11 NON-SHRINK GROUT

A. Provide prepackaged, inorganic, flowable, non-gas-liberating, non-metallic, cement-based grout requiring only addition of water.

B. Meet requirements of ASTM C 1107 and have minimum 28-day compressive strength of 7,000 psi.

2.12 VENT PIPES

A. Provide external vent pipes for manholes where indicated on Drawings.

B. Buried Vent Pipes: Provide 3-inch or 4-inch PVC DWV pipe conforming to ASTM D 2665. Alternatively, provide FRP pipe as specified for vent outlet assembly.

C. Vent Outlet Assembly: Provide vent outlet assembly as shown on Drawings, constructed of the following specified materials:

1. FRP Pipe: Provide filament wound FRP conforming to ASTM D 2996 or centrifugally cast FRP conforming to ASTM D 2997. Seal cut ends in accordance with manufacturer's recommendations.

2. Joints and Fittings: Provide epoxy bodied fittings and join pipe to fittings with epoxy adhesive.

3. Flanges: Provide socket-flange fittings for epoxy adhesive bonding to pipe ends where shown on Drawings. Meet bolt pattern and dimensions for ASME B 16.l, 125- pound flanges. Flange bolts shall be Type 304 stainless steel or hot-dip zinc coated, conforming to ASTM A 307, Class A or B.

4. Coating: Provide approved 2-component, aliphatic polyurethane coating using primer or tie coat recommended by manufacturer. Provide two or more coats to yield dry film thickness of at least 3 mils. Color shall be selected by Project Manager from manufacturer's standard colors.

2.13 PROHIBITED MATERIALS

A. Use of brick masonry is prohibited for construction of manholes, including adjustment of manholes to grade.

B. For Storm Water manholes, use of mortar is prohibited for pipe to manhole connections.

2.14 MANHOLE LADDER FOR WATERLINE MANHOLES

A. Manhole Ladder: Fiberglass with 300-lb rating at appropriate length; conform to requirements of Occupational Safety and Health Standards (OSHA), U.S. Department of Labor except where shown on Drawings:

1. Use components, including rungs, made of fiberglass, fabricated with nylon or aluminum rivets and/or epoxy. Apply non-skid coating to ladder rungs. Mount ladder using manufacturer's recommended hardware.

2. Provide ladder as manufactured by Saf-Rail or approved equal. Locate ladder as shown on Drawings.

3. Fiberglass: Premium type polyester resin, reinforced with fiberglass; constructed to provide complete wetting of glass by resin; resistant to rot, fungi, bacterial growth and adverse effects of acids, alkalis and residential and industrial waste; yellow in color

B. Provide approved petroleum-based tape encapsulating bolts in access manhole.

2.15 SOURCE QUALITY CONTROL

A. Representatives of City Engineer will inspect manufacturer's plant and casting operations as deemed necessary.

B. Precast Unit Identification: Mark date of manufacture and name or trademark of manufacturer clearly on inside of pipe.

C. Rejection: Precast units rejected for non-conformity with these specifications and for following reasons:

1. Fractures or cracks passing through shell, except for single end crack that does not exceed depth of joint.

2. Surface defects indicating honeycombed or open texture.

3. Damaged or misshaped ends, where damage would prevent making satisfactory joint.

D. Replacement: Immediately remove rejected units from Work site and replace with acceptable units.

~~C.~~E. Repairs: Occasional imperfections resulting from manufacture or accidental damage may be repaired if, in opinion of Project Manager, repaired units conform to requirements of these specifications

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that lines and grades are correct.

B. Determine if subgrade, when scarified and recompacted, can be compacted to 95 percent of maximum Standard Proctor Density, at ±3 percent optimum moisture content according to ASTM D 698 prior to placement of foundation material and base section. If it does not meet the moisture-density requirement, condition the subgrade until the required moisture-density requirement is met or treat as an unstable subgrade.

C. Do not build manholes in ditches, swales, or drainage paths unless approved by Project Manager.

3.02 PLACEMENT

A. Install precast manholes to conform to locations and dimensions shown on Drawings.

B. Place sanitary manholes at points of change in alignment, grade, size, pipe intersections, and end of sewer unless otherwise shown on Drawings.

C. Place storm manholes at points of change in alignment, grade, size, pipe intersections, and end of sewer unless otherwise shown on Drawings. Pipe connections into storm sewer precast box manholes that exceed a 7-degree angle of entry shall use a pipe elbow, bend, or curved approach as shown per detail 02082-13 Storm Sewer Precast Box Inlet/Manhole, Pipe Connection Detail.

3.03 MANHOLE BASE SECTIONS AND FOUNDATIONS

A. Foundation Material:

1. Sanitary Sewer and Waterlines

a. Place precast base on 12-inch thick (minimum) foundation of crushed stone wrapped in filter fabric, cement stabilized sand, or concrete foundation slab. Compact cement-sand in accordance with requirements of Section 02321 - Cement Stabilized Sand.

2. Storm Sewer

a. Foundation material is to be selected based on site soil type and bearing capacity established by the geotechnical investigation report. Place precast base on the foundation material that is selected, by the Engineer of Record and Geotechnical Engineer, from the options below:

(1) 12-inch thick (minimum) foundation of crushed stone wrapped in filter fabric, placed in maximum 6-inch compacted lift thickness layers.

(2) Cement stabilized sand compacted in accordance with requirements of section 02321 – Cement Stabilized Sand. Cement stabilized sand foundations are prohibited to be placed on fault lines.

(3) Concrete foundation slab.

B. Unstable Subgrade Treatment: When unstable subgrade is encountered, notify Project Manager for examination of subgrade to determine if subgrade has heaved upwards after being excavated. When heaving has not occurred, over-excavate subgrade to allow for 24-inch-thick layer of crushed stone wrapped in filter fabric as foundation material under manhole base. When there is evidence of heaving, provide pile-supported concrete foundation, as detailed on Drawings, under manhole base.

C. For manholes located over large diameter water lines, place precast base on a foundation of cement stabilized sand extending from bottom of manhole to bottom of trench. Manhole base is to be a minimum of 12-inches above water line.

3.04 PRECAST MANHOLE SECTIONS

A. Install sections, joints, and gaskets in accordance with ASTM C 1821 and the manufacturer's printed recommendations.

B. Install precast adjustment rings above tops of cones or flat-top sections as required to adjust 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 manufacturer's recommendations.

E. Place at least two precast concrete grade rings with thickness of 12 inches or less, under casting. Refer to standard details for additional requirements of precast concrete grade rings.

3.05 PIPE CONNECTIONS AT MANHOLES

A. Sanitary Sewer and Water ~~l~~Line Manholes

1. Install approved ~~r~~Resilient ~~c~~Connectors at each pipe entering and exiting manholes in accordance with manufacturer's instructions and specifications. Resilient/flexible connectors shall not be grouted unless allowed by the manufacturer. See article 2.07 for approved connection materials.

~~a. Where smooth exterior pipes, i.e. steel, ductile iron or PVC pipes are connected to manhole base or barrel, space between pipe and manhole wall shall be sealed with an assembly consisting of rubber gaskets or links mechanically compressed to form watertight. Assemblies: "Press-Wedge," "Res-Seal," "Thunderline Link-Seals," or approved equal. See Drawings for placement of assembly in manhole sections.~~

~~b. When connecting concrete or cement mortar coated steel pipes, or as an option for connecting smooth exterior pipes to manhole base or barrel, space between pipe and manhole wall may be sealed with an assembly consisting of stainless-steel power sleeve, stainless steel take-up clamp and rubber gasket. Take-up clamp: Minimum of 9/16 inch wide. Provide PSX positive seal gasket system by Press-Seal Gasket Corporation or approved equal.~~

B. Storm Sewer Manholes

1. Install connections at each pipe entering and exiting manholes in accordance with manufacturer's instructions and specifications. See 2.07 for connection material requirements. ~~Refer to 2.07.B for approved connection materials.~~When pipe to manhole connections are to be grouted, ~~grout connections to conform to requirements in ASTM C 1821. A~~all voids are to be completely filled with grout and grouted on both sides inside and outside of manhole.

~~C. Rigid Pipe Connections~~

~~1. Sanitary Sewer and Waterline Manholes~~

~~a. When making a rigid (concrete) pipe connection to a concrete manhole the pipe is to be set in flexible joint sealant conforming to ASTM C 990. Grout pipe penetration in place on both inside and outside of manhole.~~

~~2. Storm Sewer Manholes~~

~~a. When making a rigid (concrete) pipe connection to a concrete manhole the pipe is to be set in flexible joint sealant conforming to ASTM C 990.~~.

~~D. Flexible Pipe Connections~~

~~1. Sanitary Sewer and Waterline Manholes~~

~~a. Install approved resilient connectors at each flexible pipe connection as per ASTM C 923 and/or ASTM F 2510 to a concrete manhole.~~

~~2. Storm Sewer Manholes~~

~~a. Install approved resilient connectors at each flexible pipe connection per 2.07.B.1 to a concrete manhole.~~

~~E.~~C. Ensure no concrete, cement stabilized sand, fill, or other rigid material is allowed to enter space between pipe and edge of wall opening at and around ~~r~~Resilient ~~c~~Connector on either interior or exterior of manhole. If necessary, fill space with compressible material to ensure full flexibility provided by ~~r~~Resilient ~~c~~Connector.

~~F.~~D. Where a new manhole is constructed on an existing sewer, rigid joint pipe may be used. Install waterstop gasket around existing pipe at center of cast-in-place wall. Join ends of split waterstop material at pipe springline using an adhesive recommended and supplied by waterstop manufacturer.

~~G.~~E. Test connection for watertight seal before backfilling.

3.06 INVERTS FOR SANITARY SEWERS

A. Construct invert channels to provide 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 inches per foot maximum.

2. Depth of bench to invert shall be at least 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 Drawings.

B. Form invert channels with concrete if not integral with manhole base section. 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 DROP CONNECTIONS FOR SANITARY SEWERS

A. Backfill drop assembly with crushed stone wrapped in filter fabric, cement stabilized sand, or Class A concrete to form solid mass. Extend cement stabilized sand or concrete encasement minimum of 4 inches outside bells.

B. Install drop connection when sewer line enters manhole higher than 24 inches above invert of manhole.

3.08 INVERTS FOR STORM SEWERS

A. When precast, square or rectangular structures are used for sewer manholes, construct invert channels to provide 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 inches per foot maximum.

2. Depth of bench to invert: one half of 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 drawings.

B. Form invert channels with concrete, after all connections have been made

1. Refer to 2.02.B.2 for material requirements.

3.09 STUBS FOR FUTURE CONNECTIONS

A. In manholes, where future connections are indicated on Drawings, install ~~r~~Resilient ~~c~~Connectors and pipe stubs with approved watertight plugs.

3.10 MANHOLE FRAME AND ADJUSTMENT RINGS

A. Combine precast concrete or HDPE adjustment rings so elevation of installed casting cover matches pavement surface. Seal between concrete adjustment ring and precast top section with non-shrink grout; do not use mortar between adjustment rings. Apply latex-based bonding agent to precast concrete surfaces joined with non-shrink grout. Set cast iron frame on adjustment ring in bed of approved sealant material. Install sealant bed consisting of two beads of sealant, each bead having minimum dimensions of 1/2-inch and 1/2-inch wide.

B. Wrap manhole frame and adjustment rings with external sealing material, minimum 3 inches beyond joint between ring and frame and adjustment rings and precast section.

C. Manholes in unpaved areas:

1. Sanitary Sewer and Waterlines

a. For manholes in unpaved areas, set top of frame minimum of 6 inches above existing ground line unless otherwise indicated on Drawings. In unpaved areas, encase manhole frame in mortar or non-shrink grout placed flush with face of manhole ring and top edge of frame. Provide rounded corner around perimeter.

2. Storm Sewers

a. For manholes in unpaved areas, set top of frame minimum of 6 inches above existing ground line unless otherwise indicated on Drawings. In unpaved areas, where existing manholes are to be fitted with a grated cover for the purpose of storm water drainage, it is permitted to set the top of the frame at existing/proposed grade. In unpaved areas, encase manhole frame in mortar or non-shrink grout placed flush with face of manhole ring and top edge of frame. Provide rounded corner around perimeter.

3.11 BACKFILL

A. Place and compact backfill materials in area of excavation surrounding manholes in accordance with requirements of Section 02317 - Excavation and Backfill for Utilities. Provide embedment zone backfill material, as specified for adjacent utilities, from manhole foundation up to an elevation 12 inches over each pipe connected to manhole. Provide trench zone backfill, as specified for adjacent utilities, above embedment zone backfill.

B. Where rigid joints are used for connecting existing sewers to manhole, backfill under existing sewer up to springline of pipe with Class B concrete or flowable fill.

C. In unpaved areas, provide positive drainage away from manhole frame to natural grade. Provide minimum of 4 inches of topsoil conforming to requirements of Section 02911 - Topsoil. Seed in accordance with Section 02921 - Hydro Mulch Seeding. When shown on Drawings, sod disturbed areas in accordance with Section 02922 - Sodding.

3.12 FIELD QUALITY CONTROL

A. Conduct leakage testing of sanitary sewer manholes in accordance with requirements of Section 02533 - Acceptance Testing for Sanitary Sewers.

B. Before installation of storm water manholes, if the foundation's subgrade soil conditions are inconsistent with the contract documents, notify the Engineer of Record and Geotechnical Engineer. Follow the Engineer of Record's and Geotechnical Engineer's instructions on any additional soil testing, proper selection of foundation materials, and soil remediation.

3.13 PROTECTION

A. Protect manholes from damage until work has been accepted. Repair damage to manholes at no additional cost to City.

END OF SECTION

SECTION 02083

FIBERGLASS MANHOLES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Fiberglass manholes for unpaved areas placed on top of a precast base to form a manhole.

B. Fiberglass for construction in back lot easements placed on cast-in-place base.

C. Fiberglass manholes are not permitted underneath existing or proposed pavement.

1.02 RELATED SECTIONS

A. Section 01270 – Measurement and Payment

B. Section 01330 – Submittal Procedures

C. Section 02082 – Precast Concrete Manholes

D. Section 02090 – Frames, Grates, Rings, And Covers

E. Section 02317 – Excavation and Backfill for Utilities

F. Section 02321 – Cement Stabilized Sand

G. Section 02533 – Acceptance Testing for Sanitary Sewers

H. Section 02911 – Topsoil

I. Section 02921 – Hydro Mulch Seeding

J. Section 02922 – Sodding

K. Section 03315 – Concrete for Utility Construction

L. Section 04061 – Mortar

1.03 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. Payment for fiberglass manholes is on unit price basis for each manhole installed.
2. Refer to Section 01270 - Measurement and Payment for unit price procedures.

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

1.04 REFERENCES

A. ASME B 16.1 – Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250

B. ASTM A 307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 psi Tensile Strength.

~~C. ASTM C 270 - Standard Specification for Mortar for Unit Masonry.~~

~~D.~~C. ASTM C 1107 - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-shrink).

~~E.~~D. ASTM D 698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft3 (600kN-m/m3).

~~F.~~E. ASTM D 2665 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste and Vent Pipe and Fittings.

~~G. ASTM D 2996 - Standard Specification for Filament-Wound “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.~~

~~H.~~F. ASTM D 2997 - Standard Specification for Centrifugally Cast “Fiberglass” (Glass-Fiber-Reinforced Thermosetting Resin) Pipe.

~~I.~~G. ASTM D 3753 - Standard Specification for Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Manholes and Wetwells. ~~Standard Specification for Glass-Fiber-Reinforced Polyester Manholes and Wetwells.~~

~~J.~~H. American Association of State Highway and Transportation Officials (AASHTO).

1.05 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

B. Submit manufacturer's data and details of following items for approval:

1. Design and fabrication details of fiberglass manhole components
2. Installation instruction for fiberglass manholes
3. Frames, grates, rings, and covers
4. Materials to be used in fabricating drop connections
5. Materials to be used for pipe connections at manhole walls

6. Materials to be used for stubs and stub plugs, if required

7. Plugs to be used for sanitary sewer hydrostatic testing

8. Manufacturer's data for pre-mix (bag) concrete if used for channel inverts and benches

9. Manufacturer's color chart for fiberglass vent pipe coatings.

C. Submittals listed in Section 02082 – Precast Concrete Manholes, paragraph 1.0~~4~~5.

PART 2 PRODUCTS

2.01 FIBERGLASS MANHOLES AND BASE SECTIONS

A. Provide prefabricated fiberglass manholes which conform in shape, size, dimensions, and details shown on Drawings. Unless modified by Drawings, use manhole sections conforming to ASTM D 3753.

B. Provide products manufactured by companies listed on the City of Houston Standard Product List.

C. Mark date of manufacture and name or trademark of manufacturer in 1-inch high stenciled letters on inside of barrel.

D. Unless larger size is required, provide 48-inch-diameter barrel for fiberglass manholes. Provide wall section thickness for depth of manhole according to ASTM D 3753, but not less than 0.48 inches in thickness.

E. Provide fabricated reducer bonded at factory to form one continuous unit at top of manhole barrel to accept concrete grade rings and cast iron frame and cover. Reducer design shall be of sufficient strength to safely support HL-93 loading in accordance with AASHTO.

F. Provide manhole base of precast concrete conforming to Section 02082 - Precast Concrete Manholes, unless cast-in-place base is indicated on Drawings. For concrete manhole bases, use an approved steel-reinforced design of sufficient strength to withstand imposed loads. Form cast-in-place base so that joint with fiberglass manhole barrel is sealed against leakage, as shown on Drawings. When precast bases are specified, it shall be the installers responsibility to ensure a sufficient seal against leakage.

2.02 CONCRETE

A. Conform to requirements of Section 03315 - Concrete for Utility Construction.

B. Channel Inverts: Use 5 sack premix (bag) concrete or Class A concrete for inverts not integrally formed with manhole base, with minimum compressive strength of 4000 psi.

C. Concrete Foundation: Use Class A concrete with minimum compressive strength of 4000 psi for cast-in-place base and for foundation slab under manhole base section where indicated on Drawings.

D. Cement Stabilized Sand Foundation: In lieu of foundation slab, provide cement stabilized sand foundation under base section, when shown on manhole Drawings, conforming to requirements of Section 02321 - Cement Stabilized Sand.

2.03 REINFORCING STEEL

A. Provide reinforcing steel conforming to requirements of Section 03315 - Concrete for Utility Construction.

2.04 MORTAR

A. Conform to requirements of Section 04061 - Mortar.

2.05 MISCELLANEOUS METALS

A. Provide cast-iron frames, rings, and covers conforming to requirements of Section 02090 - Frames, Grates, Rings, and Covers.

2.06 DROP CONNECTIONS AND STUBS

A. Provide drop connections and stubs conforming to same pipe material requirements used in main pipe, unless otherwise indicated on Drawings.

2.07 PIPE CONNECTIONS FOR SANITARY SEWERS

A. Provide pipe connections conforming to requirements of Section 02082 - Precast Concrete Manholes.

B. For drop, provide manufactured connector, such as Insert-a-Tee or equal, which provides positive seal between pipe and wall.

2.08 SEALANT MATERIALS

A. Sealing material between adjustment ring and manhole, between each adjustment ring, and between adjustment ring and manhole cover frame shall be a hydrophilic elastic sealant, which adheres to concrete, fiberglass and metal, or approved substitute.

B. Butyl Sealant: Provide Press-Seal EZ Stick, or equal, for HDPE rings.

C. Fiberglass manhole barrel may be bedded in a flexible joint material laid on the shoulder of the concrete base joint, or any other method approved by the Engineer. It will remain the installer's responsibility to e~~i~~nsure the connection against leakage.

2.09 BACKFILL MATERIALS

A. Backfill materials shall conform to requirements of Section 02317 - Excavation and Backfill for Utilities.

2.10 NON-SHRINK GROUT

A. Provide prepackaged, inorganic, flowable, non-gas-liberating, nonmetallic, cement-based grout requiring only addition of water.

B. Grout shall meet requirements of ASTM C 1107 and shall have minimum 28-day compressive strength of 7000 psi.

2.11 VENT PIPES

A. Provide external vent pipes for manholes, where indicated on Drawings.

B. Buried Vent Pipes: ~~-~~Provide 3-inch or 4-inch PVC DWV pipe conforming to ASTM D 266~~5~~5. Alternatively, provide FRP pipe as specified for vent outlet assembly.

C. Vent Outlet Assembly: ~~-~~Provide vent outlet assembly as shown on Drawings, constructed of following specified materials:

1. Provide fiberglass~~s~~ reinforced pipe conforming to ASTM D 2997. Seal cut ends in accordance with manufacturer's recommendations

2. Joints and Fittings: ~~-~~Provide epoxy bodied fittings and join pipe to fittings with epoxy adhesive, according to pipe manufacturer's instructions

3. Flanges: Provide socket-flange fittings for epoxy adhesive bonding to pipe ends where shown on Drawings. Flanges shall meet bolt pattern and dimensions for ~~ANSI~~ASME B16.l, 125-pound flanges. Flange bolts shall be hot-dip zinc coated, conforming to ASTM A 307, Class A or B.

4. Coating: Provide 2-component, aliphatic polyurethane coating using primer or tie coat recommended by manufacturer. Provide two or more coats to yield dry film thickness of at least 3 mils. Provide Amershield, Tnemec 74, or equal. Color shall be selected by Project Manager from manufacturer's standard colors.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that lines and grades are correct.

B. Determine if subgrade, when scarified and recompacted, can be compacted to 95 percent of maximum Standard Proctor Density at +- 3 percent moisture content, according to ASTM D 698 prior to placement of foundation material and base section. If it does not meet the moisture-density requirement, condition the subgrade or treat as an unstable subgrade.

C. Do not build manholes in ditches, swales, or drainage paths unless approved by Project Manager.

3.02 PLACEMENT

A. Install fiberglass manholes to conform to locations and dimensions shown on Drawings. Do not install underneath existing or proposed pavement.

B. Place sanitary sewer manholes at points of change of alignment, grade, size, pipe intersections, and end of sewer.

3.03 MANHOLE BASE SECTIONS AND FOUNDATIONS

A. Place base section and foundation as required in Section 02082 - Precast Concrete Manholes.

3.04 CAST-IN-PLACE FOUNDATION

A. Where Drawings indicate cast-in-place manhole base, place concrete as shown on Drawings on 4-inch (minimum) layer of either crushed stone, cement stabilized sand, or seal slab. When unstable subgrade is identified, over-excavate subgrade to allow for placement of 12-inch thick layer of crushed stone wrapped in filter fabric.

3.05 MANHOLE BARREL

A. Lower manhole barrel onto base section. Seal with manufacturer's gasket or approved sealant. Wrap joint with external sealing material, minimum 12-inch width.

B. Where cast-in-place base is used, support manhole barrel in place and brace it from sides of excavation to prevent any movement of barrel during concrete placement and while concrete is setting. Provide minimum clearance between reinforcing steel and manhole barrel bottom as shown on Drawings. Do not support manhole barrel on reinforcing steel. Place bead of water swelling sealant around inside of barrel near bottom, as shown on Drawings, to form seal.

3.06 PIPE CONNECTIONS AT PRECAST MANHOLE BASE

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 solid material is allowed to enter space between pipe and edge of wall opening at and around resilient connector on either interior or exterior of manhole. When necessary, fill space with compressible material to ensure full flexibility provided by resilient connector.

C. Test connection for watertight seal before backfilling.

3.07 PIPE CONNECTIONS AT CAST-IN PLACE BASE

A. Cut manhole barrel for pipe penetrations following curvature of pipe and with maximum of 1-inch clearance. Seal cut edges with resin. Hole may be circular or cutout with semi-circular top which extends to bottom of barrel.

B. Place continuous bead of water swelling sealant, as shown on Drawings, around pipe penetrations on interior of manhole barrel. Roughen surface of fiberglass prior to placement to improve bond with sealant. Allow sealant to completely cure before placing concrete against it.

C. Extend pipe entering manhole at least 8 inches into manhole. Fit pipes with neoprene water-stop gasket seal placed tightly around pipe using stainless steel clamp. Alternately, pipes may have continuous bead of water swelling sealant, as detailed on Drawings, placed around pipe circumference.

D. When forming invert surface in bottom of manhole, mound concrete around pipe penetrations so that water swelling sealant beads and neoprene water-stop gasket have minimum 2 inches of concrete cover.

E. Test connection for watertight seal before backfilling.

3.08 INVERTS FOR SANITARY SEWERS

A. Construct invert channels as required in Section 02082 - Precast Concrete Manholes.

3.09 DROP CONNECTIONS FOR SANITARY SEWERS

A. Backfill drop assembly with crushed stone wrapped in filter fabric, cement stabilized sand, or Class A concrete to form solid mass. Extend cement stabilized sand or concrete outside of bells minimum 4 inches.

B. Install drop connection when sewer line enters manhole higher than 24 inches above invert of manhole.

C. At drop pipe connections through fiberglass barrel, cut circular hole sized to requirements of manufactured connector. Seal cut edge with resin. Install watertight connector according to manufacturer's recommendations.

3.10 STUBS FOR FUTURE CONNECTIONS

A. Where future connections are indicated on Drawings, install resilient connectors and pipe stubs with approved watertight plugs in manholes.

B. At cast-in-place base, where future connections are indicated on Drawings, install section of pipe extending no further than 12 inches from edge of foundation, ending in bell and provided with rubber-gasket watertight plug.

3.11 ADJUSTMENT RINGS AND FRAME

A. Combine precast concrete or HDPE adjustment rings so that elevation of installed casting cover matches pavement surface. Do not load manhole except on load bearing shoulder of manhole. Seal between adjustment ring and fiberglass manhole with approved sealant material. Apply a latex bonding agent to precast concrete surface and join with non-shrink grout. Set cast iron frame on adjustment ring in bed of approved sealant material. Install sealant bed consisting of two beads on sealant, each bead having minimum dimensions of 1/2-inch and 1/2-inch wide.

B. Wrap manhole frame and adjustment rings with external sealing material, minimum 3 inches beyond joint between ring and frame and ring and precast section.

C. Set cast iron frame on top of cone or adjustment rings using water swelling sealant materials and adjust elevation of casting cover to match pavement surface. For manholes in unpaved areas, set top frame minimum of 6 inches above existing ground line unless otherwise indicated on Drawings.

3.12 BACKFILL

A. After leakage testing, place and compact backfill material in area of excavation surrounding manholes in accordance with requirements of Section 02317- Excavation and Backfill for Utilities. Use embedment zone backfill material, as specified for adjacent utilities, from manhole foundation up to elevation 12-inches over each pipe connected to manhole. Provide trench zone backfill, as specified for adjacent utilities, above embedment zone backfill.

B. In unpaved areas, provide positive drainage away from manhole frame to natural grade. Provide minimum of 4-inches of topsoil conforming to requirements of Section 02911 - Topsoil and seed in accordance with Section 02921 - Hydro Mulch Seeding. When shown on Drawings, sod disturbed areas in accordance with Section 02922- Sodding.

3.13 FIELD QUALITY CONTROL

A. Conduct leakage testing of sanitary sewer manholes in accordance with requirements of Section 02533 - Acceptance Testing for Sanitary Sewers.

3.14 PROTECTION

A. Protect manholes from damage until work has been finally accepted. Repair damage to manholes at no additional cost to City.

END OF SECTION

SECTION 02086

ADJUSTING MANHOLES, INLETS, AND VALVE BOXES TO GRADE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Adjusting elevation of manholes, inlets, and valve boxes to new grades.

1.02 ~~RELTATED~~ RELATED SECTIONS

A. Section 01270 – Measurement and Payment

B. Section 02081 – Cast-In-Place Concrete Manholes

C. Section 02082 – Precast Concrete Manholes

D. Section 02083 – Fiberglass Manholes

E. Section 02090 – Frames, Grates, Rings, And Covers

F. Section 02316 – Excavation and Backfill for Structures

G. Section 02501 – Ductile Iron Pipe and Fittings

H. Section 02528 – Polyethylene Encasement-Wrap

I. Section 02632 – Cast-In-Pace Inlets, Headwalls, And Wingwalls

J. Section 02633 – Precast Concrete Inlets, Headwalls, And Wingwalls

K. Section 02911 – Topsoil

L. Section 02921 – Hydro Mulch Seeding

M. Section 02922 – Sodding

N. Section 03315 – Concrete for Utility Construction

O. Section 04061 – Mortar

P. Section 04210 – Brick Masonry for Utility Construction

1.03 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. No separate payment will be made for adjusting manhole frames and covers, inlets, valve boxes, and meter boxes to grade for new construction under this Section. Include payment in unit price for related item.

2. Payment for adjusting existing manholes, frames and covers, inlets, valve boxes, and meter boxes to a new grade is on a unit price basis for each.

3. Refer to Section 01270 - Measurement and Payment for unit price procedures.

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

PART 2 PRODUCTS

2.01 CONCRETE MATERIALS

A. Provide concrete, conforming to requirements of Section 03315 - Concrete for Utility Construction.

B. Provide precast concrete manhole sections and adjustment rings conforming to requirements of Section 02082 - Precast Concrete Manholes.

C. Provide mortar conforming to requirements of Section 04061 - Mortar.

2.02 CAST-IRON MATERIALS

A. Provide cast-iron materials conforming to requirements of Section 02090 - Frames, Grates, Rings, and Covers.

2.03 PIPING MATERIALS

A. For riser pipes and fittings, refer to Sections 02501 - Ductile-Iron Pipe and Fittings through 02528 - Polyethylene Encasement Wrap.

2.04 MASONRY MATERIALS FOR STORM SEWER MANHOLES AND INLETS

A. Provide brick masonry units conforming to the requirements of Section 04210 - Brick Masonry for Utility Construction.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine existing structure, valve box, frame and cover or inlet box, frame and cover or inlet, piping and connections for damage or defects affecting adjustment to grade. Report damage or defects to Project Manager.

3.02 ESTABLISHING GRADE

A. Coordinate grade related items with existing grade and finished grade or paving, and relate to established bench~~-~~mark or reference line.

3.03 ADJUSTING MANHOLES AND INLETS

A. Rebuild adjustment portion of manhole or inlet by adding or removing Adjustments. Follow procedures for the type of structure being adjusted detailed in the following Sections:

1. Section 02081 - Cast-In-Place Concrete Manholes
2. Section 02082 - Precast Concrete Manholes
3. Section 02083 - Fiberglass Manholes
4. Section 02632 - Cast-In-Place Inlets, Headwalls and Wingwalls
5. Section 02633 - Precast Concrete Inlets, Headwalls and Wingwalls

B. Salvage and reuse cast-iron frame and cover or grate.

C. Protect or block off manhole or inlet bottom using wood forms shaped to fit so that no debris or soil falls to bottom during adjustment.

D. Verify that manholes and inlets are free of visible leaks as result of reconstruction. Repair leaks in manner subject to Project Manger's approval.

3.04 ADJUSTING VALVE BOXES

A. Salvage and reuse valve box and surrounding concrete block as approved by Project Manager. No separate pay.

B. Remove and replace 6 inch ductile iron riser pipe with suitable length for depth of cover required to establish adjusted elevation to accommodate actual finish grade.

C. Reinstall valve box and riser piping plumbed in vertical position. Provide minimum 6 inches telescoping freeboard space between riser pipe top butt end and interior contact flange of valve box for vertical movement damping.

D. After valve box has been set, aligned, and adjusted so that top lid is level with final grade.

3.05 BACKFILL AND GRADING

A. Backfill area of excavation surrounding each adjusted manhole, inlet, and valve box and compact according to requirements of Section 02316 - Excavation and Backfill for Structures.

B. Grade ground surface to drain away from each manhole and valve box. Place earth fill around manholes to level of upper rim of manhole frame. Place earth fill around valve box concrete slab.

C. In unpaved areas, grade surface at uniform slope of 1 to 5 from manhole frame to natural grade. Provide minimum of 4 inches of topsoil conforming to requirements of Section 02911 - Topsoil. Provide seeding in accordance with Section 02921 – Hydro Mulch Seeding, or if sodding in accordance with Section 02922 - Sodding.

END OF SECTION

SECTION 02090

FRAMES, GRATES, RINGS, AND COVERS

PART 1 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. Trench Drainage.

D. Tree Grates.

1.02 RELATED SECTIONS

A. Section 01270 – Measurement and Payment

B. Section 01330 – Submittal Procedures

1.03 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. No payment will be made for frames, grates, rings, covers, and seals under this Section. Include payment in unit price for related item.

2. Payment to rack over existing manhole is on a unit price basis for each manhole.

3. Refer to Section 01270 - Measurement and Payment for unit price procedures

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

1.04 REFERENCES

A. AASHTO Standard Specifications for Highway Bridges.

B. AASHTO M 306 - Standard Specification for Drainage, Sewer, Utility, and Related Castings.

C. AASHTO M 105 - Standard Specification for Gray Iron Castings.

~~D. ASTM A 48 - Standard Specification for Gray Iron Castings.~~

~~E.~~D. ASTM A 536 - Standard Specification for Ductile Iron Castings.

~~F.~~E. ASTM A 615 - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.

~~G.~~F. AWS - D 1.4 - Structural Welding Code – Steel Reinforcing Bars.

1.05 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

B. Submit copies of manufacturer's specifications, load tables, dimension diagrams, anchor details, and installation instructions.

C. Submit shop drawings for fabrication and installation of casting assemblies that are not included in Drawings or standard City of Houston details. Include plans, elevations, sections and connection details. Show anchorage and accessory items. Include setting drawings for location and installation of castings and anchorage devices.

PART 2 PRODUCTS

2.01 CASTINGS

A. All castings shall be made from gray cast iron conforming to the requirements of AASHTO M 105 class 35b or ductile iron conforming to the requirements ASTM A 536 70-50-05.

B. Castings intended for traffic service shall be clean castings capable of withstanding an application of 40,000 pound proof load as described in Section 5 of AASHTO M 306 (includes items such as frames, grates, rings, covers, trench drainage, etc.)

C. Fabricate castings to conform to shapes, dimensions, and with wording or logos shown on Drawings.

D. All castings shall be manufactured in accordance with the requirement of Section 4 of AASHTO M 306.

E. Unless otherwise indicated, all gray iron castings shall be provided uncoated.

F. Each individual casting shall include all markings as shown on the specification drawings and shall be identified by the producing foundry showing the following: Name of producing foundry; country of manufacturer preceded by the words “Made in,” such as “Made in USA”; material designation, heat identification and cast date (MM/DD/YY), casting lettering as required by the purchaser. If a casting is melted and poured at one foundry and labeled with the name of another organization, manufacturer, or foundry the casting shall include the name of the producing foundry and the organization the casting is produced for. The name of the producing foundry and the organization the product is made for shall have lettering of equal size, be in close proximity to each other, and be easily identified from the same side of the casting. The casting shall also include any additional markings as required in Section 9 of AASHTO M 306 and Section 17 of AASHTO M 105.

2.02 TESTING REQUIREMENTS

A. Testing shall be performed in accordance with the following inspection criteria unless otherwise specified in the contract or purchase order. The manufacturer/supplier shall be responsible for carrying out all of the required tests and inspections. All testing shall be conducted in the United States using purchaser approved reliable facilities. The manufacturer/supplier shall maintain complete records of all such tests and inspections. All testing shall be paid for by the manufacturer/supplier.

B. The manufacturer shall report and certify material information obtained from separately cast test bars. If there are more than three test bar failures in a calendar year the manufacturer shall report this to the purchaser and shall discontinue supplying product. In order to resume supplying product, documentation that a new Quality System is in place to ensure material compliance must be submitted to and accepted by the purchaser.

2.03 SPECIAL FRAMES AND COVERS

A. Where indicated on Drawings, provide watertight manhole frames and covers with minimum of four bolts and gasket designed to seal cover to frame. Supply approved watertight manhole covers and frames.

B. Where shown on Drawing, provide manhole frames and covers with 48-inch diameter clear opening, with inner cover for 22-inch diameter clear opening. Provide approved inner cover with pattern shown on Drawings.

C. Where indicated on Drawings provide security enabled covers or grates, to be secured with the addition of Cam locks and lock lugs to inhibit opening and removal of cover or grate without proper authorized tool. Supply approved security feature Frames, Cover or Grates.

2.04 FABRICATED RING GRATES

A. Fabricate ring grates from reinforcing steel conforming to ASTM A 615.

B. Conform to welds connecting bars to AWS D 1.4.

C. Fabricate ring grates in accordance with City of Houston standard detail, “Ring Grate for Open End of 18 Inch to 72 Inch RCP Stubs to Ditch”.

2.05 ADJUSTMENT RINGS FOR ASPHALT OVERLAYS

A. Use castings conforming Paragraph 2.01.

B. One piece casting with dimensions to fit frame and cover.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install castings according to approved shop drawings, instructions in related specifications, and applicable directions from manufacturer's printed materials.

B. 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 form work until permanently set.

C. Set in mortar in mouth of pipe bell.

D. Install adjustment rings in existing frames with clean bearing surfaces that are free from rocking.

END OF SECTION

SECTION 02091

NON METALLIC FRAMES, GRATES, RINGS, AND COVERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Manhole frames and covers, inlet frames and grates, catch basin frames and grates, meter vault frames and covers, adjustment rings, and extensions, ring grates, and trench drainage, for application in wastewater collection system and facilities.

1.02 RELATED SECTIONS

A. Section 01270 – Measurement and Payment

B. Section 01330 – Submittal Procedures

1.03 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. No payment will be made for frames, grates, rings, covers, and seals under this Section. Include payment in unit price for related item.

2. Payment to rack over existing manhole is on a unit price basis for each manhole.

3. Refer to Section 01270 - Measurement and Payment for unit price procedures

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

1.04 REFERENCES

A. AASHTO M 306 – Standard Specification for Drainage, Sewer, Utility, and ~~r~~Related Castings

B. AASHTO - Standard Specifications for Highway Bridges

C. ASTM A 36 - Standard Specification for Carbon Structural Steel

D. ASTM A 615 - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement

E. ASTM C 501 - Standard Test~~ing~~ Method for Relative Resistance to Wear of Unglazed Ceramic Tile by the Taber Abraser

F. ASTM D 2240 - Standard Test Method for Rubber Property—Durometer Hardness

G. ASTM G 154 - Standard Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Nonmetallic Materials.

H. ASTM ~~C 1028~~ E 303- Standard Test Method for Measuring Surface Frictional Properties Using the British Pendulum Tester~~Standard Testing for Coefficient of Friction~~

I. AWS D1.1 - Structural Welding Code - Steel

J. TCEQ Chapter 217 Design Criteria for Domestic Wastewater Systems Section 217.55 Manhole Covers

K. OSHA Occupational Safety and Health Standards

~~J.~~L. EPA Environmental Protection Agency

1.05 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

B. Submit copies of manufacturer's specifications, testing data, certifications, load tables, dimension diagrams, anchor details, and installation instructions.

C. Submit shop drawings for fabrication and installation of casting assemblies that are not included in Drawings or standard City of Houston details. Include plans, elevations, sections and connection details. Show anchorage and accessory items. Include setting drawings for location and installation of castings and anchorage devices.

PART 2 PRODUCTS

2.01 MANHOLE RING AND COVER

A. All rings and covers units shall be made from high strength nonmetallic fiber reinforced polymer /composite materials. The material shall be a resin thermoset matrix that can be reinforced with continuous filament engineered fabrics, fiber rovings, short fiber filaments, or equivalent nonmetallic reinforcing structure(s). Seatings shall be encapsulated or bonded with a continuous dampener to reduce wear, shock, noise, malodors and infiltration.

B. Rings and covers intended for traffic service shall be capable of withstanding AASHTO M 306: Proof Testing (includes items such as frames, grates, rings, covers, trench drainage, etc.).

C. Fabricate rings and covers to conform to shapes, dimensions, and with wording or logos shown on Drawings.

D. All rings and covers shall be manufactured in accordance with the requirements of AASHTO M 306.

E. Covers shall be provided with a positive lock mechanism as shown on City of Houston Standard Detail for Non-Metallic Covers. Lock will have indicators to show when Lock is fully engaged. Other equivalent locking mechanisms must be approved by the City of Houston.

2.02 TESTING AND PERFORMANCE REQUIREMENTS

A. Testing shall be performed in accordance with the following inspection criteria unless otherwise specified in the contract or purchase order. The manufacturer/supplier shall be responsible for carrying out all of the required tests and inspections. All testing shall be conducted in the United States using purchaser approved reliable facilities. The manufacturer/supplier shall maintain complete records of all such tests and inspections. All testing shall be paid for by the manufacturer/supplier.

B. Frames and Covers shall be "Proof Tested" in accordance with AASHTO M 306.

C. Heavy Duty: A load of 40,000 lbs shall be concentrated on a 9" x 9" block with rubber or fiber backing pad for one minute. During the load testing process visible cracks or delamination will be cause for rejection. When load is removed, Permanent Set (Deflection) of more than 1/8-inch (0.125-inch) measured at center of load area will be cause for rejection. All testing shall be conducted on a NIST calibrated and Certified load test machine.

D. Ultraviolet resistance: ASTM G 154 Cycle 1 for 1000 hrs. Specimens shall be tested for ultimate flexural strength, retaining at least 75% of control values for load and deflection at failure.

E. ~~Coefficient of Friction: Shall be greater than 0.6 when tested~~ Skid resistance: Measure skid resistance in accordance ~~to~~ with ASTM ~~C 1028~~E 303. A pendulum test value of at least 50 is required.

F. Wear and Abrasion: Shall be tested in accordance with ASTM C 501, Test shall be 1000 cycles of a H22 wheel with 1000g load. Wear Index is calculated 88/ Weight Loss (grams). The average of four test cycles shall have a calculated wear index of >300.

G. At the request of the Project Manager, the quality process manual shall be available for review, manufacturing facility shall also be available for inspection to ensure quality standards are met along with EPA and OSHA standards.

2.03 FABRICATED RING GRATES

A. Fabricate ring grates from reinforcing steel conforming to ASTM A 36.

B. Conform to welds connecting bars to AWS D 1.1.

C. Fabricate ring grates in accordance with City of Houston standard detail, “Ring Grate for Open End of 18 Inch to 72 Inch RCP Stubs to Ditch”.

2.04 GRADE ADJUSTMENT RINGS

A. Conform to Paragraph 2.01.

B. One piece unit with dimensions to fit frame and cover.

C. Physical properties shall comply with ASTM D 2240 with a Shore Durometer of 77A ±5.

D. Adjustment Risers shall be of uniform quality, free from cracks, holes, and any other surface debris. Riser rings shall be available in ½-inch height increments. Molded adjustment risers tolerance shall be ±1/16-inch (1.6mm) from required nominal dimensions. Adjustment Risers shall be designed for heavy duty street traffic, and meet or exceed minimum load capacity requirements of AASHTO M 306.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install castings according to approved shop drawings, instructions in related specifications, and applicable directions from manufacturer's printed materials.

B. Set units accurately at required locations to proper alignment and elevation. Keep units plumb, level, true, and free of rack. Measure location accurately from established lines and grades. Brace or anchor frames temporarily in form work until permanently set.

C. Set in mortar in mouth of pipe bell.

D. Install adjustment rings in existing frames with clean bearing surfaces that are free from rocking.

END OF SECTION

SECTION 02221

REMOVING EXISTING PAVEMENTS, STRUCTURES, WOOD, AND DEMOLITION DEBRIS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Removing concrete paving, asphaltic concrete pavement, brick pavement and base courses.

B. Removing concrete curbs, concrete curbs and gutters, sidewalks and driveways.

C. Removing pipe culverts, sewers, and sewer leads.

D. Removing waterlines and water services lines including asbestos cement pipe per OSHA guidelines.

E. Removing existing inlets and manholes.

F. Removing and disposing of pre-stressed concrete beams and drill shafts.

G. Removing miscellaneous structures of concrete or masonry.

H. Removing existing bridge.

I. Removing existing wood and demolition debris.

1.02 RELATED SECTIONS

A. Section 01270 – Measurement and Payment

B. Section 01576 – Waste Material Disposal

C. Section 02316 – Excavation and Backfill for Structures

D. Section 02960 – Milling Pavement

1.03 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. Payment for removing and disposing of asphaltic surfacing with or without base, regardless of thickness encountered, is on square yard basis measured between lips of gutters.

2. Payment for removing and disposing of reinforced concrete pavement, with or without asphalt overlay, regardless of its thickness, is on square yard basis measured from back- to-back of curbs. Payment includes concrete pavement, esplanade curbs, curbs and gutters, and paving headers.

3. Payment for removing and disposing of curb or curb and gutter without removal of pavement is on a linear foot basis, if only curb or curb and gutter is being removed and disposed.

~~3.~~4. Payment for removing and disposing of cement stabilized shell base course, with or without asphaltic surfacing, is on square yard basis.

~~4.~~5. Payment for removing and disposing of concrete sidewalks and driveways is on square yard basis. Include removal and disposal of curb ramps in the cost for removal of sidewalks.

~~5.~~6. Payment for removing asphaltic pavement surface by milling shall be in accordance with Section 02960 – Milling Pavement.

~~6.~~7. Payment for removing and disposing of miscellaneous concrete and masonry is on cubic yard basis of structure in place.

~~7.~~8. Payment for removing and disposing of pipe culverts, sewers, and sewer leads, is on linear foot basis for each diameter and each material type of pipe removed.

~~8.~~9. Payment for removing and disposing of waterlines and water service lines including asbestos cement pipe is on linear foot basis for each diameter pipe and each material type of pipe removed.

~~9.~~10. Payment for removing and disposing of existing inlets is on unit price basis for each inlet removed.

~~10.~~11. Payment for removing and disposing of prestressed concrete piles and drill shafts is on linear foot basis.

12. Payment for removing and disposing of existing bridge, including piles and abutments to minimum of 4 feet below ground level, is on a lump sum basis.

13. Payment for removing existing pole foundations, including traffic signal pole foundations to minimum of 2 feet below grade, is on a unit price basis for each pole foundation removed.

~~11.~~14. Payment for removing and disposing of existing manholes is on unit price basis for each manhole removed.

~~12.~~15. Payment for removing and disposing of miscellaneous wood and demolition debris is on cubic yard basis.

~~13.~~16. Payment for removing and disposing of existing wheelchair ramps, except for concrete curb ramps, of any thickness is on square yard basis.

~~14.~~17. No payment for saw cutting of pavement, curbs, or curbs and gutters will be made under this section. Include cost of such work in unit prices for items listed in bid form requiring saw cutting.

~~15.~~18. No payment will be made for work outside maximum payment limits indicated on Drawings, or for pavements or structures removed for Contractor's convenience.

a. For utility installations: Match actual pavement replaced but no greater than maximum pavement replacement limits shown on Drawings. Limits of measurement will be as shown on Street Cut Pavement Replacement Rules.

~~16.~~19. Refer to Section 01270 - Measurement and Payment for unit price procedures

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

1.04 REFERENCES

A. EPA 40 CFR 763 – Asbestos

B. EPA 40 CFR 61, Subpart M – National Emission Standard for Asbestos

C. OSHA 29 CFR 1926.1101 – Asbestos

D. OSHA 29 CFR 1926.32 – General Safety and Health Provisions

E. OSHA 29 CFR 1910.134 – Respiratory Protection

F. National Institute of Occupational Safety and Health (NIOSH)

1.05 REGULATORY REQUIREMENTS

A. Conform to applicable codes for disposal of debris.

B. For removal of asbestos containing materials, or material that could potentially contain asbestos, comply with applicable provisions of OSHA 29 CFR 1926.1101 – Asbestos, OSHA 29 CFR 1926.32 – General Safety and Health Provisions, and EPA 40 CFR 61 Subpart M – National Emission Standard for Asbestos.

1.06 COORDINATION

~~C.~~A. Coordinate removal work with utility companies.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 PREPARATION

A. Obtain advance approval from Project Manager for dimensions and limits of removal work.

B. Identify known utilities below grade. Stake and flag locations.

C. For removal of asbestos-containing materials, or materials that could potentially contain asbestos, comply with the following:

1. Crew members must be trained in accordance with OSHA 29 CFR 1926.1101 – Asbestos.

2. Conduct negative exposure assessment to demonstrate asbestos exposure below permissible exposure limit (PEL) in accordance with OSHA 29 CFR 1926.1101 – Asbestos and EPA 40 CFR 763 – Asbestos

3. If negative exposure assessment not conducted, or if results are above PEL, provide respiratory protection in accordance with Paragraph 3.02 of this Section.

D. Removal of existing pole foundations:.

~~4.~~1. Unless otherwise specified on Drawings, the tops of unused foundations shall be removed to a depth of two feet (minimum) below grade and backfilled according to specifications.

3.02 PROTECTION

A. Protect following from damage or displacement:

1. Adjacent public and private property.

2. Trees, plants, and other landscape features designated to remain.

3. Utilities designated to remain.

4. Pavement and utility structures designated to remain.

5. Bench marks, monuments, and existing structures designated to remain.

B. When required, provide respiratory protection in accordance with OSHA 29 CFR 1910.134 – Respiratory Protection, and National Institute of Occupational Safety and Health (NIOSH).

3.03 REMOVALS

A. Remove pavements and structures by methods that will not damage underground utilities. Do not use drop hammer near existing underground utilities.

B. Minimize amount of earth loaded during removal operations.

C. Where existing pavement is to remain, make straight saw cuts in existing pavement to provide clean breaks prior to removal. Do not break concrete pavement or base with drop hammer unless concrete or base has been saw cut to minimum depth of 2 inches.

D. When street and driveway saw cut location is greater than one-half of pavement lane width, remove pavement for full lane width or to nearest longitudinal joint as directed by Project Manager.

E. Remove sidewalks and curbs to nearest existing dummy, expansion, or construction joint.

F. Where existing end of pipe culvert or end of sewer is to remain, install 8-inch-thick masonry plug in pipe end prior to backfill in accordance with requirements of Section 02316 - Excavation and Backfill for Structures.

G. Labeling of Asbestos Cement (AC) Pipe:

1. Label leak-tight container with warning statement of hazardous asbestos content in accordance with OSHA 29 CFR 1926.1101 and as noted below.

2. Label waste material with following warning:

DANGER
CONTAINS ASBESTOS FIBERS
MAY CAUSE CANCER
CAUSES DAMAGE TO LUNGS
DO NOT BREATHE DUST
AVOID CREATING DUST

3. Neatly print labels in letters of sufficient size and contrast so label is easily visible and legible.

3.04 BACKFILL

A. Backfill of removal areas shall be in accordance with requirements of Section 02316 - Excavation and Backfill for Structures.

3.05 DISPOSALS

A. Inlet frames, grates, and plates; and manhole frames and covers, may remain City property. Disposal shall be in accordance with requirements of Section 01576 - Waste Material Disposal.

B. Remove from site, debris resulting from work under this section in accordance with requirements of Section 01576 - Waste Material Disposal.

C. For asbestos-containing materials:

1. Comply with 40 CFR Part 61 and 30 TAC Sections 330.137(b) for Industrial Class 1 waste.

2. Inspect load to ensure correct packaging and labeling.

3. Line vehicles with two layers of 6-mil polyethylene sheeting.

4. Remove asbestos-containing waste from site daily.

END OF SECTION

SECTION 02260

TRENCH SAFETY SYSTEM

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Trench ~~s~~Safety ~~s~~System for the construction of trench excavations.

B. Trench ~~s~~Safety ~~s~~System for excavations which fall under provisions of State and Federal trench safety laws.

C. This Standard Specification Section replaces previously published Section 01561-Trench Safety System.

D. The ~~t~~Trench ~~s~~Safety ~~s~~System requirements will apply to larger open excavations if the erection of structures or other installations limits the space between the excavation slope and these installation to dimensions equivalent of a trench as defined.

1.02 RELATED SECTIONS

A. Document 00410 – Bid Form

B. Document 00830 – Trench Safety Geotechnical Information

C. Section 01270 – Measurement and Payment

D. Section 01330 – Submittal Procedures

1.03 MEASUREMENT AND PAYMENT

A. Unit Prices:

1. Measurement for ~~t~~Trench ~~s~~Safety ~~s~~Systems used on trench excavations is on a linear foot basis measured along the centerline of the trench, including manholes and other line structures.

2. No payment will be made under this section for ~~t~~Trench ~~s~~Safety ~~s~~Systems for structural excavations, tunnel shafts, auger pits, or excavation for trenchless installations, and also for any necessary non trenchless installations included in the aforementioned methods of construction unless included as a bid item in Documents 00410 – Bid Form. Include payment for ~~t~~Trench ~~s~~Safety ~~s~~Systems in applicable structural or utility installation sections.

3. Refer to Section 01270 - Measurement and payment for unit price procedures.

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

1.04 DEFINITIONS

A. A trench shall be defined as a narrow excavation (in relation to its depth) made below the surface of the ground. In general, the depth is greater than the width, but the width of a trench (measured at the bottom) is not greater than 15 feet.

B. Trench Safety Systems include but are not limited to sloping, sheeting, trench boxes or trench shields, sheet piling, cribbing, bracing, shoring, dewatering or diversion of water to provide adequate drainage.

C. Trench Safety Program is the safety procedures governing the presence and activities of individuals working in and around trench excavations.

1.05 REFERENCES

A. Occupational Safety and Health Standards - OSHA 29CFR.

B. Occupational Safety and Health Standards - OSHA Sections 1926-650 through 1926-652.

C. Texas Health and Safety Code, §756, subchapter C.

~~1.05~~1.06 SUBMITTALS

A. Submittals shall conform to requirements of Section 01330 - Submittal Procedures.

B. Submit a safety program specifically for the construction of trench excavation. Design the ~~t~~Trench ~~s~~Safety ~~p~~Program to be in accordance with OSHA 29CFR standards governing the presence and activities of individuals working in and around trench excavations.

C. Construction and shop drawings containing deviations from OSHA standards or special designs shall be sealed by a licensed Engineer retained and paid by Contractor.

D. Review of the safety program by the City Engineer will only be in regard to compliance with this specification and will not constitute approval by the City Engineer nor relieve Contractor of obligations under State and Federal trench safety laws.

E. Submit certification that ~~t~~Trench ~~s~~Safety ~~s~~System will not be subjected to loads exceeding those which the system was designed to withstand according to the available construction and geotechnical information.

~~1.06~~1.07 REGULATORY REQUIREMENTS

A. Install and maintain ~~t~~Trench ~~s~~Safety ~~s~~Systems in accordance with the detail specifications set out in the provision of Excavations, Trenching, and Shoring, Federal Occupation Safety and Health Administration (OSHA) Standards, 29CFR, Part 1926, Subpart P, as amended, including Final Rule, published in the Federal Register Vol. 54, No. 209 on Tuesday, October 31, 1989. The sections that are incorporated into these specifications by reference include Sections 1926-650 through 1926-652.

B. A reproduction of the OSHA standards included in "Subpart P - Excavations" from the Federal Register Vol. 54, No. 209 is available upon request to Contractors bidding on City projects. The City assumes no responsibility for the accuracy of the reproduction. The Contractor is responsible for obtaining a copy of this section of the Federal Register.

C. Legislation that has been enacted by the Texas Legislature with regard to Trench Safety Systems, is hereby incorporated, by reference, into these specifications. Refer to Texas Health and Safety Code~~ Ann.~~, §756, ~~.021~~subchapter C~~ (Vernon 1991)~~.

D. Reference materials, if developed for a specific project, will be issued with the Bid Documents, including the following:

1. Document 00830 - Trench Safety Geotechnical Information: Geotechnical information obtained for use in design of the ~~t~~Trench ~~s~~Safety ~~s~~System.

~~1.07~~1.08 INDEMNIFICATION

A. Contractor shall indemnify and hold harmless the City, its employees and agents, from any and all damages, costs (including, without limitation, legal fees, court costs, and the cost of investigation), judgements or claims by anyone for injury or death of persons resulting from the collapse or failure of trenches constructed under this Contract.

B. Contractor acknowledges and agrees that this indemnity provision provides indemnity for the City in case the City is negligent either by act or omission in providing for trench safety, including, but not limited to safety program and design reviews, inspections, failures to issue stop work orders, and the hiring of the Contractor.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 INSTALLATION

A. Install and maintain ~~t~~Trench ~~s~~Safety ~~s~~Systems in accordance with provisions of OSHA 29CFR.

B. Install specially designed ~~t~~Trench ~~s~~Safety ~~s~~Systems in accordance with the Contractor's trench excavation safety program for the locations and conditions identified in the program.

C. A competent person, as identified in the Contractor's Trench Safety Program, shall verify that trench boxes and other premanufactured systems are certified for the actual installation conditions.

3.02 INSPECTION

A. Contractor, or Contractor's independently retained consultant, shall make daily inspections of the ~~t~~Trench ~~s~~Safety ~~s~~Systems to ensure that the installed systems and operations meet OSHA 29CFR and other personnel protection regulations requirements.

B. If evidence of possible cave-ins or slides is apparent, Contractor shall immediately stop work in the trench and move personnel to safe locations until the necessary precautions have been taken by Contractor to safeguard personnel entering the trench.

C. Maintain a permanent record of daily inspections.

3.03 FIELD QUALITY CONTROL

A. Contractor shall verify specific applicability of the selected or specially designed ~~t~~Trench ~~s~~Safety ~~s~~Systems to each field condition encountered on the project.

END OF SECTION

SECTION 02316

EXCAVATION AND BACKFILL FOR STRUCTURES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Excavation, backfilling, and compaction of ~~b~~Backfill for structures.

1.02 RELATED SECTIONS

A. Section 01270 – Measurement and Payment

B. Section 01330 – Submittal Procedures

C. Section 01454 – Testing Laboratory Services

D. Section 01555 – Traffic Control and Regulation

E. Section 01562 – Tree and Plant Protection

F. Section 01576 – Waste Material Disposal

G. Section 01578 – Control of Ground and Surface Water

H. Section 01785 – Project Record Documents

I. Section 02221 – Removing Existing Pavements, Structures, Wood, and Demolition Debris

J. Section 02260 – Trench Safety System

K. Section 02319 – Borrow

L. Section 02320 – Utility Backfill Materials

M. Section 02321 – Cement Stabilized Sand

N. Section 02621 – Geotextile

1.03 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. No payment will be made for structural excavation and ~~b~~Backfill under this Section. Include payment in unit price or lump sum for construction of structures.

2. Refer to Section 01270 - Measurement and Payment for unit price procedures.

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

1.04 DEFINITIONS

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 required density due to gradation, plasticity, or moisture content.

3. Materials that contain large clods, aggregates, stones greater than 4 inches in any dimension, debris, vegetation, waste or any other deleterious materials.

4. Materials that are contaminated with hydrocarbons or other chemical contaminants.

B. Suitable Material: Suitable soil materials are those meeting specification requirements. Unsuitable soils meeting specification requirements for suitable soils after treatment with lime or cement shall be considered suitable, unless otherwise indicated.

C. Select Material: Material as defined in Section 02320 - Utility Backfill Materials.

D. Backfill: Material meeting specified quality requirements, placed and compacted under controlled conditions around structures.

E. Foundation Backfill Materials: Natural soil or manufactured aggregate meeting Class I requirements and geotextile filter fabrics as required, to control drainage and material separation. Foundation ~~b~~Backfill material is placed and compacted as ~~b~~Backfill where needed to provide stable support for structure ~~f~~Foundation ~~b~~Base. Foundation ~~b~~Backfill materials may include concrete fill and seal slabs.

F. Foundation Base: For ~~f~~Foundation ~~b~~Base material, use crushed stone aggregate with filter fabric as required, cement stabilized sand, or concrete seal slab. Foundation ~~b~~Base provides smooth, level working surface for construction of concrete foundation.

G. Foundation Subgrade: Foundation ~~s~~Subgrade is surface of natural soil which has been excavated and prepared to support ~~f~~Foundation ~~b~~Base or foundation ~~b~~Backfill, where needed.

H. Ground Water Control Systems: Installations external to excavation such as well points, eductors, or deep wells. Ground water control includes dewatering to lower ground water, intercepting seepage which would otherwise emerge from side or bottom of excavation, and depressurization to prevent failure or heaving of excavation bottom. Refer to Section 01578 - Control of Ground and Surface Water.

I. Surface Water Control: Diversion and drainage of surface water runoff and rain water away from excavation. Remove rain water and surface water which accidentally enters excavation as part of excavation drainage.

J. Excavation Drainage: Removal of surface and seepage water in excavation by sump pumping and using French drains surrounding foundation to intercept water.

K. Over-Excavation and Backfill: Excavation of subgrade soils with unsatisfactory bearing capacity or composed of otherwise ~~u~~Unsuitable ~~m~~Materials below foundation as shown on Drawings, and ~~b~~Backfilled with ~~f~~Foundation ~~b~~Backfill ~~m~~Material.

L. Shoring System: Structure that supports sides of an excavation to maintain stable soil conditions and prevent cave-ins.

1.05 REFERENCES

A. ASTM D 698 - Standard Test Methods for Laboratory Compaction of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600kN-m/m3)).

B. ASTM D 1556 - Standard Test Method for Density and Unit weight of Soil in Place by Sand-Cone Method.

C. ASTM D 2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).

D. ASTM D 4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

E. ASTM D 6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

F. TxDOT Tex-101-E - Preparing ~~Soil and Flexible Base Materials for~~ and Testing Soils and Base Materials.

G. TxDOT Tex-110-E - ~~Particle Size Analysis of Soils.~~ Sieve Analysis of Soils and Base Materials.

H. ~~Federal Regulations, 29 CFR, Part 1926, Standards –~~Excavation, Occupational Safety and Health Administration (OSHA).

1.06 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

B. Submit work plan for excavation and ~~b~~Backfill for each structure with complete written description which identifies details of proposed method of construction and sequence of operations for construction relative to excavation and ~~b~~Backfill activities. Use descriptions, with supporting illustrations, sufficiently detailed to demonstrate to Project Manager that procedures meet requirements of Specifications and Drawings.

C. Submit excavation safety system plan.

1. Submit excavation safety system plan in accordance with applicable OSHA requirements for excavations.

2. Submit excavation safety system plan in accordance with requirements of Section 02260 - Trench Safety System, for excavations that fall under State and Federal trench safety laws.

D. Submit ground and surface water control plan in accordance with requirements in this Section and Section 01578 - Control of Ground and Surface Water.

E. Submit ~~b~~Backfill material sources and product quality information in accordance with requirements of Section 02320 - Utility Backfill Materials.

F. Submit project record documents under provisions of Section 01785 - Project Record Documents. Record location of utilities, as installed, referenced to survey benchmarks. Include location of utilities encountered or rerouted. Give horizontal dimensions, elevations, inverts and gradients.

1.07 ~~TESTS~~QUALITY ASSURANCE

A. Testing and analysis of ~~b~~Backfill materials for soil classification and compaction during construction will be performed by an independent laboratory provided by City in accordance with requirements of Section 01454 - Testing Laboratory Services and as specified in this Section.

B. Perform embedment and ~~b~~Backfill material source qualification testing in accordance with requirements of Section 02320 - Utility Backfill Materials.

PART 2 PRODUCTS

2.01 EQUIPMENT

A. Perform excavation with equipment suitable for achieving requirements of this Specification.

B. Use equipment which will produce degree of compaction specified. Compact ~~b~~Backfill within 3 feet of walls with hand operated equipment. Do not use equipment weighing more than 10,000 pounds closer to walls than a horizontal distance equal to depth of fill at that time. Use hand operated power compaction equipment where use of heavier equipment is impractical or restricted due to weight limitations.

2.02 MATERIAL CLASSIFICATIONS

A. Use ~~b~~Backfill materials conforming to classifications and product descriptions of Section 02320 - Utility Backfill Materials. Use classification or product description for ~~b~~Backfill applications as shown on Drawings and as specified.

PART 3 EXECUTION

3.01 PREPARATION

A. Conduct an inspection to determine condition of existing structures and other permanent installations.

B. Set up necessary street detours and barricades in preparation for excavation if construction will affect traffic. Conform to requirements of Section 01555 - Traffic Control and Regulation. Maintain barricades and warning devices at all times for streets and intersections where work is in progress, or where construction work is considered hazardous to traffic movements.

C. Perform work in accordance with OSHA standards. Employ an excavation safety system as specified in Section 02260 - Trench Safety Systems.

D. Remove existing pavements and structures, including sidewalks and driveways, in accordance with requirements of Section 02221 - Removing Existing Pavements, Structures, Wood, and Demolition Debris.

E. Install and operate necessary dewatering and surface water control measures in accordance with requirements of Section 01578 - Control of Ground and Surface Water.

3.02 PROTECTION

A. Protect trees, shrubs, lawns, existing structures, and other permanent objects outside of grading limits and within grading limits as designated on Drawings, and in accordance with requirements of Section 01562 - Tree and Plant Protection.

B. Protect and support above-grade and below-grade utilities which are to remain.

C. Restore damaged permanent facilities to pre-construction conditions unless replacement or abandonment of facilities is indicated on Drawings.

D. Prevent erosion of excavations and ~~b~~Backfill. Do not allow water to pond in excavations.

E. Maintain excavation and ~~b~~Backfill areas until start of subsequent work. Repair and recompact slides, washouts, settlements, or areas with loss of density at no additional cost to City.

3.03 EXCAVATION

A. Perform excavation work so that underground structure can be installed to depths and alignments shown on Drawings. Use caution during excavation work to avoid disturbing surrounding ground and existing facilities and improvements. Keep excavation to absolute minimum necessary. No additional payment will be made for excess excavation not authorized by Project Manager.

B. Upon discovery of unknown utilities, badly deteriorated utilities not designated for removal, or concealed conditions, discontinue work at that location. Notify Project Manager and obtain instructions before proceeding in such areas.

C. Immediately notify agency or company owning any line which is damaged, broken or disturbed. Obtain approval from Project Manager and agency for any repairs or relocations, either temporary or permanent.

D. Avoid settlement of surrounding soil due to equipment operations, excavation procedures, vibration, dewatering, or other construction methods.

E. Provide surface drainage during construction to protect work and to avoid nuisance to adjoining property. Where required, provide proper dewatering and piezometric pressure control during construction.

F. Conduct hauling operations so that trucks and other vehicles do not create dirt nuisance in streets. Verify that truck beds are sufficiently tight and loaded in such a manner such that objectionable materials will not spill onto streets. Promptly clear away any dirt, mud, or other materials that spill onto streets or are deposited onto streets by vehicle tires.

G. Maintain permanent benchmarks, monumentation, and other reference points. Unless otherwise directed, replace those which are damaged or destroyed by Work.

H. Provide sheeting, shoring, and bracing where required to safely complete Work, to prevent excavation from extending beyond limits indicated on Drawings, and to protect Work and adjacent structures or improvements. Use sheeting, shoring, and bracing to protect workmen and public conforming to requirements of Section 02260 - Trench Safety Systems.

I. Prevent voids from forming outside of sheeting. Immediately fill voids with grout, cement stabilized sand, or other material approved by Project Manager and compact to 95 percent standard density.

J. After completion of structure, remove sheeting, shoring, and bracing unless shown on Drawings to remain in place or directed by Project Manager in writing that such temporary structures may remain. Remove sheeting, shoring and bracing in such a manner as to maintain safety during backfilling operations and to prevent damage to Work and adjacent structures or improvements.

K. Immediately fill and compact voids left or caused by removal of sheeting with cement stabilized sand or other material approved by Project Manager and compact to 95 percent standard density.

3.04 HANDLING EXCAVATED MATERIALS

A. Classify excavated materials. Place material which is suitable for use as ~~b~~Backfill in orderly piles at sufficient distance from excavation to prevent slides or cave-ins.

B. Provide additional ~~b~~Backfill material in accordance with requirements of Section 02319 - Borrow, if adequate quantities of ~~s~~Suitable ~~m~~Material are not available from excavation and trenching operations at site.

3.05 DEWATERING

A. Provide ground water control per Section 01578 - Control of Ground and Surface Water.

B. Keep ground water surface elevation minimum of 2 feet below bottom of ~~f~~Foundation ~~b~~Base.

C. Maintain ground water control as directed by Section 01578 - Control of Ground and Surface Water and until structure is sufficiently complete to provide required weight to resist hydrostatic uplift with minimum safety factor of 1.2.

3.06 FOUNDATION EXCAVATION

A. Notify Project Manager at least 48 hours prior to planned completion of foundation excavations. Do not place ~~f~~Foundation ~~b~~Base until excavation is accepted by Project Manager.

B. Excavate to elevations shown on Drawings, as needed to provide space for ~~f~~Foundation ~~b~~Base, forming level undisturbed surface, free of mud or soft material. Remove pockets of soft or otherwise unstable soils and replace with ~~f~~Foundation ~~b~~Backfill ~~m~~Material or material as directed by Project Manager. Prior to placing material over it, recompact subgrade where indicated on Drawings, scarifying as needed, to 95 percent of maximum Standard Dry Density according to ASTM D 698. If specified level of compaction cannot be achieved, moisture condition subgrade and recompact until 95 percent is achieved, over-excavate to provide minimum layer of 24 inches of ~~f~~Foundation ~~b~~Backfill ~~m~~Material, or other means acceptable to Project Manager.

C. Fill unauthorized excessive excavation with ~~f~~Foundation ~~b~~Backfill ~~m~~Material or other material as directed by Project Manager.

D. Protect open excavations from rainfall, runoff, freezing groundwater, or excessive drying so as to maintain ~~f~~Foundation ~~s~~Subgrade in satisfactory, undisturbed condition. Keep excavations free of standing water and completely free of water during concrete placement.

E. Remove soils which become unsuitable due to inadequate dewatering or other causes, after initial excavation to required subgrade, and replace with ~~f~~Foundation ~~b~~Backfill ~~m~~Material, as directed by Project Manager, at no additional cost to City.

F. Place ~~f~~Foundation ~~b~~Base, or ~~f~~Foundation ~~b~~Backfill ~~m~~Material where needed, over subgrade on same day that excavation is completed to final grade. Where base of excavations ~~are~~is left open for longer periods, protect ~~them~~it with seal slab or cement-stabilized sand.

G. Use filter fabric as specified in Section 02621 - Geotextile to separate crushed aggregate, and other free draining Class I materials from native soils or ~~s~~Select ~~m~~Material ~~b~~Backfill. Overlap fabric minimum of 12 inches beyond where another material stops contact with soil.

H. Place crushed aggregate, and other Class I materials, in uniform layers of 8-inch maximum thickness. Perform compaction by means of at least two passes of vibratory compactor.

3.07 FOUNDATION BASE.

A. Place ~~f~~Foundation ~~b~~Base after subgrade is properly prepared, including placement of ~~f~~Foundation ~~b~~Backfill where needed. Use ~~f~~Foundation ~~b~~Base consisting of 12-inch layer of crushed stone aggregate or cement stabilized sand. Alternately, seal slab with minimum thickness of 4 inches may be placed. Extend ~~f~~Foundation ~~b~~Base minimum of 12 inches beyond edge of structure foundation, unless shown otherwise on Drawings.

B. Where ~~f~~Foundation ~~b~~Base and ~~f~~Foundation ~~b~~Backfill are of same material, both can be placed in one operation.

3.08 BACKFILL

A. Complete ~~b~~Backfill to surface of natural ground or to lines and grades shown on Drawings. Remove forms, lumber, trash and debris from structures. Deposit ~~b~~Backfill in uniform layers and compact each layer as specified.

1. Unless otherwise shown on Drawings, for structures under pavement or within one foot back of curb, use cement stabilized sand up to the top of the proposed structure. Use suitable on-site material (random ~~b~~Backfill) up to 12 inches below pavement base or subgrade. Place minimum of 12 inches of select ~~b~~Backfill below pavement base or subgrade.

2. Unless otherwise shown on Drawings, for structures not under pavement, use random ~~b~~Backfill of ~~s~~Suitable ~~m~~Material up to the surface.

B. Do not place ~~b~~Backfill against concrete walls or similar structures until laboratory test breaks indicate that concrete has reached minimum of 85 percent of specified compressive strength. Where walls are supported by slabs or intermediate walls, do not begin ~~b~~Backfill operations until slab or intermediate walls have been placed and concrete has attained sufficient strength.

C. Remove concrete forms before starting ~~b~~Backfill and remove shoring and bracing as work progresses.

D. Maintain ~~b~~Backfill material at no less than 2 percent below nor more than 2 percent above optimum moisture content, unless otherwise approved by Project Manager. Place fill material in uniform 8-inch maximum loose layers. Compact fill to at least 95 percent of maximum Standard Proctor Density according to ASTM D 698 below paved areas. Compact fill to at least 90 percent around structures below unpaved areas.

E. Where ~~b~~Backfill is placed against sloped excavation surface, run compaction equipment across boundary of cut slope and ~~b~~Backfill to form compacted slope surface for placement of next layer of ~~b~~Backfill.

F. Place ~~b~~Backfill using cement stabilized sand in accordance with Section 02321 - Cement Stabilized Sand.

3.09 FIELD QUALITY CONTROL

A. Testing will be performed under provisions of Section 01454 - Testing Laboratory Services.

B. Tests will be performed initially on minimum of one different sample 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 noticeable change in material gradation or plasticity.

C. In-place density tests of compacted subgrade and ~~b~~Backfill will be performed according to ASTM D 1556, or ASTM D 6938, and at following frequencies and conditions:

1. Minimum of one test for every 50 to 100 cubic yards of compacted ~~b~~Backfill material as directed by Project Manager.

2. A minimum of three density tests for each full work shift.

3. Density tests will be performed in all placement areas.

4. Number of tests will be increased when inspection determines that soil types or moisture contents are not uniform or when compacting effort is variable and not considered sufficient to attain uniform density.

5. Identify elevation of test with respect to natural ground.

6. Record approximate depth of lift tested.

D. At least one test for moisture-density relationships will be initially performed for each type of ~~b~~Backfill material in accordance with ASTM D 698. Perform additional moisture-density relationship test once a month or whenever there is noticeable change in material gradation or plasticity.

E. When tests indicate work does not meet specified compaction requirements, recondition, recompact, and retest at Contractor's expense.

3.10 DISPOSAL OF EXCESS MATERIAL

A. Dispose of excess materials in accordance with requirements of Section 01576 - Waste Material Disposal.

END OF SECTION

SECTION 02317

EXCAVATION AND BACKFILL FOR UTILITIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Excavation, trenching, foundation, embedment, and ~~b~~Backfill for installation of utilities, including manholes and other pipeline structures.

1.02 RELATED SECTIONS

A. Section 01270 – Measurement and Payment

B. Section 01330 – Submittal Procedures

C. Section 01454 – Testing Laboratory Services

D. Section 01504 – Temporary Facilities and Controls

E. Section 01555 – Traffic Control and Regulation

F. Section 01562 – Tree and Plant Protection

G. Section 01576 – Waste Material Disposal

H. Section 01578 – Control of Ground and Surface Water

I. Section 01725 – Field Surveying

J. Section 02221 – Removing Existing Pavements, Structures, Wood, and Demolition Debris

K. Section 02260 – Trench Safety System

L. Section 02320 – Utility Backfill Materials

M. Section 02321 – Cement Stabilized Sand

N. Section 02322 – Flowable Fill

O. Section 02621 – Geotextile

P. Section 03315 – Concrete for Utility Construction

1.03 MEASUREMENT AND PAYMENT

A. Unit Prices

1. No additional payment will be made for trench excavation, embedment and ~~b~~Backfill under this Section. Include cost in unit price for installed underground piping, sewer, conduit, or duct work.

2. When Project Manager directs Contractor to over excavate trench bottom, Contractor will be paid by unit price bid per linear foot under bid item ~~-~~-6-inches Over Excavation of Trench Bottom.

   a. No payment will be paid if Project Manager does not direct Contractor to over excavate trench bottom.

   b. No over excavation will be measured or paid when unsuitable conditions result from dewatering system not in conformance with Section 01578 - Control of Ground and Surface Water.

3. No additional payment will be made for performing Critical Location exploratory excavation. Include cost in unit price for installed underground piping, sewer, conduit, or duct work.

4. Refer to Section 01270 - Measurement and Payment for unit price procedures.

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

1.04 DEFINITIONS

A. Pipe Foundation: Suitable and stable native soils that are exposed at trench subgrade after excavation to depth of bottom of bedding as shown on Drawings, or foundation ~~b~~Backfill material placed and compacted in over-excavations.

B. Pipe Bedding: Portion of trench ~~b~~Backfill that extends vertically from top of foundation up to level line at bottom of pipe, and horizontally from one trench sidewall to opposite sidewall.

C. Haunching: Material placed on either side of pipe from top of bedding up to springline of pipe and horizontally from one trench sidewall to opposite sidewall.

D. Initial Backfill: Portion of trench ~~b~~Backfill that extends vertically from springline of pipe (top of ~~h~~Haunching) up to level line 12-inches above top of pipe, and horizontally from one trench sidewall to opposite sidewall.

E. Pipe Embedment: Portion of trench ~~b~~Backfill that consists of bedding, ~~h~~Haunching and ~~i~~Initial ~~b~~Backfill.

F. Trench Zone: Portion of trench ~~b~~Backfill that extends vertically from top of ~~p~~Pipe ~~e~~Embedment up to pavement subgrade or up to final grade when not beneath pavement.

G. Unsuitable Material: Unsuitable soil materials are the following:

1. Materials that are classified as ML, CL-ML, MH, PT, OH, and OL according to ASTM D 2487.

2. Materials that cannot be compacted to required density due to gradation, plasticity, or moisture content.

3. Materials that contain large clods, aggregates, stones greater than 4-inches in any dimension, debris, vegetation, waste or any other deleterious materials.

4. Materials that are contaminated with hydrocarbons or other chemical contaminants.

H. Suitable Material: Suitable soil materials are those meeting specification requirements. Materials mixed with lime, fly ash, or cement that can be compacted to required density and meeting requirements for ~~s~~Suitable ~~m~~Materials may be considered ~~s~~Suitable ~~m~~Materials, unless otherwise indicated.

I. Backfill: Suitable material meeting specified quality requirements placed and compacted under controlled conditions.

J. Ground Water Control Systems: Installations external to trench, such as well points, eductors, or deep wells. Ground water control includes dewatering to lower ground water, intercepting seepage which would otherwise emerge from side or bottom of trench excavation, and depressurization to prevent failure or heaving of excavation bottom. Refer to Section 01578 - Control of Ground Water and Surface Water.

K. Surface Water Control: Diversion and drainage of surface water runoff and rain water away from trench excavation. Rain water and surface water accidentally entering trench shall be controlled and removed as part of ~~e~~Excavation ~~d~~Drainage.

L. Excavation Drainage: Removal of surface and seepage water in trench by sump pumping and using drainage layer, as defined in ASTM D 2321, placed on foundation beneath ~~p~~Pipe ~~b~~Bedding or thickened bedding layer of Class I material.

M. Trench Conditions are defined with regard to stability of trench bottom and trench walls of ~~p~~Pipe ~~e~~Embedment zone. Maintain trench conditions that provide for effective placement and compaction of embedment material directly on or against undisturbed soils or foundation ~~b~~Backfill, except where structural trench support is necessary.

1. Dry Stable Trench: Stable and substantially dry trench conditions exist in ~~p~~Pipe ~~e~~Embedment zone as result of typically dry soils or achieved by ground water control (dewatering or depressurization) for trenches extending below ground water level.

2. Stable Trench with Seepage: Stable trench in which ground water seepage is controlled by ~~e~~Excavation ~~d~~Drainage.

a. Stable Trench with Seepage in Clayey Soils: Excavation ~~d~~Drainage is provided in lieu of or to supplement ~~g~~Ground ~~w~~Water ~~c~~Control ~~s~~Systems to control seepage and provide stable trench subgrade in predominately clayey soils prior to bedding placement.

b. Stable Wet Trench in Sandy Soils: Excavation ~~d~~Drainage is provided in embedment zone in combination with ground water control in predominately sandy or silty soils.

3. Unstable Trench: Unstable trench conditions exist in ~~p~~Pipe ~~e~~Embedment zone if ground water inflow or high water content causes soil disturbances, such as sloughing, sliding, boiling, heaving or loss of density.

N. Sub-trench: Sub-trench is special case of benched excavation. Sub-trench excavation below ~~t~~Trench ~~s~~Shields or shoring installations may be used to allow placement and compaction of foundation or embedment materials directly against undisturbed soils. Depth of sub-trench depends upon trench stability and safety as determined by Contractor.

O. Trench Dam: Placement of low permeability material in ~~p~~Pipe ~~e~~Embedment zone or foundation to prohibit ground water flow along trench.

P. Over-excavation and Backfill: Excavation of subgrade soils with unsatisfactory bearing capacity or composed of otherwise ~~u~~Unsuitable ~~m~~Materials below top of foundation as shown on Drawings, and ~~b~~Backfilled with foundation bedding.

Q. Foundation Bedding: Natural soil or manufactured aggregate of controlled gradation, and geotextile filter fabrics as required, to control drainage and material separation. Foundation ~~b~~Bedding is placed and compacted as ~~b~~Backfill to provide stable support for bedding. Foundation ~~b~~Bedding materials may include concrete seal slabs.

R. Trench Safety Systems include both protective systems and ~~s~~Shoring ~~s~~Systems as defined in Section 02260 - Trench Safety Systems.

S. Trench Shield (Trench Box): Portable worker safety structure moved along trench as work proceeds, used as protective system and designed to withstand forces imposed on it by cave in, thereby protecting persons within trench. Trench ~~s~~Shields may be stacked if so designed or placed in series depending on depth and length of excavation to be protected.

T. Shoring System: Structure that supports sides of an excavation to maintain stable soil conditions and prevent cave-ins, or to prevent movement of ground affecting adjacent installations or improvements.

U. Special Shoring: Shoring ~~s~~System meeting ~~s~~Special ~~s~~Shoring as specified in Paragraph ~~1.08~~1.09, Special Shoring Design Requirements, for locations identified on Drawings.

V. Vacuum Excavation: An excavation technique performed by an experienced subcontractor in which water or air jetting is used to slough off and vacuum away soil.

W. Large Diameter Water Line (LDWL): Water line that is 24-inches in diameter or larger. X. Emergency Action Plan (EAP): The EAP document should include a discussion of procedures for timely and reliable detection, classification (level of emergency) and response procedure to a potential emergency condition associated with a ~~l~~Large ~~d~~Diameter ~~w~~Water ~~l~~Line.

X. Subsurface Utility Exploration (SUE): Non-destructive excavation, unless otherwise approved by ~~p~~Project ~~m~~Manager.

1.05 REFERENCES

~~A. ASTM A 798 - Standard Practice for Installing Factory-Made Corrugated Steel Pipe for Sewers and Other Applications.~~

~~B. ASTM C 12 - Standard Practice for Installing Vitrified Clay Pipe Lines.~~

~~C. ASTM C 891 - Standard Practice for Installation of Underground Precast Concrete Utility Structures~~

~~D. ASTM C 1479 - Standard Practice for Installation of Precast Concrete Sewer, Storm Drain, and Culvert Pipe Using Standard Installations~~

~~E. ASTM C 1675 - Standard Practice for Installation of Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewers~~

~~F. ASTM C 1821 - Standard Practice for Installation of Underground Circular Precast Concrete Manhole Structures~~

~~G.~~A. ASTM D 558 - Standard Test Methods for Moisture-Density (Unit Weight) Relations of Soil-Cement Mixtures.

~~H.~~B. ASTM D 698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft3 (600 kN-m/m3)).

~~I.~~C. ASTM D 1556 - Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method.

~~J.~~D. ASTM D 2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity Flow Applications.

~~K.~~E. ASTM D 2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classifications System).

~~L.~~F. ASTM D 4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

~~M.~~G. ASTM D 6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

~~N.~~H. TxDOT Tex-101-E - Preparing ~~Soil and Flexible Base Materials for Testing~~ and Testing Soils and Base Materials.

~~O.~~I. TxDOT Tex-110-E - ~~Particle Size Analysis of Soils~~ Sieve Analysis of Soils and Base Materials.

~~P.~~J. ~~Federal Regulations, 29 CFR Part 1926, Standards-Excavation, Occupational Safety and Health Administration (OSHA)~~.

1.06 SCHEDULING

A. Schedule work so that ~~p~~Pipe ~~e~~Embedment can be completed on same day that acceptable foundation has been achieved for each section of pipe installation, manhole, or other structures.

B. For proposed utility adjacent to or across existing LDWL:

1. Conduct a meeting between ~~c~~Contractor, Drinking Water Operations and Utility Maintenance Branch prior to beginning excavation to coordinate the EAP in the event a water line shut down becomes necessary.

2. Notify Drinking Water Operations a minimum of 1 week prior to beginning construction activities.

3. Notify Drinking Water Operations a minimum of 48 hours prior to beginning SUE work near LDWL.

4. Unless otherwise approved by City Engineer, perform construction activities between 7 AM and 7 PM, Monday through Friday. No work permitted around a LDWL on weekends or City Holiday.

5. A City Inspector must be present during SUE or construction activities occurring within four feet or one diameter of the LDWL, whichever is greater, from a LDWL or appurtenance.

1.07 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

B. Submit planned typical method of excavation, backfill placement and compaction including:

1. Trench widths.

2. Procedures for foundation and pipe zone bedding placement, and trench ~~b~~Backfill compaction.

3. Procedures for assuring compaction against undisturbed soil when pre-manufactured trench safety systems are proposed.

C. Submit ~~b~~Backfill material sources and product quality information in accordance with requirements of Section 02320 - Utility Backfill Materials.

D. Submit trench excavation safety program in accordance with requirements of Section 02260 - Trench Safety System. Include designs for ~~s~~Special ~~s~~Shoring meeting requirements defined in Paragraph 1.08, Special Shoring Design Requirements contained herein.

E. Submit record of location of utilities as installed, referenced to survey control points. Include locations of utilities encountered or rerouted. Give stations, horizontal dimensions, elevations, inverts, and gradients.

F. Submit 11-inch by 17-inch or 12-inch by 18-inch copy of Drawing with plotted utility or obstruction location titled "Critical Location Report" to Project Manager.

G. For installation of proposed utility adjacent to or across existing LDWL, prepare and submit the following to Drinking Water Operations prior to beginning construction activities. Obtain approval from Drinking Water Operations prior to commencing prelocate or utility work near LDWL.

1. Trench details, ~~s~~Shoring ~~s~~System designs, installation sequences, and flowable fill mix designs.

2. Emergency Action Plan (EAP) to address contingency plans in the event of damage to or failure of LDWL. Include the following:

a. Contact personnel and agencies including primary and secondary telephone numbers.

b. Contractor’s hierarchy of responsible personnel.

c. Traffic control measures

d. Identification of resources to be available on or near ~~p~~Project site in event of damage to or failure of LDWL.

1.08 ~~TESTS~~QUALITY ASSURANCE

A. Testing and analysis of ~~b~~Backfill materials for soil classification and compaction during construction will be performed by an independent laboratory provided by City in accordance with requirements of Section 01454 - Testing Laboratory Services and as specified in this Section.

B. Perform ~~b~~Backfill material source qualification testing in accordance with requirements of Section 02320 - Utility Backfill Materials.

1.09 SPECIAL SHORING DESIGN REQUIREMENTS

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

PART 2 PRODUCTS

2.01 EQUIPMENT

A. Perform excavation with hydraulic excavator or other equipment suitable for achieving requirements of this Section.

B. Use only hand-operated tamping equipment until minimum cover of 12-inches is obtained over pipes, conduits, and ducts. Do not use heavy compacting equipment until adequate cover is attained to prevent damage to pipes, conduits, or ducts.

C. Use ~~t~~Trench ~~s~~Shields or other protective systems or ~~s~~Shoring ~~s~~Systems which are designed and operated to achieve placement and compaction of ~~b~~Backfill directly against undisturbed native soil.

D. Use special ~~s~~Shoring ~~s~~Systems where required which may consist of braced sheeting, braced soldier piles and lagging, slide rail systems, or other systems meeting requirements as specified in Paragraph 1.08, Special Shoring Design Requirements.

2.02 MATERIAL CLASSIFICATIONS

A. Embedment and Trench Zone Backfill Materials: Conform to classifications and product descriptions of Section 02320 - Utility Backfill Materials and Section 02321 – Cement Stabilized Sand.

B. Concrete Backfill: Conform to requirements for Class B concrete as specified in Section 03315 - Concrete for Utility Construction.

C. Geotextile (Filter Fabric): Conform to requirements of Section 02621 - Geotextile.

D. Concrete for Trench Dams: Concrete ~~b~~Backfill or 3 sack premixed (bag) concrete.

PART 3 EXECUTION

3.01 ~~STANDARD PRACTICE~~GENERAL REQUIREMENTS

~~A. Install flexible pipe, including "semi-rigid" pipe, to conform to standard practice described in ASTM D 2321, and as described in this Section. Where an apparent conflict occurs between standard practice and requirements of this Section, this Section governs~~

~~B.~~A. ~~Install rigid pipe to conform to standard practice described in ASTM C 12, C 1479, or C 1675as applicable , and as described in this Section. Where an apparent conflict occurs between standard practice and requirements of this Section, this Section governs.~~In addition to requirements found in this Section, conform to requirements found in the applicable Sections for utility material/type. Where an apparent conflict occurs between the Sections, this Section governs.

3.02 PREPARATION

A. Establish traffic control to conform to requirements of Section 01555 - Traffic Control and Regulation. Maintain barricades and warning lights for streets and intersections affected by Work, and are considered hazardous to traffic movements.

B. Perform work to conform to applicable safety standards and regulations. Employ trench safety system as specified in Section 02260 - Trench Safety Systems.

C. Immediately notify agency or company owning any existing utility line which is damaged, broken, or disturbed. Obtain approval from Project Manager and agency for any repairs or relocations, either temporary or permanent.

D. Remove existing pavements and structures, including sidewalks and driveways, to conform to requirements of Section 02221 - Removing Existing Pavements, Structures, Wood and Demolition Debris, as applicable.

E. Install and operate necessary dewatering and surface-water control measures to conform to Section 01578 - Control of Ground and Surface Water. Provide stable trench to allow installation in accordance with Specifications.

F. Maintain permanent benchmarks, monumentation, and other reference points. Unless otherwise directed in writing, replace those which are damaged or destroyed in accordance with Section 01725 - Field Surveying.

3.03 CRITICAL LOCATION INVESTIGATION

A. Horizontal and vertical location of various underground lines shown on Drawings, including but not limited to water lines, gas lines, storm sewers, sanitary sewers, telecommunication lines, electric lines or power ducts, pipelines, concrete and debris, are based on best information available but are only approximate locations. Unless otherwise approved by Project Manager, at Critical Locations shown on Drawings, perform ~~v~~Vacuum ~~e~~Excavation to field verify horizontal and vertical locations of such lines within a zone 2 feet vertically and 4 feet horizontally of proposed work exclude water jetting at PCCP water line.

1. Verify location of existing utilities minimum of 7 working days in advance of pipe laying activities based on daily pipe laying rate or prior to beginning installation of auger pit or tunnel shaft. Use extreme caution and care when uncovering utilities designated by Critical Locate.

2. Notify Project Manager in writing immediately upon identification of obstruction. In event of failure to identify obstruction in minimum of 7 days, Contractor will not be entitled to extra cost for downtime including, but not limited to, payroll, equipment, overhead, demobilization and remobilization, until 7 days has passed from time Project Manager was~~is~~ notified of obstruction.

B. Notify involved utility companies of date and time that investigation excavation will occur and request that their respective utility lines be marked in field. Comply with utility or pipeline company requirements that their representative be present during excavation. Provide Project Manager with 48~~-~~-hours notice prior to field excavation or related work.

C. Survey vertical and horizontal locations of obstructions relative to project baseline and datum and plot on 12-inch by 18-inch copy of Drawings. For ~~l~~Large diameter ~~w~~Water ~~l~~Lines, submit to Project Manager for approval, horizontal and vertical alignment dimensions for connections to existing lines, tied into ~~p~~Project baseline, signed and sealed by R.P.L.S.

D. LDWL Prelocate Requirements:

1. Field-locate LDWL, appurtenances and laterals connected directly to LDWL through use of non-probing method such as a vacuum truck (non-water jetting method) at no greater than 50-foot intervals. Locate upstream and downstream of proposed work or utility installation.

2. Record crown and side of LDWL adjacent to proposed work or utility installation. Record LDWL locations horizontally and vertically using same coordinate system employed on proposed utility drawings.

3. Tie horizontal and vertical coordinates into project baseline. Submit recordings performed by R.P.L.S to City a minimum of 14 days prior to mobilizing to site.

3.04 PROTECTION

A. Protect trees, shrubs, lawns, existing structures, and other permanent objects outside of grading limits and within grading limits as designated on Drawings, and in accordance with requirements of Section 01562 - Tree and Plant Protection.

B. Protect and support above-grade and below-grade utilities which are to remain.

C. Restore damaged permanent facilities to pre-construction conditions unless replacement or abandonment of facilities is indicated on Drawings.

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

E. Contingency plans for proposed work or utility installation adjacent to or across a LDWL:

1. Conduct on-site emergency drill prior to commencing proposed utility installation, and at ~~three month~~three-month intervals to assure EAP is current.

2. In the event a LDWL shut down becomes necessary, secure site and provide assistance to City personnel to access pipe and isolation valves as needed.

3.05 EXCAVATION

A. Except as otherwise specified or shown on Drawings, install underground utilities in open cut trenches with vertical sides.

B. Perform excavation work so that pipe, conduit, and ducts can be installed to depths and alignments shown on Drawings. Avoid disturbing surrounding ground and existing facilities and improvements.

C. Determine trench excavation widths using following schedule as related to pipe outside diameter (O.D.). Excavate trench so that pipe is centered in trench.

Nominal Pipe Size, Inches	Minimum Trench Width, Inches
~~Less than 18~~	~~O.D. + 18~~
~~18 to~~ 30 or less	O.D. + 24
36 to 42	O.D. + 36
Greater than 42	O.D. + 48

D. Do not obstruct sight distance for vehicles utilizing roadway or detours with stockpiled materials.

E. Use sufficient trench width or benches above embedment zone for installation of well point headers or manifolds and pumps where depth of trench makes it uneconomical or impractical to pump from surface elevation. Provide sufficient space between shoring cross braces to permit equipment operations and handling of forms, pipe, embedment and ~~b~~Backfill, and other materials.

F. Upon discovery of unknown utilities, badly deteriorated utilities not designated for removal, or concealed conditions, discontinue work at that location. Notify Project Manager and obtain instructions before proceeding.

G. Shoring of Trench Walls.

1. Install Special Shoring in advance of trench excavation or simultaneously with trench excavation, so that soils within full height of trench excavation walls will remain laterally supported at all times.

2. For all types of shoring, support trench walls in ~~p~~Pipe ~~e~~Embedment zone throughout installation. Provide trench wall supports sufficiently tight to prevent washing trench wall soil out from behind trench wall support.

3. Leave sheeting driven into or below ~~p~~Pipe ~~e~~Embedment zone in place to preclude loss of support of foundation and embedment materials, unless otherwise directed by Project Manager. Leave rangers, walers, and braces in place as long as required to support sheeting, which has been cut off, and trench wall in vicinity of pipe zone.

4. Employ special methods for maintaining integrity of embedment or foundation material. Before moving supports, place and compact embedment to sufficient depths to provide protection of pipe and stability of trench walls. As supports are moved, finish placing and compacting embedment.

5. If sheeting or other shoring is used below top of ~~p~~Pipe ~~e~~Embedment zone, do not disturb ~~p~~Pipe ~~f~~Foundation and embedment materials by subsequent removal. Maximum thickness of removable sheeting extending into embedment zone shall be equivalent of 1-inch-thick steel plate. As sheeting is removed, fill in voids left with grouting material.

H. Use of Trench Shields. When ~~t~~Trench ~~s~~Shield (~~t~~Trench ~~b~~Box) is used as worker safety device, the following requirements apply:

1. Make trench excavations of sufficient width to allow shield to be lifted or pulled freely, without damage to trench sidewalls.

2. Move ~~t~~Trench ~~s~~Shields so that pipe, and ~~b~~Backfill materials, after placement and compaction, are not damaged nor disturbed, nor degree of compaction reduced. Re-compact after shield is moved if soil is disturbed.

3. When required, place, spread, and compact ~~p~~Pipe ~~f~~Foundation and bedding materials beneath shield. For backfill above bedding, lift shield as each layer of ~~b~~Backfill is placed and spread. Place and compact ~~b~~Backfill materials against undisturbed trench walls and foundation.

4. Maintain ~~t~~Trench ~~s~~Shield in position to allow sampling and testing to be performed in safe manner.

5. Conform to applicable Government regulations.

I. Voids under paving area outside shield caused by Contractor's work will require removal of pavement, consolidation and replacement of pavement in accordance with Contract Documents. Repair damage resulting from failure to provide adequate supports.

J. Place sand or soil behind shoring or ~~t~~Trench ~~s~~Shield to prevent soil outside shoring from collapsing and causing voids under pavement. Immediately pack ~~s~~Suitable ~~m~~Material in outside voids following excavation to avoid caving of trench walls.

K. Coordinate excavation within 15 feet of pipeline with company's representative. Support pipeline with methods agreed to by pipeline company's representative. Use small, rubber-tired excavator, such as backhoe, to do exploratory excavation. Bucket that is used to dig in close proximity to pipelines shall not have teeth or shall have guard installed over teeth to approximate bucket without teeth. Excavate by hand within 1 foot of Pipeline Company’s line. Do not use larger excavation equipment than normally used to dig trench in vicinity of pipeline until pipelines have been uncovered and fully exposed. Do not place large excavation and hauling equipment directly over pipelines unless approved by Pipeline Company’s representative.

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

M. Excavation and shoring requirements for proposed work or utility installation adjacent to or across a LDWL:

1. Identify LDWL area in field and barricade off from construction activities. Allow no construction related activities including, but not limited to, loading of dump trucks and material staging or storage, on top of LDWL.

2. Employ a groundwater control system when performing excavation activities within ten feet of LDWL to:

   a. Effectively reduce hydrostatic pressure affecting excavations.~~,~~

   b. Develop substantially dry and stable subgrade for subsequent construction operations.~~,~~

   c. Prevent loss of fines, seepage, boils, quick condition or softening of foundation strata.~~, and~~

   d. Maintain stability of sides and bottom of excavations.

3. When edge of proposed trench or shoring is within a distance equal to one diameter of LDWL from outside of wall of LDWL, valve or appurtenance:

   a. Maintain minimum of four (4) feet horizontal clearance and minimum of two (2) feet vertical clearance between proposed utility and LDWL.

   b. Auger Construction.

(1) Maintain minimum of four (4) feet horizontal clearance between proposed utility and LDWL.

(2) Dry auger method required when auger hole is 12-inches and larger in diameter.

c. Open Cut Construction and Auger pits

(1) Perform hand excavation when within four (4) feet of LDWL.

(2) Employ hydraulic or pneumatic ~~s~~Shoring ~~s~~System. Do not use vibratory or impact driven shoring or piling.

(3) Expose no more than 30-feet of trench prior to backfilling.

(4) A maximum of one (1) foot of vertical trench shall be un-braced at a time to maintain constant pressure on face of excavated soil.

(5) Upon removal of ~~s~~Shoring ~~s~~System, inject flowable fill into void space left behind by ~~s~~Shoring ~~s~~System. Comply with Standard Specification 02322 - Flowable Fill.

d. When edge of utility excavation is greater than one diameter of LDWL from outside wall of LDWL, use a shielding system as required by Project Manager and proposed utility standards and practices.

3.06 HANDLING EXCAVATED MATERIALS

A. Use only excavated materials, which are suitable as defined in this Section and conforming to Section 02320 - Utility Backfill Materials. Place material suitable for backfilling in stockpiles at distance from trench to prevent slides or cave-ins.

B. When required, provide additional ~~b~~Backfill material conforming to requirements of Section 02320 - Utility Backfill Materials.

C. Do not place stockpiles of excess excavated materials on streets and adjacent properties. Protect ~~b~~Backfill material to be used on site. Maintain site conditions in accordance with Section 01504 - Temporary Facilities and Controls. Excavate trench so that pipe is centered in trench. Do not obstruct sight distance for vehicles utilizing roadway or detours with stockpiled materials.

3.07 TRENCH FOUNDATION

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

B. When wet soil is encountered on trench bottom and dewatering system is not required, over excavate an additional 6-inches with approval by Project Manager. Place non-woven geotextile fabric and then compact 12-inches of crushed stone in one lift on top of fabric. Compact crushed stone with four passes of vibratory-type compaction equipment.

C. Perform over excavation, when directed by Project Manager, in accordance with Paragraph 3.07.B above. Removal of unstable or ~~u~~Unsuitable ~~m~~Material may be required if approved by Project Manager~~;~~.

1. Even though Contractor has not determined material to be unsuitable, or

2. If unstable trench bottom is encountered and an adequate ground water control system is installed and operating according to Section 01578 - Control of Ground and Surface Water.

D. Place ~~t~~Trench ~~d~~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 ~~t~~Trench ~~d~~Dams closer than 5 feet from manholes.

3.08 PIPE EMBEDMENT, PLACEMENT, AND COMPACTION

A. Remove loose, sloughing, caving, or otherwise unsuitable soil from bottoms and sidewalls of trenches immediately prior to placement of embedment materials.

B. Place embedment including bedding, ~~h~~Haunching, and ~~i~~Initial ~~b~~Backfill as shown on Drawings.

C. For pipe installation, manually spread embedment materials around pipe to provide uniform bearing and side support when compacted. Protect flexible pipe from damage during placing of pipe zone bedding material. Perform placement and compaction directly against undisturbed soils in trench sidewalls, or against sheeting which is to remain in place.

D. Do not place ~~t~~Trench ~~s~~Shields or shoring within height of ~~e~~Embedment ~~z~~Zone unless means to maintain density of compacted embedment material are used. If moveable supports are used in ~~e~~Embedment ~~z~~Zone, lift supports incrementally to allow placement and compaction of material against undisturbed soil.

E. Place geotextile to prevent particle migration from in-situ soil into open-graded (Class I) embedment materials or drainage layers.

F. Do not damage coatings or wrappings of pipes during backfilling and compacting operations. When embedding coated or wrapped pipes, do not use crushed stone or other sharp, angular aggregates.

G. Place ~~h~~Haunching material manually around pipe and compact it to provide uniform bearing and side support. If necessary, hold small-diameter or lightweight pipe in place during compaction of haunch areas and placement beside pipe with sand bags or other suitable means.

H. Place electrical conduit, if used, directly on foundation without bedding.

I. Shovel in-place and compact embedment material using pneumatic tampers in restricted areas, and vibratory-plate compactors or engine-powered jumping jacks in unrestricted areas. Compact each lift before proceeding with placement of next lift. Water tamping is not allowed.

J. For water lines construction embedment, use bank run sand, concrete sand, gem sand, pea gravel, or crushed limestone as specified in Section 02320 - Utility Backfill Material. Adhere to the following subparagraph numbers 1 and 2.

1. Class I, II and III Embedment Materials:

   a. Maximum 6-inches compacted lift thickness.

   b. Compact to achieve minimum of 95 percent of maximum dry density as determined according to ASTM D 698.

   c. Moisture content to be within -3 percent to +5 percent of optimum as determined according to ASTM D 698, unless otherwise approved by Project Manager.

2. Cement Stabilized Sand (where required for special installations):

   a. Maximum 6-inches compacted thickness.

   b. Compact to achieve minimum of 95 percent of maximum dry density as determined according to ASTM D 698.

   c. Moisture content to be on dry side of optimum as determined according to ASTM D 698 but sufficient for effective hydration.

K. For Sanitary Sewers adhere to subparagraph number 1 and 2. For Storm Sewers provide cement stabilized sand Embedment ~~-~~per paragraph 2. ~~This provision does not apply to Storm Sewers constructed of HDPE pipe installed under pavement.~~

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 pipe to meet deflection test criteria.

c. Moisture content as determined by Contractor for effective compaction without softening 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 minimum of 95 percent of 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 dry side of optimum as determined according to ASTM D 558 but sufficient for effective hydration

~~L. For Storm Sewers constructed of any flexible pipe product and installed under pavement provide flowable fill pipe embedment as specified in Section 02322 – Flowable Fill.~~

~~M.~~L. Place ~~t~~Trench ~~d~~Dams in Class I embedment in line segments longer than 100 feet between manholes, and not less than one in every 500 feet of pipe placed. Install additional dams as needed to achieve workable construction conditions. Do not place ~~t~~Trench ~~d~~Dams closer than 5 feet from manholes.

3.09 TRENCH ZONE BACKFILL PLACEMENT AND COMPACTION

A. Place ~~b~~Backfill for pipe or conduits and restore surface as soon as practicable. Leave only minimum length of trench open as necessary for construction.

B. For water lines, under pavement and to within one foot back of curb, use ~~b~~Backfill materials described below:

1. For water lines 20-inches in diameter and smaller, use bank run sand or select ~~b~~Backfill materials up to pavement base or subgrade.

2. For water lines 24-inches in diameter and larger, ~~b~~Backfill with suitable on-site material (random ~~b~~Backfill) up to 12-inches below pavement base or subgrade. Place minimum of 12-inches of select ~~b~~Backfill below pavement base or subgrade.

C. For sewer pipes (Storm and Sanitary), use ~~b~~Backfill materials described by trench limits. For "~~t~~Trench ~~z~~Zone ~~b~~Backfill" under pavement and to within one foot back of curb, use cement stabilized sand for pipes of nominal sizes 36-inches in diameter and smaller to level 12 inches below the pavement. For sewer pipes 42-inches in diameter and larger, under pavement or natural ground, backfill from 12-inches above top of pipe to 120 inches below pavement with suitable on-site material or ~~s~~Select ~~b~~Backfill. Use select ~~b~~Backfill for rigid pavements or flexible base material for asphalt pavements for 12-inch ~~b~~Backfill directly under pavement. For ~~b~~Backfill ~~m~~Materials reference Section 02320 - Utility Backfill Materials. ~~This provision does not apply where a Storm Sewer is constructed of any flexible pipe product.~~

~~D. For Storm Sewers constructed of any flexible pipe product and installed under pavement provide flowable fill as specified in Section 02322 - Flowable Fill. For Storm Sewers constructed of any flexible pipe product and not installed under pavement provide cement stabilized sand.~~

D. For Storm Sewers constructed of thermoplastic pipe Backfill shall not exceed 20 ft. in depth from the top of pipe to the pavement surface/-ground surface.

E. Unless otherwise shown in the plans or permitted in writing, do not use heavy earth-moving equipment over the structure until a minimum of 4 ft. of permanent or temporary compacted fill is placed over the top of the structure.

~~E.~~F. Where damage to completed pipe installation work is likely to result from withdrawal of sheeting, leave sheeting in place. Cut off sheeting 1.5 ~~-~~feet or more above crown of pipe. Remove trench supports within 5 ~~-~~feet from ground surface.

~~F.~~G. Compaction: Unless otherwise shown on Drawings, ~~. U~~use ~~one of the following~~ ~~t~~Trench ~~z~~Zone ~~b~~Backfills under pavement and to within one foot of edge of pavement as required in 3.09. B, 3.09.C and 3.09.D. Place ~~t~~Trench ~~z~~Zone ~~b~~Backfill in lifts and compact. Fully compact each lift before placement of next lift.

1. Class I, II, or III or combination thereof:

   a. Place in maximum 12-inch thick loose layers.

   b. Compact by vibratory equipment to minimum of 95 percent of maximum dry density determined according to ASTM D 698.

   c. Moisture content within zero percent to 5 percent above optimum determined according to ASTM D 698, unless otherwise approved by Project Manager.

2. Cement-Stabilized Sand:

   a. Maximum lift thickness determined by Contractor to achieve uniform placement and required compaction, but do not exceed 12-inches.

b. Compact by vibratory equipment to minimum of 95 percent of maximum dry density determined according to ASTM D 558.

c. Moisture content on dry side of optimum determined according to ASTM D 558 but sufficient for cement hydration.

3. Class IVA and IVB (Clay Soils):

a. Place in maximum 8-inch thick loose lifts.

b. Compaction by vibratory Sheepfoot roller to minimum of 95 percent of maximum dry density determined according to ASTM D 698.

c. Moisture content within zero percent to 5 percent above optimum determined according to ASTM D 698, unless approved by Project Manager.

~~G.~~H. Unless otherwise shown on Drawings, for trench excavations not under pavement, random backfill of ~~s~~Suitable ~~m~~Material may be used in ~~t~~Trench ~~z~~Zone. This provision does not apply to flexible pipe used for storm sewers.

1. Fat clays (CH) may be used as ~~t~~Trench ~~z~~Zone ~~b~~Backfill outside paved areas at Contractor's option. When required density is not achieved, at any additional cost to City, rework, dry out, use lime stabilization or other approved methods to achieve compaction requirements, or use different ~~s~~Suitable ~~m~~Material.

2. Maximum 9-inch compacted lift thickness for clayey soils and maximum 12-inch lift thickness for granular soils.

3. Compact to minimum of 90 percent of maximum dry density determined according to ASTM D 698.

4. Moisture content as necessary to achieve density.

~~H.~~I. For electric conduits, remove form work used for construction of conduits before placing ~~t~~Trench ~~z~~Zone ~~b~~Backfill.

3.10 MANHOLES, JUNCTION BOXES AND OTHER PIPELINE STRUCTURES

A. Below paved areas or where shown on Drawings, encapsulate manhole with cement stabilized sand; minimum of 2 foot below base, minimum 2 foot around walls, up to pavement subgrade or natural ground. Compact in accordance with Paragraph 3.09.F.2 of this Section.

B. In unpaved areas, use select fill for backfill. Existing material that qualifies as select material may be used, unless indicated otherwise on Drawings. Deposit ~~b~~Backfill in uniform layers and compact each layer as specified. Maintain ~~b~~Backfill ~~m~~Material at no less than 2 percent below nor more than 5 percent above optimum moisture content, unless otherwise approved by Project Manager. Place fill material in uniform 8-inch maximum loose layers. Compact fill to at least 95 percent of maximum Standard Proctor Density according to ASTM D 698.

C. For LDWL projects, encapsulate manhole with cement stabilized sand; minimum of 1 foot below base, minimum of 2 feet around walls, up to within 12~~-~~ inches of pavement subgrade or natural ground. For manholes over water line, extend encapsulation to bottom of trench. Compact in accordance with Paragraph 3.09 F.2 of this Section.

3.11 FIELD QUALITY CONTROL

A. Test for material source qualifications as defined in Section 02320 - Utility Backfill Materials.

B. Provide excavation and trench safety systems at locations and to depths required for testing and retesting during construction at no additional cost to City.

C. Tests will be performed on 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 noticeable change in material gradation or plasticity, or when requested by Project Manager.

D. At least three tests for moisture-density relationships will be performed initially for ~~b~~Backfill materials in accordance with ASTM D 698, and for cement~~-~~stabilized sand in accordance with ASTM D 558. Perform additional moisture-density relationship tests once a month or whenever there is noticeable change in material gradation or plasticity.

E. In-place density tests of compacted ~~p~~Pipe ~~f~~Foundation, embedment and ~~t~~Trench ~~z~~Zone ~~b~~Backfill soil materials will be performed according to ASTM D 1556 or ASTM D 6938, and at following frequencies and conditions~~.~~:

1. For open cut construction projects and auger pits: Unless otherwise approved by Project Manager, successful compaction to be measured by one test per 40 linear feet measured along pipe for compacted embedment and two tests per 40 linear feet measured along pipe for compacted ~~t~~Trench ~~z~~Zone ~~b~~Backfill material. Length of auger pits to be measured to arrive at 40 linear feet.

2. A minimum of three density tests for each full shift of Work.

3. Density tests will be distributed among placement areas. Placement areas are: foundation, outer bedding, ~~h~~Haunching, ~~i~~Initial ~~b~~Backfill and ~~t~~Trench ~~z~~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 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 acceptance criteria. Placement will be rejected unless both verification tests show acceptable results.

7. Recompacted placement will be retested at same frequency as first test series, including verification tests.

8. Identify elevation of test with respect to natural ground or pavement.

F. Recondition, re-compact, and retest at Contractor's expense if tests indicate Work does not meet specified compaction requirements. For hardened soil cement with nonconforming density, core and test for compressive strength at Contractor's expense.

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

3.12 DISPOSAL OF EXCESS MATERIAL

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

END OF SECTION

SECTION 02318

EXTRA UNIT PRICE WORK FOR EXCAVATION AND BACKFILL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Measurement and payment applicable to extra unit price work items for excavation and backfill made necessary by unusual or unforeseen circumstances encountered during utility installations.

B. Extra unit price work for excavation and backfill is paid only when authorized in advance by Project Manager.

1.02 ~~REALATED~~RELATED SECTIONS

A. Section 01270 – Measurement and Payment

B. Section 02316 – Excavation and Backfill for Structures

C. Section 02317 – Excavation and Backfill for Utilities

D. Section 02320 – Utility Backfill Materials

1.03 MEASUREMENT AND PAYMENT

A. UNIT PRICES

1. Excavation Around Obstructions: Payment for ~~e~~Excavation ~~a~~Around ~~o~~Obstructions is on cubic yard basis, measured in place, without deduction for volume occupied by portions of pipes, ducts, or other structures left in place across trenches excavated under this item.

2. Extra Hand Excavation: Payment for ~~e~~Extra ~~h~~Hand ~~e~~Excavation is on cubic yard basis, measured in place.

3. Extra Machine Excavation: Payment for ~~e~~Extra ~~m~~Machine ~~e~~Excavation is on cubic yard basis, measured in place.

4. Extra Placement of Backfill Material: Payment for ~~e~~Extra ~~p~~Placement of ~~b~~Backfill ~~m~~Material is on cubic yard basis, measured in place, for material installed as part of Work. At discretion of Project Manager, measurement of cubic yards may be calculated from volume of Extra Hand Excavation or Extra Machine Excavation for which replacement is made, minus volume of any Extra Placement of Granular Backfill authorized in conjunction with Work.

5. Extra Placement of Granular Backfill: Payment for ~~e~~Extra ~~p~~Placement of ~~g~~Granular ~~b~~Backfill material is on cubic yard basis, measured in place.

6. Extra Select Backfill: Payment for ~~e~~Extra ~~s~~Select ~~b~~Backfill is on cubic yard basis, measured in place for a theoretical minimum trench width. The ~~p~~Project Manager may authorize ~~e~~Extra ~~s~~Select ~~b~~Backfill when soil from the excavation work does not include adequate quantities for placement of suitable on-site material (random backfill).

7. Refer to Section 01270 – Measurement and payment for unit price procedures.

1.04 DEFINITIONS

A. Excavation Around Obstructions: Excavation necessitated by obstruction of pipes (other than service connections 3 inches in diameter or less), ducts, or other structures, not shown on Drawings, and of an unusual or unforeseen nature which interfere with installation of utility piping by normal methods of excavation or auguring.

B. Extra Hand Excavation: Excavation by manual labor made necessary by unusual or unforeseen circumstances at locations approved in advance by Project Manager.

C. Extra Machine Excavation: Excavation by machine at or near project site to perform related work not included in original project scope but added for convenience of City, as approved in advance by Project Manager.

D. Extra Replacement of Backfill Material: Handling, backfill, and compaction of excavated material authorized under extra work bid items for Extra Hand Excavation or Extra Machine Excavation. Placement and compaction shall conform to requirements specified for excavation and backfill in Sections 02316 – Excavation and Backfill for Structures and 02317 – Excavation and Backfill for Utilities.

E. Extra Placement of Granular Backfill: Hauling, placing, and compacting granular backfill materials as approved by Project Manager in conjunction with Extra Replacement of Backfill Material. Materials placed under this item shall conform to requirements for Bank Run Sand, Cement Stabilized Sand, Concrete Sand, Gem Sand, Crushed Stone, or Crushed Concrete specified for backfill material in Sections 02316 – Excavation and Backfill for Structures and 02317 – Excavation and Backfill for Utilities.

F. Extra Select Backfill: Unsuitable material removed from the project and select backfill material hauled to the project, or conditioning unsuitable material on the site to make it select backfill. Provide select backfill material specified in Section 02320 – Utility Backfill Materials.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

SECTION 02319

BORROW

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Soil materials for embankment or backfill.

1.02 ~~REALTED~~RELATED SECTIONS

A. Section 01270 – Measurement and Payment

B. Section 01330 – Submittal Procedures

C. Section 01454 – Testing Laboratory Services

D. Section 01555 – Traffic Control and Regulation

E. Section 02330 – Embankment

1.03 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. Payment for borrow is on cubic yard basis calculated by theoretical quantities using average end area method based on Drawings.

2. Refer to Section 01270 - Measurement and Payment for unit price procedures.

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

1.04 REFERENCES

A. ASTM D 2216 - Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.

B. ASTM D 4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

1.05 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

B. Submit location and description of proposed borrow area for approval.

C. Submit material samples for testing.

PART 2 PRODUCTS

2.01 SOIL MATERIAL

A. Grade borrow material used for embankment or backfill free of lumps greater than 6 inches, rocks larger than 3 inches, organic material, chemical waste or other contamination, and debris. Take borrow material from sources approved by Project Manager.

B. Use material with plasticity index not less than 12, nor more than 20 when tested in accordance with ASTM D 4318. Maximum liquid limit shall be 45, unless approved by Project Manager. Do not use blend of cohesive and granular soils to achieve required plasticity index

PART 3 EXECUTION

3.01 PREPARATION

A. Notify Project Manager and testing laboratory 5 days in advance of opening borrow source to permit obtaining samples for qualification testing. When material does not meet specification requirements, locate another source of borrow.

B. Clear approved source area of trees, stumps, brush, roots, vegetation, organic matter, and other unacceptable material before excavation.

3.02 TESTS

A. Test and analyze soil materials in accordance with ASTM D 4318 and ASTM D 2216 under provisions of Section 01454 - Testing Laboratory Services.

3.03 EXCAVATION

A. Provide adequate drainage of surface water so that surface water run off does not enter borrow pit excavation.

3.04 HAULING

A. Use covered trucks. Conform to requirements of Section 01555 - Traffic Control and Regulation.

3.05 EMBANKMENT

A. Conform to requirements of Section 02330 - Embankment.

END OF SECTION

SECTION 02320

UTILITY BACKFILL MATERIALS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Material Classifications.

B. Utility Backfill Materials:

1. Concrete sand
2. Gem sand
3. Pea gravel
4. Crushed stone
5. Crushed concrete
6. Bank run sand
7. Select backfill
8. Random backfill
9. Cement stabilized sand

C. Material Handling and Quality Control Requirements.

1.02 RELATED SECTIONS

A. Section 01270 – Measurement and Payment

B. Section 01330 – Submittal Procedures

C. Section 01454 – Testing Laboratory Services

D. Section 02316 – Excavation and Backfill for Structures

E. Section 02317 – Excavation and Backfill for Utilities

F. Section 02318 – Extra Unit Price Work Price Work for Excavation and Backfill

G. Section 02321 – Cement Stabilized Sand

H. Section 02711 – Hot Mix Asphalt Base Course

I. Section 02712 – Cement Stabilized Base Course

J. Section 02713 – Recycled Crushed Concrete Base Course

K. Section 02951 – Pavement Repair and Restoration

L. Section 03315 – Concrete for Utility Construction

1.03 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. No payment will be made for backfill material. Include payment in unit price for applicable utility installation.

2. Payment for backfill material, when included as separate pay item or when directed by Project Manager, is on cubic yard basis for material placed and compacted within theoretical trench width limits and thickness of material according to Drawings, or as directed by Project Manager.

3. Payment for backfill of authorized over-excavation is in accordance with Section 02318 - Extra Unit Price Work for Excavation and Backfill.

4. Refer to Section 01270 - Measurement and Payment for unit price procedures.

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

1.04 DEFINITIONS

A. Unsuitable Material:

1. Materials classified as ML, CL-ML, MH, PT, OH, and OL according to ASTM D 2487.

2. Materials that cannot be compacted to required density due to gradation, plasticity, or moisture content.

3. Materials containing large clods, aggregates, or stones greater than 4 inches in any dimension; debris, vegetation, or waste; or any other deleterious materials.

4. Materials contaminated with hydrocarbons or other chemical contaminants.

B. Suitable Material:

1. Materials meeting specification requirements.

2. Unsuitable materials meeting specification requirements for suitable soils after treatment with lime or cement.

C. Foundation Backfill Materials: Natural soil or manufactured aggregate meeting Class I requirements and geotextile filter fabrics as required, to control drainage and material separation. Foundation backfill material is placed and compacted as backfill where needed to provide stable support for structure ~~f~~Foundation ~~b~~Base. Foundation ~~b~~Backfill ~~m~~Materials may include concrete fill and seal slabs.

D. Foundation Base: Crushed stone aggregate with filter fabric as required, cement stabilized sand, or concrete seal slab. Foundation ~~b~~Base provides smooth, level working surface for construction of concrete ~~f~~Foundation.

E. Backfill Material: Classified soil material meeting specified quality requirements for designated application as embedment or ~~t~~Trench ~~z~~Zone ~~b~~Backfill.

F. Embedment Material: Soil material placed under controlled conditions within embedment zone extending vertically upward from top of ~~f~~Foundation to an elevation 12 inches above top of pipe, and including pipe bedding, haunching and initial backfill.

G. Trench Zone Backfill: Classified soil material meeting specified quality requirements and placed under controlled conditions in trench zone from top of embedment zone to base course in paved areas or to surface grading material in unpaved areas.

H. Foundation: Either suitable soil of trench bottom or material placed as backfill of over- excavation for removal and replacement of unsuitable or otherwise unstable soils.

I. Source: Source selected by Contractor for supply of embedment or trench zone ~~b~~Backfill ~~m~~Material. Selected ~~s~~Source may be ~~p~~Project excavation, off-site borrow pits, commercial borrow pits, or sand and aggregate production or manufacturing plants.

J. Refer to Section 02317 - Excavation and Backfill for Utilities for other definitions regarding utility installation by trench construction.

1.05 REFERENCES

A. ASTM C 33 - Standard Specification for Concrete Aggregates.

B. ASTM C 40 - Standard Test Method for Organic Impurities in Fine Aggregates for Concrete.

C. ASTM C 123 - Standard Test Method for Lightweight Particles in Aggregate.

D. ASTM C 131 - Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in Los Angeles Machine.

E. ASTM C 136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.

F. ASTM C 142 - Standard Test Method for Clay Lumps and Friable Particles in Aggregates.

G. ASTM D 1140 - Standard Test Methods for Determining the Amount of Material Finer Than 75-µm (No. 200) Sieve in soils by Washing.

H. ASTM D 2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).

I. ASTM D 4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

~~J. ASTM D 4643 - Standard Test Method for Determination of Water Content of Soil and Rock by Microwave Oven Heating.~~

~~K.~~J. TxDOT Tex-110-E - Sieve Analysis of Soils and Base Materials~~Particle Size Analysis of Soils.~~

~~L.~~K. TxDOT Tex-460-A - Determining Crushed Face Particle count

1.06 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

B. Submit description of ~~s~~Source, material classification and product description, production method, and application of ~~b~~Backfill ~~m~~Materials.

C. Submit test results for samples of off-site ~~b~~Backfill ~~m~~Materials. Comply with Paragraph 2.03, Material Testing.

D. Before stockpiling materials, submit copy of approval from landowner for stockpiling ~~b~~Backfill ~~m~~Material on private property.

E. Provide delivery ticket which includes ~~s~~Source location for each delivery of material that is obtained from off-site ~~s~~Sources or is being paid as specific bid item.

1.07 ~~TESTS~~QUALITY ASSURANCE

A. Perform tests of ~~s~~Sources for ~~b~~Backfill ~~m~~Material in accordance with Paragraph 2.03B.

B. Verification tests of ~~b~~Backfill ~~m~~Materials may be performed by City in accordance with Section 01454 - Testing Laboratory Services and in accordance with Paragraph 3.03.

PART 2 PRODUCTS

2.01 MATERIAL CLASSIFICATIONS

A. Classify materials for backfill for purpose of quality control in accordance with Unified Soil Classification Symbols as defined in ASTM D 2487. Material use and application is defined in utility installation specifications and Drawings either by class, as described in Paragraph 2.01B, or by product descriptions, as given in Paragraph 2.02.

B. Class Designations Based on Laboratory Testing:

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: D60/D10 - 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 (GM, GP, SP, SM):

a. Plasticity index: non-plastic to 4.

b. Gradations:

(1) Gradation (GP, SP): amount passing No. 200 sieve - less than 5 percent.

(2) Gradation (GM, SM): amount passing No. 200 sieve - between 12 percent and 50 percent.

(3) 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:

(1) Plasticity index: greater than 7, and above A line.

(2) 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.

6. Use soils with dual class designation according to ASTM D 2487, and which are not defined above, according to more restrictive class.

2.02 PRODUCT DESCRIPTIONS

A. Soils classified as silt (ML) silty clay (CL-ML with PI of 4 to 7), elastic silt (MH), organic clay and organic silt (OL, OH), and organic matter (PT) are not acceptable as ~~b~~Backfill ~~m~~Materials. These soils may be used for site grading and restoration in unimproved areas as approved by Project Manager. Soils in Class IVB, fat clay (CH) may be used as ~~b~~Backfill ~~m~~Materials where allowed by applicable backfill installation specification. Refer to Section 02316 - Excavation and Backfill for Structures and Section 02317 - Excavation and Backfill for Utilities.

B. Provide ~~b~~Backfill ~~m~~Material that is free of stones greater than 6 inches, free of roots, waste, debris, trash, organic material, unstable material, non-soil matter, hydrocarbon or other contamination, conforming to 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.

C. Manufactured materials, such as crushed concrete, may be substituted for natural soil or rock products where indicated in product specification, and approved by Project Manager, provided that physical property criteria are determined to be satisfactory by testing.

D. Bank Run Sand: Durable bank run sand classified as SP, SW, or SM by Unified Soil Classification System (ASTM D 2487) meeting following requirements:

1. Less than 15 percent passing number 200 sieve when tested in accordance with ASTM D 1140. Amount of clay lumps or balls may not exceed 2 percent.

2. Material passing number 40 sieve shall meet the following requirements when tested in accordance with ASTM D 4318: Plasticity index: not exceeding 7.

E. Concrete Sand: Natural sand, manufactured sand, or combination of natural and manufactured sand conforming to requirements of ASTM C 33 and graded within following limits when tested in accordance with ASTM C 136:

Sieve	Percent Passing
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

F. Gem Sand: Sand conforming to 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:

Sieve	Percent Passing
3/8”	95 to 100
No. 4	60 to 80
No. 8	15 to 40

G. 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

H. Crushed Aggregates: Crushed aggregates consist of durable particles obtained from an approved ~~s~~Source and meeting the following requirements:

1. Materials of one product delivered for same construction activity from single ~~s~~Source, unless otherwise approved by Project Manager.

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 minimum of 90 percent of particles retained on No. 4 sieve with 2 or more crushed faces as determined by Tex-460-A, Part I.

5. Crushed stone: Produced from oversize plant processed stone or gravel, sized by crushing to predominantly angular particles from naturally occurring single ~~s~~Source. Uncrushed gravel is not acceptable materials for embedment where crushed stone is shown on 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 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 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

I. Select Backfill: Class III clayey gravel or sand or Class IV lean clay with plasticity index between 7 and 20 or clayey soils treated with lime in accordance with Section 02951 - Pavement Repair and Restoration to meet plasticity criteria.

J. Random Backfill: Any suitable soil or mixture of soils within Classes I, II, III and IV; or fat clay (CH) where allowed by applicable backfill installation specification. Refer to Section 02316 - Excavation and Backfill for Structures and Section 02317 - Excavation and Backfill for Utilities.

K. Cement Stabilized Sand: Conform to requirements of Section 02321 - Cement Stabilized Sand.

L. Concrete Backfill: Conform to Class B concrete as specified in Section 03315 - Concrete for Utility Construction.

M. Flexible Base Course Material: Conform to requirements of applicable portions of Section 02711 - Hot Mix Asphaltic Base Course, Section 02712 - Cement Stabilized Base Course, and Section 02713 - Recycled Crushed Concrete Base Course.

2.03 MATERIAL TESTING

A. Source Qualification. Perform testing to obtain tests by suppliers for selection of material ~~s~~Sources and products not from the ~~p~~Project site. Test samples of processed materials from current production representing material to be delivered. Use tests to verify that materials meet specification requirements. Repeat qualification test procedures each time ~~s~~Source characteristics change or there is planned change in ~~s~~Source location or supplier. Include the following qualification tests, as applicable:

1. Gradation. Report complete sieve analyses regardless of specified control sieves from largest particle through No. 200 sieve.

2. Plasticity of material passing No. 40 sieve

3. Los Angeles abrasion wear of material retained on No. 4 sieve

4. Clay lumps

5. Lightweight pieces

6. Organic impurities

B. Production Testing. Provide reports to Project Manager from an independent testing laboratory that ~~b~~Backfill ~~m~~Materials to be placed in Work meet applicable specification requirements.

C. Assist Project Manager in obtaining material samples for verification testing at ~~s~~Source or at production plant.

PART 3 EXECUTION

3.01 SOURCES

A. Use of existing material in trench excavations is acceptable, provided applicable specification requirements are satisfied.

B. Identify off-site ~~s~~Sources for ~~b~~Backfill ~~m~~Materials at least 14 days ahead of intended use so that Project Manager may obtain samples for verification testing.

C. Materials may be subjected to inspection or additional verification testing after delivery. Materials which do not meet requirements of specifications 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 material is approved by Project Manager, expense for sampling and testing required to change to different material will be credited to City through change order.

D. Bank run sand, select backfill, and random backfill, if available in ~~p~~Project excavation, may be obtained by selective excavation and acceptance testing. Obtain additional quantities of these materials and other materials required to complete ~~w~~Work from off-site ~~s~~Sources.

E. City does not represent or guarantee that any soil found in excavation work will be suitable and acceptable as ~~b~~Backfill ~~m~~Material.

3.02 MATERIAL HANDLING

A. When ~~b~~Backfill ~~m~~Material is obtained from either commercial or non-commercial borrow pit, open pit to expose vertical faces of various strata for identification and selection of approved material to be used. Excavate selected material by vertical cuts extending through exposed strata to achieve uniformity in product.

B. Establish temporary stockpile locations for practical material handling, control, and verification testing by Project Manager in advance of final placement. Obtain approval from landowner for storage of ~~b~~Backfill ~~m~~Material on adjacent private property.

C. When stockpiling ~~b~~Backfill ~~m~~Material near ~~p~~Project site, use appropriate covers to eliminate blowing of materials into adjacent areas and prevent runoff containing sediments from entering drainage system.

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

3.03 FIELD QUALITY CONTROL

A. Quality Control

1. The Project Manager 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 Work.

2. The Project Manager may re-sample material at any stage of ~~w~~Work or location if changes in characteristics are apparent.

B. Production Verification Testing: City's testing laboratory will provide verification testing on ~~b~~Backfill ~~m~~Materials, as directed by Project Manager. Samples may be taken at ~~s~~Source or at production plant, as applicable.

END OF SECTION

SECTION 02321

CEMENT STABILIZED SAND

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Cement stabilized sand.

1.02 RELATED SECTIONS

A. Section 01270 – Measurement and Payment

B. Section 01330 - Submittal Procedures

C. Section 01454 – Testing Laboratory Services

D. Section 02320 – Utility Backfill Materials

1.03 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. No separate payment will be made for work performed under this Section. Include cost of such work in Contract unit prices for items listed in bid form requiring cement stabilized sand.

2. Refer to Paragraph 3.04 for material credit.

3. Refer to Section 01270 - Measurement and Payment for unit price procedures.

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

1.04 REFERENCES

A. ASTM C 33 - Standard Specification for Concrete Aggregates.

B. ASTM C 40 - Standard Test Method for Organic Impurities in Fine Aggregates for Concrete.

C. ASTM C 42 - Standard Test Methods for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.

D. ASTM C 94 - Standard Specification for Ready-Mixed Concrete.

E. ASTM C 123 - Standard Test Method for Lightweight Particles in Aggregate.

F. ASTM C 142 - Standard Test Method for Clay Lumps and Friable Particles in Aggregates.

G. ASTM C 150 - Standard Specification for Portland Cement.

H. ASTM D 558 - Standard Test Method for Moisture-Density (Unit Weight) Relations of Soil-Cement Mixtures.

I. ASTM D 1632 - Standard Practice for Making and Curing Soil-Cement Compression and Flexure Test Specimens in the Laboratory.

J. ASTM D 1633 - Standard Test Method for Compressive Strength of Molded Soil-Cement Cylinders.

K. ASTM D 2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).

L. ASTM D 3665 - Standard Practice for Random Sampling of Construction Materials.

M. ASTM D 4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

~~N. STM D 6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)~~

1.05 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

B. Submit proposed target cement content and production data for sand-cement mixture in accordance with requirements of Paragraph 2.03, Materials Qualifications.

1.06 DESIGN REQUIREMENTS

A. Use sand-cement mixture producing minimum unconfined compressive strength of 100 pounds per square inch (psi) in 48 hours.

1. Design will be based on strength specimens molded in accordance with ASTM D 558 at moisture content within 3 percent of optimum and within 4 hours of batching.

2. Determine minimum cement content from production data and statistical history. Provide no less than 1.1 sacks of cement per ton of dry sand.

PART 2 PRODUCTS

2.01 MATERIALS

A. Cement: Type I Portland cement conforming to ASTM C 150.

B. Sand: Clean, durable sand meeting grading requirements for fine aggregates of ASTM C 33, or requirements for bank run sand of Section 02320 - Utility Backfill Materials, and the following requirements:

1. Classified as SW, SP, SW-SM, SP-SM, or SM by Unified Soil Classification System of ASTM D 2487.

2. Deleterious materials:

a. Clay lumps, ASTM C 142 - less than 0.5 percent.

b. Lightweight pieces, ASTM C 123; less than 5.0 percent.

c. Organic impurities, ASTM C 40, color no darker than standard color.

3. Plasticity index of 4 or less when tested in accordance with ASTM D 4318.

C. Water: Potable water, free of oils, acids, alkalies, organic matter or other deleterious substances, meeting requirements of ASTM C 94.

2.02 MIXING MATERIALS

A. Add required amount of water and mix thoroughly in pugmill-type mixer.

B. Stamp batch ticket at plant with time of loading. Reject material not placed and compacted within 4 hours after mixing.

2.03 ~~MATERIAL QUALIFICATION~~SOURCE QUALITY CONTROL

A. Determine target cement content of material as follows:

1. Obtain samples of sand-cement mixtures at production facility representing range of cement content consisting of at least three points.

2. Complete molding of samples within 4 hours after addition of water.

3. Perform compressive strength tests (average of two specimens) at 48 hours and 7 days.

4. Perform cement content tests on each sample.

5. Perform moisture content tests on each sample.

6. Plot average 48-hour strength vs. cement content.

7. Record scale calibration date, sample date, sample time, molding time, cement feed dial settings, and silo pressure (if applicable).

B. Test raw sand for following properties at point of entry into pug-mill:

1. Gradation

2. Plasticity index

3. Organic impurities

4. Clay lumps and friable particles

5. Lightweight pieces

6. Moisture content

7. Classification

C. Present data obtained in format similar to that provided in sample data form attached to this Section.

D. The target content may be adjusted when statistical history so indicates. For determination of minimum product performance use formula:

f'c% 1/2 standard deviation

PART 3 EXECUTION

3.01 PLACING

A. Place sand-cement mixture in maximum 12-inch-thick loose lifts and compact to 95 percent of maximum density as determined in accordance with ASTM D 558, unless otherwise specified. Refer to related specifications for thickness of lifts in other applications. Target moisture content during compaction is +3 percent of optimum. Perform and complete compaction of sand-cement mixture within 4 hours after addition of water to mix at plant.

B. Do not place or compact sand-cement mixture in standing or free water.

C. Where potable water lines cross wastewater line, embed wastewater line with cement stabilized sand in accordance with Texas Administrative Code §290.44(e)(4)(B):

1. Provide minimum of 10% cement per cubic yard of cement stabilized sand mixture, based on loose dry weight volume. Use at least 2.5 bags of cement per cubic yard of mixture (2 sacks per ton of dry sand).

2. Unless otherwise shown on Drawings, embed wastewater main or lateral minimum of six inches above and below.

3. Use brown coloring in cement stabilized sand for wastewater main or lateral bedding for identification of pressure rated wastewater mains during future construction.

3.02 FIELD QUALITY CONTROL

A. Testing will be performed under provisions of Section 01454 - Testing Laboratory Services.

B. 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 ~~stabililized~~ 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.

C. Prepare and mold four specimens (for each sample obtained) in accordance with ASTM D 558, 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.

D. After molding, specimens will be removed from molds and cured in accordance with ASTM D 1632.

E. 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.

F. 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.

G. Precision and Bias: Test results shall meet recommended guideline for precision in ASTM D 1633 ~~Section 9~~.

H. 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.

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 Contractor's 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 Contractor's 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 ~~that~~ 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.

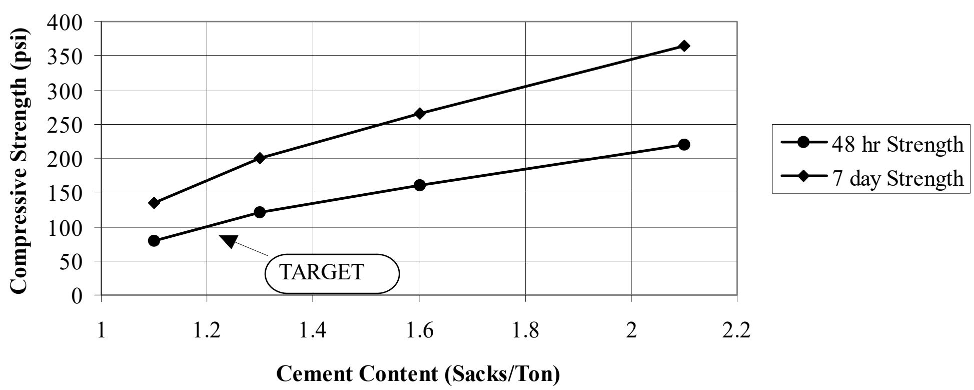
Supplier: City Stabilized Sand	Plant No: 1 - Main Street	Date of Tests: January 1, 1997

Item	Raw Sand	1.1 Sack	100 psi	1.5 Sack	2.0 Sack
Moisture Content	10.9	15.7	14.0	13.8	13.7
Cement Feed Dial Setting	--	2.25	2.5	2.75	3.75
Silo Pressure (psi)	--	4	4	4	4
Batch Time	10:00	10:10	10:15	10:20	10:25
Sample Time	--	10:10	10:15	10:20	10:25
Molding Time	--	12:30	12:45	1:00	1:15
Cement Content (sacks/ton)	--	1.1	1.3	1.6	2.1
Compressive Strength at 48 hrs. (avg of 2)	--	80	120	160	220
Compressive Strength at 7 days (avg of 2)	--	135	200	265	365

Sieve size	Percent Passing	COH Spec. Section 02320
3/8 Inch	100	--
No. 16	100	--
No. 40	100	--
No. 50	99	--
No. 100	41	--
No. 200	11	0 to 15

Raw Sand Tests	Result	City of Houston
Plasticity Index	Non-Plastic	4 Maximum
Organic Impurities	Passing	No Darker Than
Clay Lumps & Friable Parts (%)	0.0	0.5 % Maximum
Lightweight Pieces (%)	0.0	5.0 % Maximum
Classification	SP-SM	SW, SP, SW-SM, SP-SM, SM

Compressive Strength vs Cement Content



END OF SECTION

SECTION 02322

FLOWABLE FILL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. ~~Flowable Fill for f~~Furnishing, mixing, transporting and placing flowable fill.

1.02 RELATED SECTIONS

A. Section 01270 – Measurement and Payment

B. Section 01330 – Submittal Procedures

C. Section 01454 – Testing Laboratory Services

D. Section 02120 – Off-Site Transportation and Disposal

1.03 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. No separate payment will be made for flowable fill under this Section. Include cost in unit prices for work, as specified in Section 01270 – Measurement and Payment.

1.04 REFERENCES

A. ASTM C 31 – Standard Practice for Making and Curing Concrete Test Specimens in the ~~f~~Field.

B. ASTM C 39 – Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.

C. ASTM C 40 – Standard Test Method for Organic Impurities in Fine Aggregates for Concrete.

D. ASTM C 94 - Standard Specification for Ready-Mixed Concrete.

E. ASTM C 150 - Standard Specification for Portland Cement.

~~F. ASTM C 192 – Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.~~

~~G.~~F. ASTM C 260 – Standard Specification for Air-Entraining Admixtures for Concrete.

~~H.~~G. ASTM C 494 - Standard Specification for Chemical Admixtures for Concrete.

~~I.~~H. ASTM C 618 – Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.

~~J.~~I. ASTM D 4318 – Standard Test Methods for Liquid Limit, Plastic Limit and Plasticity Index of Soils.

1.05 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures

B. Submit proposed mix design

C. Submit a copy of delivery tickets accompanied by batch tickets, providing the information required by ASTM C 94 to ~~Engineer~~Project Manager in the field at time of delivery.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide material conforming to:

1. Cement- ASTM C 150, Type I.

2. Fly Ash – ASTM C 618, Class C, with a minimum CaO content of 20 percent.

3. Water- ASTM C 94.

4. Fine Aggregate – Natural or manufactured fine aggregate, or a combination there of, free from deleterious amounts of salt, alkali, vegetable matter or other objectionable material. The plasticity index shall be 4 or less when tested in accordance with ASTM D 4318. Organic impurities, when tested in accordance with ASTM C 40, shall not show a color darker than the standard color. It is intended that the fine aggregate be fine enough to stay in suspension in the mortar to the extent required for proper flow. The fine aggregate shall conform to the following gradation:

Sieve Size	Percent Passing
3/8 inch	100
No. 200	0-10

5. If flowable mixture cannot be produced, the fine aggregate may not be approved.

6. Admixtures – ASTM C 260 and /or C 494.

2.02 MIX DESIGN

A. Mix design shall state the following information:

1. Mix design number or code designation to order the concrete from the supplier.

2. Design strength at 7 days (unless otherwise noted on the Plans).

3. Cement type and brand.

4. Fly ash type and brand.

5. Admixtures type and brand.

6. Proportions of each material used.

B. Minimum strength requirement is 100 psi in 7 days unless otherwise noted on the Plans.

PART 3 EXECUTION

3.01 BATCHING, MIXING AND TRANSPORTATION

A. Batch, mix and transport flowable fill in accordance with ASTM C 94, except when directed otherwise by the ~~Engineer~~Project Manager.

B. Mix flowable fill in quantities required for immediate use. Do not use portions which have developed initial set or which are not in place within 90 minutes after the initial water has been added.

C. Do not mix flowable fill while the air temperature is at or below 35 degrees F. without prior approval of the ~~Engineer~~Project Manager.

3.02 PLACEMENT

A. Seal off the area to be repaired.

B. Monitor and control the fluid pressure during placement of flowable fill prior to set. Take appropriate measures to avoid excessive pressure that may damage or displace structures or cause flotation. Cease operations if flowable fill is observed leaking from the repair area. Repair or replace damaged or displaced structures at no additional cost.

3.03 TESTING AND INSPECTION

A. Refer to Section 01454 – Testing Laboratory Services.

3.04 CLEAN UP

A. Clean up excess flowable fill discharged from the work area and remove excess flowable fill from pipes at no additional cost.

B. Refer to Section 02120 – Off-Site Transportation and Disposal.

END OF SECTION

SECTION 02330

EMBANKMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Construction of embankments with excess excavated material and borrow.

1.02 RELATED SECTIONS

A. Section 01270 – Measurement and Payment

B. Section 01454 – Testing Laboratory Services

C. Section 01576 – Waste Material Disposal

D. Section 02315 – Roadway Excavation

E. Section 02316 – Excavation and Backfill for Structures

F. Section 02317 – Excavation and Backfill for Utilities

G. Section 02319 – Borrow

H. Section 02320 – Utility Backfill Materials

I. Section 02511 – Water Lines

J. Section 02531 – Gravity Sanitary Sewers

K. Section 02532 – Sanitary Sewer Force Mains

1.03 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. No separate payment will be made for embankment under this section. Include payment in unit price for excavation or borrow.

2. Refer to Section 01270 - Measurement and Payment for unit price procedures.

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

1.04 REFERENCES

A. ASTM D 698 - Standard Test Methods for Laboratory Compaction Characteristics of Soils Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)).

B. ASTM D 6938 - Standard ~~Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete~~ Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

PART 2 PRODUCTS`

2.01 MATERIALS

A. Refer to Section 02315 - Roadway Excavation for acceptable excess materials from roadway excavation.

B. Refer to Section 02317 - Excavation and Backfill for Utilities for acceptable excess materials from utility excavation and trenching.

C. Refer to Section 02319 - Borrow for acceptable borrow materials.

PART 3 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.

3.02 PREPARATION

A. Backfill test pits, stump holes, small swales and other surface irregularities. Backfill and compact in designated lift depths to requirements for embankment compaction.

B. Record location and plug and fill inactive water and oil wells. Conform to Texas State Health Department, Texas Commission on Environmental Quality and Texas Railroad Commission requirements. Notify City Engineer prior to plugging wells.

C. Excavate and dispose of unsuitable soil and other unsuitable materials which will not consolidate. Backfill and compact to requirements for embankment. Unsuitable soil is defined in Section 02316 - Excavation and Backfill for Structures and Section 02320 - Utility Backfill Materials.

D. Backfill new utilities below future grade. Conform to requirements of Sections 02317 - Excavation and Backfill For Utilities, 02511 - Water Lines, 02531 - Gravity Sanitary Sewers, and 02532 - Sanitary Sewer Force Mains.

3.03 PROTECTION

A. Protect trees, shrubs, lawns, existing structures, and other features outside of embankment limits.

B. Protect utilities above and below grade, which are to remain.

C. Conform to protection requirements of Section 02315 - Roadway Excavation.

3.04 PLACING EMBANKMENT

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

B. Do not place embankment fill until density and moisture content of previously placed material comply with specified requirements.

C. Scarify areas to be filled to minimum depth of 4 inches to bond existing and new materials. Mix with first fill layer.

D. Spread fill 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, disking or other approved method. Extend each layer across full width of fill.

E. Each layer shall be homogeneous and contain uniform moisture content before compaction. Mix dissimilar abutting materials to prevent abrupt changes in composition of fill.

F. Layers shall not exceed the following compacted thickness:

1. Areas indicated to be under future paving or shoulders, to be constructed within 6 months: 6 inches when compacted with pneumatic rollers, or 8 inches when compacted with other rollers.

2. Other areas: 12 inches

G. For steep slopes, cut benches into slope and scarify before placing fill. Place increasingly wider horizontal layers of specified depth to 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 4 inches and recompact with next fill layer.

I. Construct to lines and grades shown on Drawings.

J. Remove unsuitable material and excess soil not being used for embankment from site in accordance with requirements of Section 01576 - Waste Material Disposal.

K. Maintain moisture content of embankment materials to attain required density.

L. Compact to following minimum densities at moisture content of optimum to 3 percent above optimum as determined by ASTM D 698, unless otherwise indicated on 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.

3.05 TOLERANCES

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

3.06 FIELD QUALITY CONTROL

A. Compaction Testing will be performed in accordance with ASTM D 698 or ASTM D 6938 under provisions of Section 01454 - Testing Laboratory Services.

B. A minimum of three tests will be taken for each 1000 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, recompact, and retest at no cost to City.

END OF SECTION

SECTION 02336

LIME STABILIZED SUBGRADE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Foundation course of lime stabilized subgrade material.

1. Application of lime slurry to subgrade.

2. Mixing, compaction, and curing of lime slurry, water, and subgrade into a stabilized foundation.

1.02 RELATED SECTIONS

A. Section 01270 – Measurement and Payment

B. Section 01330 – Submittal Procedures

C. Section 01454 – Testing Laboratory Services

1.03 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. Measurement and payment for lime stabilized subgrade is on a square yard basis compacted in place to proper density. Separate measurement will be made for each required thickness of subgrade course.

   a. 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 lime stabilized subgrade material that extends 2 f~~oo~~eet 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 lime stabilized subgrade in areas beyond these limits.

   b. Limits of measurement and payment shall match pavement replacement limits shown on Drawings, except as noted in Paragraph 1.0~~2~~3.A.1.a, or as approved by Project Manager.

2. Measurement and payment for lime is by ton of 2000 pounds dry weight basis. Calculate weight of dry solids for lime slurry based on percentage by dry weight solids.

3. Refer to Section 01270 - Measurement and Payment for unit price procedures.

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

1.04 DEFINITION

A. Moist Cure: Curing soil and lime to obtain optimum hydration.

B. 1000-Foot Roadway Section: 1000 feet per lane width or approximately 500 square yards of compacted subgrade for other than full-lane-width roadway sections.

1.05 REFERENCES

A. ASTM D 698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3).

B. ASTM D 4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

C. ASTM D 6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

D. TxDOT Tex-101-E (Part III) - Preparing and Testing Soils and ~~Flexible~~ Base Materials~~ for Testing~~.

E. TxDOT Tex-140-E - Measuring Depth of Compacted Base and Treated Materials.~~Thickness of Pavement Layer.~~

F. TxDOT Tex-600-J - Sampling and Testing Hydrated Lime, Quicklime, and Commercial Lime Slurry.

1.06 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

B. Submit certification that hydrated lime, quicklime, or commercial lime slurry complies with specifications.

C. Submit weight tickets, certified by supplier, with each bulk delivery of lime to work site.

1.07 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.

PART 2 PRODUCTS

2.01 WATER

A. Use clean, clear water, free from oil, acids, alkali, or vegetation.

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 as listed in chemical composition chart.

B. Type B - Commercial 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 gradation suitable for use in preparation of slurry for wet placing.

2. Grade S: Finely-graded quicklime for use in preparation of slurry for wet placing. Donor use grade S quicklime for dry placing.

D. Conform to the following requirements:

CHEMICAL COMPOSITION	TYPE		
	A	B	C
Active lime content, % by weight Ca(OH)2+CaO	90.0 min[1]	87.0 min[2]	-
Unhydrated lime content, % by weight CaO	5.0 max	-	87.0 min
Free water content, % by weight H2O :	5.0 max	-	-
SIZING			
Wet Sieve, as % by weight residue retained:			
No. 6	0.2 max	0.2 max[2]	8.0 max[3]
No. 30	4.0 max	4.0 max[2]	-
Dry sieve, as % by weight residue retained:			
1-inch	-	-	0.0
1/2-inch	-	-	10.0 max

Notes:
1. Maximum 5.0% by weight CaO shall be allowed in determining total active lime content.
2. Maximum solids content of slurry.
3. Total active lime content, as CaO, in material retained on No. 6 sieve shall not exceed 2.0% by weight of original Type C lime.

E. Deliver lime slurry to job site as commercial lime, or prepare at job site by using hydrated lime or quicklime. Provide slurry free of liquids other than water and of consistency that can be handled and uniformly applied without difficulty.

F. Lime containing magnesium hydroxide is prohibited.

2.03 SOIL.

A. Soil to receive lime treatment may include borrow or existing subgrade material, existing pavement structure, or combination of all three. Where existing pavement or base material is encountered, pulverized or scarify material so that 100 percent of sampled material passes 2- inch sieve.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify compacted subgrade will support imposed loads.

B. Verify subgrade lines and grades.

3.02 PREPARATION

A. Complete backfill of utilities prior to stabilization.

B. Cut material to bottom of subgrade using an approved cutting and pulverizing machine meeting following requirements:

1. Cutters accurately provide smooth surface over entire width of cut to plane of secondary grade.

2. Provide cut to depth as specified or shown in the Drawings.

C. Alternatively, scarify or excavate to bottom of stabilized subgrade. Remove material or windrow to expose secondary grade. Obtain uniform stability.

D. Correct wet or unstable material below secondary grade by scarifying, adding lime, and compacting as directed by Project Manager.

E. Pulverize existing material so that 100 percent passes a 1-3/4-inch sieve.

3.03 LIME SLURRY APPLICATION

A. Apply slurry with distributor truck equipped with an agitator to keep lime and water in 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 same working day.

B. Minimum lime content shall be 5 percent of dry unit weight of subgrade as determined by ASTM D 698

3.04 PRELIMINARY MIXING

A. Use approved single-pass or multiple-pass rotary speed mixers to mix soil, lime, and water to required depth. Obtain homogeneous friable mixture free of clods and lumps.

B. Shape mixed subgrade to final lines and grades.

C. Eliminate following operations and final mixing if pulverization requirements of Paragraph 3.05C can be met during preliminary mixing:

1. Seal subgrade as precaution against heavy rainfall by rolling lightly with light pneumatic rollers

2. Cure soil lime material for 24 to 72 hours or as required to obtain optimum hydration. 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 optimum or above.

C. Mix and pulverize until all material passes 1-3/4-inch sieve; minimum of 85 percent, excluding non-slacking fractions, passes 3/4-inch sieve; and minimum of 60 percent excluding non-slacking fractions passes No. 4 sieve. Test according to TxDOT Tex-101-E, Part III using dry method.

D. Shape mixed subgrade to final lines and grades.

E. Do not expose hydrated lime to open air for 6 hours or more during interval between application and mixing. Avoid excessive hydrated lime loss due to washing or blowing.

3.06 COMPACTION

A. Aerate or sprinkle to attain optimum moisture content to 3 percent above optimum, as determined by ASTM D 698 on material sample from roadway after final mix with lime.

B. Start compaction immediately after final mixing.

C. Spread and compact in two or more equal layers where total compacted thickness is greater than equipment manufacturer's recommended range of mixing and compaction.

D. Compact with approved heavy pneumatic or vibrating rollers, or combination of tamping rollers and light pneumatic rollers. Begin compaction at bottom and continue until entire depth is uniformly compacted.

E. Do not allow stabilized subgrade to mix with underlying material. Correct irregularities or weak spots immediately by replacing material and recompacting.

F. Compact subgrade to minimum density of 95 percent of maximum dry density, according to ASTM D 698, at moisture content of optimum to 3 percent above optimum, unless otherwise indicated on Drawings~~:~~.

G. Seal with approved light pneumatic tired rollers. Prevent surface hair line cracking. Rework and recompact at areas where hairline cracking develops.

3.07 CURING

A. Moist ~~c~~Cure for minimum of 3 days before placing base or surface course, or opening to traffic. Subgrade may be opened to traffic after 2 days when 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 or surface within 14 days after final mixing and compaction. Restart compaction and moisture content of base material when time is exceeded.

3.08 TOLERANCES

A. Completed surface: smooth and conforming to typical section and established lines and grades.

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

C. Depth of lime stabilization shall be plus or minus one inch of specified depth for each 1000- ~~f~~Foot ~~r~~Roadway ~~s~~Section.

3.09 FIELD QUALITY CONTROL

A. Testing will be performed under provisions of Section 01454 - Testing Laboratory Services.

B. Test soils, lime, and mixtures as follows:

1. Tests and analysis of soil materials will be performed in accordance with ASTM D 4318, using the wet preparation method.

2. Sampling and testing of lime slurry shall be in accordance with TxDOT Tex-600-J, except using a lime slurry cup.

3. Sample mixtures of hydrated lime or quicklime in slurry form will be tested to establish compliance with specifications.

4. Moisture-density relationship will be established on material sampled from roadway, after stabilization with lime and final mixing, in accordance with ASTM 698, Moist preparation Method.

C. In-place depth will be evaluated for each 1000-~~f~~Foot ~~r~~Roadway ~~s~~Section and determined in accordance with TxDOT Tex-140-E in hand excavated holes. For each 1000-foot section, 3 phenolphthalein tests will be performed. Average stabilization depth for 1000-foot section will be based on average depth for three tests.

D. Perform compaction testing in accordance with ASTM D 6938. Three tests will be performed for each 1000-~~f~~Foot ~~r~~Roadway ~~s~~Section.

E. Pulverization analysis will be performed as required by Paragraph 3.05C on material sampled during mixing of each production area. Three tests will be performed per 1000-~~f~~Foot ~~r~~Roadway ~~s~~Section or a minimum of once daily.

3.10 REWORK OF FAILED SECTIONS

A. Rework sections that do not meet specified thickness.

B. Perform the following steps when more than 72 hours have lapsed since completion of compaction.

1. Moist ~~c~~Cure for minimum of 3 days after compaction to required density.

2. Add lime at rate of 25 percent of specified rate at no additional cost to City.

3. Moisture density test of reworked material must be completed by laboratory before field compaction testing can be completed.

3.11 PROTECTION

A. Maintain stabilized subgrade to lines and grades and in good condition until placement of base or surface course. Protect asphalt membrane from being picked up by traffic.

B. Repair defects immediately by replacing material to full depth.

END OF SECTION

SECTION 02337

LIME/FLY ASH STABILIZED SUBGRADE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Foundation course of lime/fly ash stabilized subgrade material.

1. Application of lime slurry and fly ash to subgrade.

2. Mixing, compaction, and curing of lime, slurry, fly ash, water and subgrade into a stabilized foundation.

1.02 RELATED SECTIONS

A. Section 01270 – Measurement and Payment

B. Section 01330 – Submittal Procedures

C. Section 01454 – Testing Laboratory Services

D. Section 02336 – Lime Stabilized Subgrade

1.03 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. Measurement and payment for lime/fly ash stabilized subgrade is on a square yard basis compacted in place to proper density. Separate measurement will be made for each required thickness of subgrade course.

    a. Limits of measurement shall match actual pavement replaced, but no greater than the maximum pavement replacement limits shown on Drawings. Limits for measurement will be extended to include installed lime/fly ash stabilized subgrade material that extends 2-foot beyond outside edge of pavement to be replaced, except where proposed pavement section shares a common longitudinal or transverse edge with existing pavement section. No payment will be made for lime/fly ash stabilized subgrade in areas beyond these limits.

    b. Limits of measurement and payment shall match pavement replacement limits shown on Drawings, except as noted in Paragraph 1.03.A.1.a, or as approved by Project Manager.

2. Payment for hydrated lime and quicklime is by ton of 2000 pounds dry-weight basis.

3. Payment for commercial lime slurry is by ton of 2000 pounds of lime calculated on percentage by weight of dry solids for grade of slurry.

4. Payment for fly ash is on unit price basis per ton.

5. Refer to Section 01270 - Measurement and Payment for unit price procedures.

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

1.04 DEFINITIONS

A. Moist Cure: Curing soil lime/fly ash material to obtain optimum hydration.

B. 1000-Foot Roadway Section: 1000 feet per lane width or approximately 500 square yards of compacted subgrade for other than full-lane-width roadway sections.

1.05 REFERENCES

A. ASTM C 618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.

1.06 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

B. Submit certification that fly ash, hydrated lime, quicklime, or commercial lime slurry complies with these specifications.

C. Submit weight tickets, certified by supplier, with each bulk delivery of materials to work site.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Conform to requirements of Section 02336 - Lime Stabilized Subgrade.

B. Quicklime can be dangerous; exercise extreme caution if used for Work. Become informed about recommended precautions in handling, storage and use of quicklime.

PART 2 PRODUCTS

2.01 MATERIALS

A. Water: clean, clear and free from oil, acids, alkali, or vegetable matter.

B. Lime: Conform to requirements of Section 02336 - Lime Stabilized Subgrade for Type A hydrated lime, Type C quicklime, and Type B commercial lime slurry.

C. Fly ash: Residue or ash remaining after burning finely pulverized coal at high temperatures conforming to requirements of ASTM C 618, Type ‘C” or “F” and following:

1. Minimum CaO content of 20 percent.

2. Loss on ignition not to exceed 3 percent.

3. Contain no lignite ash.

D. Asphaltic Seal Cure: Conform to requirements of Section 02336 - Lime Stabilized Subgrade.

PART 3 EXECUTION

3.01 INSTALLATION

A. Conform to Part 3 of Section 02336 - Lime Stabilized Subgrade with following exceptions:

1. Include fly ash in percentage amounts in lime or lime slurry as established from geotechnical evaluation for application, mixing, and compaction.

2. Apply lime/fly ash as single mix, single pass over lower PI soils.

3. Conduct operations to minimize elapsed time between mixing and compacting lime/fly ash 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 last stabilizing agent.

3.02 FIELD QUALITY CONTROL

A. Testing will be performed under provisions of Section 01454 - Testing Laboratory Services.

B. Soil will be sampled to establish percent of fly ash and hydrated lime, quicklime, or lime slurry to be applied to subgrade material.

C. Testing will be in accordance with Part 3 of Section 02336-Lime-Stabilized Subgrade.

END OF SECTION

SECTION 02338

PORTLAND CEMENT STABILIZED SUBGRADE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Foundation course of Portland cement stabilized natural subgrade material.

1.02 RELATED SECTIONS

A. Section 01270 – Measurement and Payment

B. Section 01330 – Submittal Procedures

C. Section 01454 – Testing Laboratory Services

1.03 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. Payment for Portland cement stabilized subgrade is on a square yard basis compacted in place to proper density. Separate measurement will be made for each different required thickness of subgrade course.

a. 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 Portland cement 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 Portland cement stabilized subgrade in areas beyond these limits.

b. Limits of measurement and payment shall match pavement replacement limits shown on Drawings, except as noted in Paragraph 1.0~~2~~3.A.1.a, or as approved by Project Manager

2. Payment for Portland cement is by ton of 2000 pounds dry-weight basis.

3. Refer to Section 01270 - Measurement and Payment for unit price procedures.

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

1.04 REFERENCES

A. ASTM C 150 - Standard Specification for Portland Cement.

B. ASTM D 558 - Standard Test Methods for Moisture-Density (Unit Weight) Relations of Soil-Cement- Mixtures.

C. ASTM D 698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft3 (600 kN-m/m3).

D. ASTM D 4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

E. ASTM D 6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.05 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

B. Submit certification that Portland cement complies with these specifications.

PART 2 PRODUCTS

2.01 WATER

A. Water: clean, clear and free from oil, acids, alkali, or organic matter.

2.02 PORTLAND CEMENT

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

2.03 SOIL

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

2.04 TESTS

A. Testing will be performed under provisions of Section 01454 - Testing Laboratory Services.

B. Tests and analysis of soil materials will be performed in accordance with ASTM D 4318.

C. 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.

D. 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.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify compacted subgrade is ready to support imposed loads.

B. Verify subgrade lines and grades are correct.

3.02 EQUIPMENT

A. Apply Portland cement treatment with machine or combination of machines and auxiliary equipment to produce specified results. Mixing may be accomplished by multiple-pass traveling mixing plant or single-pass traveling mixing plant. Provide sufficient equipment to enable continuous prosecution of work

3.03 PREPARATION

A. Backfill for utilities below future grade.

B. Verify subgrade is firm and able to support, without displacement, construction equipment at specified density. Correct soft or yielding subgrade and stabilize by scarifying and aerating or by adding cement and compacting to uniform stability.

C. Grade, shape, and compact, as required, to allow construction of Portland cement treatment for in-place materials to lines, grades, thickness, and typical cross section shown on Drawings. Remove unsuitable soil or material and replace with acceptable material.

D. Pulverize soil so that at completion of moist-mixing, 100 percent by dry weight passes 1-inch sieve, and minimum of 80 percent passes No. 4 sieve, exclusive of gravel or stone retained on these sieves. Pulverize existing bituminous wearing surfaces so that 100 percent will pass 2-inch sieve.

3.04 MIXING

A. Do not place and mix cement when temperature is below 40 degrees F and falling. Place 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.

3.05 COMPACTION

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.

3.06 CONSTRUCTION JOINTS

A. At end of each day's construction, form straight transverse construction joint by cutting back into total width of completed work to form true 2-inch depth vertical face free of loose and shattered material. Construct cement treatment for large wide areas in series of parallel lanes of convenient length and width approved in advance by Project Manager.

3.07 CURING

A. Moist cure for minimum of 3 days before placing base or surface course, or opening to traffic. When open, 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 and surface within 14 days after final mixing and compaction, unless prior approval is obtained from Project Manager.

3.08 TOLERANCES

A. Completed surface: smooth and conforming to typical section and established lines and grades.

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

3.09 FIELD QUALITY CONTROL

A. Testing will be performed under provisions of Section 01454 - Testing Laboratory Services.

B. In-place density will be determined in accordance with ASTM D 6938 or ASTM D 698. Minimum of three tests will be taken for each 1000 feet per lane of roadway or 500 square yards of embankment.

3.10 PROTECTION

A. Maintain stabilized subgrade to lines and grades and in good condition until placement of base or surface course.

B. Repair defects immediately by replacing material to full depth.

END OF SECTION

SECTION 02400

TUNNEL SHAFTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Construction, maintenance, and backfilling requirements of tunnel shafts.

1.02 RELATED SECTIONS

A. Document 00410 – Bid Form

B. Section 01292 – Schedule of Values

C. Section 01330 – Submittal Procedures

D. Section 01504 – Temporary Facilities and Controls

E. Section 01555 – Traffic Control and Regulation

F. Section 01576 – Waste Material Disposal

G. Section 01578 – Control of Ground and Surface Water

H. Section 02081 – Cast-In-Place Concrete Manholes

I. Section 02082 – Precast Concrete Manholes

J. Section 02316 – Excavation and Backfill for Structures

K. Section 02317 – Excavation and Backfill for Utilities

L. Section 02321 – Cement Stabilized Sand

M. Section 02401 – Common Tunnel Shafts

N. Section 02431 – Tunnel Grout

1.03 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. Tunnel shafts, both those shown on Drawings and those additional ones needed for Contractor's operations, are bid as lump sum for all shafts, collectively. Prior to construction, provide schedule of values as specified in Section 01292 - Schedule of Values. Itemize cost by station for each shaft designated on Drawings and additionally required for construction operations. ~~Seventy five~~75 percent of itemized amount will be submitted on pay estimate upon completion for each shaft installed~~ation~~; ~~twenty five~~25 percent will be submitted on pay estimate upon completion of backfill and site restoration (including topsoil, sodding and hydro-mulching) for each shaft. Payment will include excavation, disposal of excavated materials, ground support systems, backfilling, and cleanup. Manholes constructed in tunnel shafts are to be paid separately at contract unit price as specified in Section 02081 - Cast-I~~i~~n-P~~p~~lace Concrete Manholes or Section 02082 - Precast Concrete Manholes.

2. Removal and replacement of surface improvements necessary for shaft construction, including but not limited to sidewalks, asphaltic or concrete pavement, base and subbase, curbs, curb and gutter, driveways, topsoil, sodding, and hydro-mulch shall be included in lump sum for tunnel shafts.

3. Pay for relocation of City-owned utilities at contract unit price, only when included in Document 00410 - Bid Form.

4. If Contractor's alternative construction method or alignment is approved by the City, the Contractor shall resubmit the schedule of values per the alternative alignment for approval. Itemize cost by station for each shaft designated on the revised plan and any additional shaft required for construction operations. If a portion of the Work requiring tunnel shafts is removed by the City from the project scope, the Contractor will be compensated by a deduction from the original lump sum bid price based on the fair market value of the portion of the Work removed (e.g. bid price for removal of one tunnel shaft from project scope will result in deduction from the original lump sum bid price by fair market value of one tunnel shaft).

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

C. Unit Prices for water main Projects.

1. Payment will be made for construction of tunnel shafts and related work on a lump sum basis only if include on Document 00410 – Bid Form. If work is not included on Document 00410 – Bid Form, include the cost for construction of tunnel shafts in unit price for related items.

2. Unless otherwise shown on Drawings removal and replacement of surfaces necessary for shaft construction, including but not limited to sidewalks, asphaltic and correct pavement, base and sub-base shall be paid to limits no further than 5 feet from shaft wall.

1.04 REFERENCE ~~STANDARD~~S

A. American Association of State Highway and Transportation Officials (AASHTO), AASHTO LRFD Bridge Design Specifications, current edition.

1.05 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

B. Shaft design submittals by Contractor shall be signed and sealed by Professional Engineer registered in State of Texas. If trench box is used in tunnel shaft and such utilization is in a manner other than what is indicated and certified in manufacturer's technical data, submit trench box manufacturer certification of proposed usage.

C. Submit shaft construction drawings and seal slabs. Clearly indicate allowable surcharge loads and restrictions on surcharge capacity, including live loads, on shaft construction drawings. Indicate thrust blocks or other reactions required for pipe jacking, when applicable.

1. Location of shafts by station and limits of working sites.

2. Description of site security arrangements in conformance with Paragraph 3.03, Shaft Construction.

3. Description of method of extending shaft above flood level in conformance with Paragraph 3.03, Shaft Construction.

4. Any geotechnical / boring undertaken by Contractor for whatever purpose connected to Work.

D. Shaft Monitoring Plan: Submit for review prior to construction, shaft monitoring plan that includes schedule of instrumentation design, layout of instrumentation parts, equipment installation details, manufacturer's catalog literature, and monitoring report forms.

E. Structures Assessment:~~.~~ Provide preconstruction and post-construction assessment reports for critical structures located within radius of shaft center equal to shaft depth plus shaft radius, measured in plan. Include photographs or video of any existing damage to structures in vicinity of shafts in assessment reports.

F. Submit shaft surface settlement monitoring plan for review prior to construction. Identify location of settlement monitoring points, reference benchmarks, survey frequency and procedures, and reporting formats on plan.

G. Submit readings of monitoring plans to Project Manager as soon as readings have been taken.

H. Submit shaft temporary deck drawings and calculations to Project Manager, signed and sealed by Contractor's Professional Engineer in event that shaft is not needed for immediate construction activity, in conformance with Paragraph 3.03, Shaft Construction.

1.06 PERFORMANCE REQUIREMENTS

A. Shaft design must include allowance for contractor's equipment and stored material and spoil stockpile as appropriate. Design must also allow for HL-93 highway loading if located in the vicinity of a paved area.

B. Design shaft to withstand full hydrostatic head without failure. In case of common shaft in conformance to Section 02401- Common Tunnel Shafts, design shaft with adequate factor of safety for full hydrostatic head.

C. Design shaft located within 50-year flood plain with water retaining liner extending 2 feet above 50-year flood elevation. It is acceptable when liner is stored at site for immediate installation in lieu of it being installed at shaft, provided that shaft liner extends at least 2 feet above existing ground elevation.

D. Design shaft cover for minimum 25 pounds per square foot distributed load plus 300-pound point load.

E. Design steel plate deck, if such is required, for HL-93 loading.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 LOCATION OF ACCESS SHAFTS

A. Contractor has sole responsibility for selection of shaft sites needed for construction operations unless otherwise indicated on Drawings. Location will be subject to the approval of the Project Manager.

B. Locate shafts and associated work areas to avoid blocking driveways and cross streets, and to minimize disruption to business and commercial interests. Avoid shaft locations near areas identified as residential or potentially contaminated.

C. Plan shaft locations to minimize interference with storm drainage channels, ditches, water lines, sanitary sewers, storm water sewers or culverts, which, when damaged, could result in ground washout or flooding of shafts and tunnels.

3.02 UTILITY RELOCATION

A. Relocate utilities as shown on Drawings. Utility relocations required by Contractor for shaft construction shall take into account zone of potential settlement in vicinity of shaft.

B. Obtain approval from Project Manager for permanent relocations prior to relocating.

3.03 SHAFT CONSTRUCTION

A. Conform to the following for ground support systems:

1. Install liner elements, bracing and shoring structural members at locations and in method sequence and tolerances defined on shaft construction drawings as excavation progresses.

2. Ensure bracing and shoring are in contact with liner to provide full support as shown in shaft construction drawings. Evaluate and check modifications to liner, bracing and shoring. Obtain approval from Contractor's Professional Engineer and submit to Project Manager.

3. Install seal slab as soon as final depth and stable bottom conditions have been reached and accepted by Project Manager. Construct seal slab capable of withstanding full piezometric pressure, either by pressure relief using under drains, or in case of more permeable ground condition, by use of structural reinforced slab. Construct seal slab in accordance with design provided by Contractor's Professional Engineer.

4. Design and construct entire shaft to appropriate factors of safety against yield, deformation, or instability as determined by Contractor's Professional Engineer. Shaft must withstand full hydrostatic head without failure.

5. Special framing, bracing or shoring required around tunnel "eyes" or other penetrations shall be in ~~-~~place according to shaft construction drawings before liner or any bracing or shoring at penetration is cut or removed.

6. Securely breast and shore face of starter or back tunnels to resist both soil and hydrostatic pressure.

7. When applicable, pressure grout voids or seepage paths around shafts and adjoining tunnels in accordance with Section 02431- Tunnel Grout. Pressure grout bolted steel liner plates as they are installed, unless otherwise approved by Project Manager. Perform secondary or 'back grouting' as ground measurement, voids or deformation of shaft liner are detected.

B. Install suitable thrust or reaction blocks as required for pipe jacking equipment.

C. Provide drainage from shafts while work is in progress and until adjacent pipe joints have been sealed and shaft is backfilled. Conform to requirements of Section 01578 - Control of Ground and Surface Water.

D. Surface Water Control. Divert surface water runoff and discharge from dewatering system away from shaft. Protect shafts from infiltration or flooding.

E. Each surface work site is to be surrounded by security fence meeting requirements of Section 01504 - Temporary Facilities and Controls, which shall be secure any time site is unattended by Contractor's personnel.

F. Protect shaft, when not in use by second security fence at perimeter of shaft, or alternatively by cover designed in accordance with Paragraph 1.06, Performance Requirements.

G. Provide portable concrete traffic barriers at locations where work site is situated adjacent to highway, road, driveway, or parking lot. Angle traffic barriers in direction of lane flow. Do not place perpendicular to on-coming traffic.

H. Provide and maintain traffic control system in accordance with provision of Section 01555 - Traffic Control and Regulation.

I. Cover shaft which is constructed more than 60 days in advance of its intended use by steel plate deck designed by Contractor's Professional Engineer, and restore surface to permit full traffic flow during time shaft is not in use. Remove from site other material and equipment used by Contractor including portable concrete traffic barriers, traffic control system, fencing and reinstall at time shaft is re-opened for use.

J. Construct suitable guardrail barrier around periphery of shaft, meeting applicable safety standards. Properly maintain barrier throughout period shaft remains open. Repair broken boards, supports, and structural members. Provide ladder with safety cage, when required by OSHA, in each shaft. Provide security barrier for each access shaft in which there is no construction activity or which is unattended by Contractor's personnel.

K. Size of Shafts: Make size adequate for construction of permanent structures indicated on Drawings and to provide adequate room to meet operational requirements for tunnel construction and backfill.

3.04 BACKFILL

A. Provide cement-stabilized sand to minimum depth of 10 feet above crown of sanitary sewer, but where shaft is located in paved area, cement-stabilized sand shall be used to within one foot of pavement subgrade elevation. Provide cement-stabilized sand in accordance with Section 02321 ~~-~~– Cement Stabilized Sand. Compact cement stabilized sand in accordance with Section 02317 - Excavation and Backfill for Utilities. In locations where backfill is not subject to traffic loading, depth above initial cement-stabilized sand may be backfilled with select backfill in accordance with Section 02316 - Excavation and Backfill of Structures. When insufficient work space exists, g~~G~~rout manhole or structure annular space in accordance with Section 02431 - Tunnel Grout.

B. Remove shaft liner above level of 8 feet below ground surface, unless otherwise indicated on Drawings. Maintain sufficient ground support to meet excavation safety requirements while removing shaft structure.

C. Where common shafts are indicated, refer to Section 02401 - Common Tunnel Shafts.

3.05 MONITORING

A. Monitoring Instrumentation. Instrumentation specified and readings shall be accessible at all times to Project Manager.

1. Install and maintain instrumentation system to monitor and detect movement of ground surface and adjacent structures. Establish vertical survey control points at distance from construction area that avoids disturbance due to ground settlement.

2. Project Manager may through independent contractor or consultant, from installing instrumentation in, on, near, or adjacent to construction work. Provide access to work for such independent installations.

3. Install instruments in accordance with Drawings and manufacturer's recommendations.

B. Surface Settlement Monitoring

1. Establish monitoring points on all critical structures.

2. Record location of settlement monitoring points with respect to construction baselines and elevations. Record elevations to an accuracy of 0.01 feet for each monitoring point location. Establish monitoring points at locations and by methods that protect them from damage by construction operations, tampering, or other external influences.

3. Monitoring points to measure ground elevation are required at distance of 10 feet and 20 feet from perimeter of shaft on each of four radial lines, at 90 degrees to each other.

4. Railroads. Monitor ground settlement of track subbase at centerline of each track when within zone of potential settlement.

C. Reading Frequency and Reporting. Submit to Project Manager, records of readings from various instruments and survey points.

1. Record all shaft monitoring readings at least once per week starting prior to shaft construction and continuing until shaft has been backfilled and until no more detectable movement occurs.

2. Immediately report to Project Manager any movement, cracking, or settlement which is detected.

3. Following substantial completion but prior to final completion, make final survey of all shaft related monitoring points.

3.06 DISPOSAL OF EXCESS MATERIAL

A. Remove spoil in accordance with Section 01576 - Waste Material Disposal.

END OF SECTION

SECTION 02401

COMMON TUNNEL SHAFTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Requirements for design and construction of common tunnel shaft used for tunnel construction by ~~c~~Contractor (First Contractor) followed by transfer of shaft and work site to separate ~~c~~Contractor (Second Contractor) for use in completing interconnecting tunneling operations and permanent work within shaft.

1.02 RELATED SECTIONS

A. Document 00800 – Supplementary Conditions

B. Section 01110 – Summary of Work

C. Section 01292 – Schedule of Values

D. Section 01330 – Submittal Procedures

E. Section 01555 – Traffic Control and Regulation

F. Section 02400 – Tunnel Shafts

1.03 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. Common ~~s~~Shafts are bid as part of Work defined in Section 02400 - Tunnel Shafts, except as modified in this Section.

2. Construction of ~~c~~Common ~~s~~Shaft includes installation of site security, removal of affected site improvements, shaft excavation, disposal of excess material, sheeting, shoring or bracing, seal slab, ground water control, and installation of temporary plug in pipe. Payment is made in accordance with Section 02400 - Tunnel Shafts and as specified in Section 01292 - Schedule of Values.

3. Work within ~~c~~Common ~~s~~Shaft, previously constructed by First Contractor, and transferred to Second Contractor includes maintaining site, security, groundwater control, permanent backfilling, replacement of permanent site improvements, such as sidewalks, asphaltic and concrete pavement, pavement base and subbase, curbs, curb and gutter, driveways, topsoil, sodding, and hydro-mulch. Payment is made in accordance with Section 02400 - Tunnel Shafts and as specified in Section 01292 - Schedule of Values.

4. Traffic control and regulation, including flagmen are paid under Section 01555 - Traffic Control and Regulation.

5. Agreement which may be reached between two cContractors involving common tunnel shaft which results in departure from or omits element of cCommon sShaft concept specified in this Section will not result in an adjustment in Contract Price by City for either cContractor.

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

1.04 DEFINITIONS

A. Common Shaft. Shaft that First Contractor constructs under one contract and then is transferred as responsibility of Second Contractor, under separate contract, who completes interconnected tunneling operations, permanent work, backfill, and restoration of site improvements.

B. First Contractor. Contractor responsible for design and construction of cCommon sShaft. First Contractor uses shaft for tunneling and installing permanent sewer line, and then relinquishes responsibility at time of transfer to Second Contractor.

C. Second Contractor. Contractor who takes responsibility for shaft constructed by First Contractor and uses it to complete interconnected tunneling and to complete permanent work at that location.

D. Starter Shaft. Generally, downstream shaft of First Contractor; shaft from which First Contractor begins tunnel work. This shaft, when common, becomes rReceiving sShaft for Second Contractor.

E. Receiving Shaft. Generally, shaft at upstream end of tunnel work where tunneling operation ends. When common, it will have been constructed by First Contractor as sStarter sShaft.

F. Back Tunnel. Short length of tunnel constructed at sStarter sShaft in opposite direction to main tunnel to facilitate construction operations.

1.05 REFERENCES ~~STANDARDS~~

A. American Association of State Highway and Transportation Officials (AASHTO), AASHTO LRFD Bridge Design Specifications HL-93, current edition.

1.06 SYSTEM DESCRIPTION

A. Design Requirements. Common sShaft design to be site specific with minimum clear dimensions, depth and at location shown on Drawings. Differing dimensions may only be used with written consent of Second Contractor, and approval of City Engineer.

1. Design shaft to withstand full piezometric pressure with adequate factor of safety, and without dependence on ground water control system.

2. Design seal slab to have sump for purposes of pumping out seepage and surface water inflow.

3. Design shaft liner for uniformly distributed loading of 200 pounds per square foot at surface, or HL-93 vehicle loading, as applicable.

4. Second Contractor designs shaft structural modifications required to suit his construction needs.

5. Design ~~c~~Common ~~s~~Shaft using materials which minimize ground water intake and prevent migration of fines into shaft.

6. Design shaft with liner or ground support system such that it may be readily removed to depth of 8 feet below existing pavement or ground elevation.

1.07 SUBMITTALS

A. First Contractor.

1. Conform to requirements of Section 02400 - Tunnel Shafts and Section 01330 - Submittal Procedures.

2. Submit to City Engineer, two copies of record photographs showing shaft condition immediately prior to handover.

3. Prepare record drawings for shaft and submit to City Engineer prior to Second Contractor taking over shaft and work site.

B. Second Contractor.

1. Conform shaft modification submittals to requirements of Section 02400 - Tunnel Shafts and Section 01330 - Submittal Procedures.

2. Submit monitoring results in accordance with Section 02400 - Tunnel Shafts and Section 01330 - Submittal Procedures.

1.08 TRANSFER OF SHAFT RESPONSIBILITY

A. First Contractor. First Contractor relinquishes site of ~~c~~Common ~~s~~Shaft and transfers responsibility to Second Contractor on date specified in Section 01110 - Summary of Work. Date is based on specified number of days from Date of Commencement. First Contractor may transfer responsibility of shaft prior to date specified when approved by Second Contractor and City Engineer. Failure to transfer that responsibility by date specified will cause assessment of liquidated damages against First Contractor in accordance with Article 9.12 of Document 00800 - Supplementary Conditions.

B. Second Contractor. Second Contractor takes responsibility for ~~c~~Common ~~s~~Shaft site on date First Contractor relinquishes site. Date shall occur within period specified in Section 01110 - Summary of Work. Second Contractor is not required to take responsibility for shaft prior to first date of period specified, but shall be prepared to take over responsibility on date thereafter. Second Contractor shall have no claim for delay provided First Contractor turns over shaft prior to last day of period specified.

C. Mutual Agreements on Transfer of Responsibility. Changes to date specified for occupation of site requires written approval of both Contractors, with approvals forwarded to City Engineer.

PART 2 PRODUCTS

2.01 EQUIPMENT AND MATERIALS

A. Use equipment and materials for construction in good condition.

B. Construct permanent work as specified and as shown on Drawings.

C. Material or equipment left in shaft or at site by First Contractor, either as defined by this Section, or otherwise, becomes property of Second Contractor.

PART 3 EXECUTION

3.01 SITE EXAMINATION

A. First Contractor: Repair damage to existing structures or facilities which has been caused by construction activity. Leave site in clean condition.

B. Second Contractor: Inspect site and report damage observed to City Engineer immediately prior to transfer. Site includes surrounding area insofar as it may have been impacted by First Contractor’s construction activity.

3.02 CONSTRUCTION

A. First Contractor.

1. Construct ~~c~~Common ~~s~~Shaft, including utility relocations, dewatering, shaft excavation and ground support, seal slab, traffic control, and safety and security barriers in accordance with Section 02400 - Tunnel Shafts.

2. Do not construct back-tunnel in common shaft.

3. Repair damage to shaft liner and grout voids outside shaft ground support to restore integrity of shaft to its original design capabilities, prior to transfer.

4. Install plug immediately upstream of shaft.

5. Clean out shaft, including removal of construction equipment and debris prior to transfer.

6. Monitor for settlement in conformance with Section 02400 - Tunnel Shafts.

7. Remove dewatering system, when used, including backfilling wells and removing header pipes.

8. Repair damage to pavement outside immediate limits of shaft, such as settlement damage to pavement resulting from shaft or tunneling operations.

9. Remove equipment from shaft including thrust blocks when used, except access ladder, prior to handover.

10. Remove traffic control system. Coordinate with Second Contractor to maintain continuous traffic control.

11. Repair damage to site security fencing, shaft fencing or cover, and portable concrete traffic barriers.

12. Transfer security fencing, covers, and portable concrete traffic barriers to Second Contractor.

13. Provide, install, and handover temporary plug at downstream end of sewer pipe installed by First Contractor.

14. Provide and deliver to Second Contractor, two new and undamaged joints of pipe identical to pipe installed by First Contractor immediately upstream of ~~c~~Common ~~s~~Shaft.

B. Second Contractor.

1. Install traffic control system. Coordinate with First Contractor to maintain continuous traffic control.

2. Provide necessary pumps and power source at shaft. Provide ground water control at shaft as required to control inflow.

3. Design, fabricate, and install modification of existing shaft to suit Second Contractor's needs.

4. Install necessary hoisting equipment, communication system, and other safety provisions, including ventilation and lighting.

5. Monitor for earth settlement in conformance with Section 02400 - Tunnel Shafts.

6. Complete upstream sewer construction within shaft.

7. Complete downstream sewer construction in accordance with Drawings.

8. Complete other permanent construction work within shaft as shown on Drawings and in accordance with Specifications. Place backfill in accordance with Section 02400 - Tunnel Shafts.

9. Restore permanent pavement in accordance with Drawings, including repairs needed to existing pavement outside immediate limits of shaft, such as settlement damage to pavement resulting from shaft or tunnel operations.

10. Clean site and restore site and surrounding area to original condition as shown in Drawings and in accordance with Specifications.

11. Remove and dispose of temporary plug in upstream sewer pipe.

END OF SECTION

SECTION 02425

TUNNEL EXCAVATION AND PRIMARY LINER

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Tunnel construction by placement of ~~p~~Primary L~~l~~iner for installation of pipe using a primary tunnel liner with a C~~c~~arrier P~~p~~ipe. Placement of sewer pipe inside tunnel constructed with P~~p~~rimary L~~l~~iner shall be in accordance with Section 02426 - Sewer Line in Tunnels.

B. Various construction methods for tunneling, including ~~t~~Tunnel B~~b~~oring M~~m~~achine (TBM), hand tunneling, or S~~s~~hield. Liners include rib and lagging, steel liner plate, bolted steel liner, box tunnels, and segmented concrete. Liners may be expanded or grouted.

1.02 RELATED SECTIONS

A. Section 01270 – Measurement and Payment

B. Section 01330 – Submittal Procedures

C. Section 01576 – Waste Material Disposal

D. Section 01578 – Control of Ground and Surface Water

E. Section 02426 – Sewer Line in Tunnels

F. Section 02431 – Tunnel Grout

1.03 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. Work performed under this Section such as excavation, P~~p~~rimary L~~l~~iner, and grouting will not be paid directly. Include cost of this work in unit prices for installation of sewer line in tunnel, in accordance with Section 02426 - Sanitary Sewer Line in Tunnels.

2. Monitoring will be paid lump sum price for installation, observation, and reporting.

3. Refer to Section 01270 - Measurement and Payment for unit price procedures.

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

1.04 REFERENCE STANDARDS

A. American Association of State Highway and Transportation Officials (AASHTO), AASHTO LRFD Bridge Design Specifications, current edition.

B. American Railway Engineering and Maintenance-of-Way Association (AREMA) Manual for Railway Engineering.

C. ~~American Society for Testing and Materials (ASTM).~~ASTM A 307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength.

~~1. ASTM A 36 - Standard Specifications for Carbon Structural Steel.~~

~~2. ASTM A 283 - Standard Specifications for Low and Intermediate Tensile Strength Carbon Steel Plates.~~

~~3. ASTM A 307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength.~~

D. Occupational Safety and Health Administration (OSHA).

E. National Electrical Code – NFPA 70.

1.05 DEFINITION

A. Primary liner: First tunnel support installed by Contractor in 2-pass method.

B. Carrier Ppipe: Sewer line as specified in Section 02426 - Sewer Line in Tunnels.

C. Zone of Active Excavation. Area located within radial distance about surface point immediately above face of excavation equal to depth to bottom of excavation.

D. Critical Structure: Building, structure, bridge, pier, or similar construction partially or entirely located within Zzone of Aactive Eexcavation.

E. Tunnel Boring Machine (TBM): Mechanized and fully shielded excavating equipment that is steerable, guided and articulated, with man entry.

F. Tunneling Methodology: Written description, together with supporting documentation that defines Contractor's plans and procedures for tunneling operations.

G. Shield: Fabricated ground support, circular in section, providing 360 degree protection to those working in it. Shield will have cutting edge, and be equipped with independently operated hydraulic propulsion rams, allowing it to be steered. Liner is erected within tail attached to Sshield.

H. Open Face: Face of heading or tunnel which is unsupported during excavation (e.g., in hand mining or shield excavation).

I. Closed Face: Face of heading or tunnel which is supported during excavation process from TBM, where cutter head allows both partial exposure of face and full closure, by means of hydraulically operated gates.

1.06 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

B. The following submittals are required:

1. Tunneling Methodology. Provide a brief description of proposed tunnel methodology for review. Description should be sufficient to convey following:

a. Proposed method of tunnel construction and type of face support and lining system.

b. Manufacturer and type of tunneling equipment proposed; type of lighting and ventilation systems.

c. Number and duration of shifts planned to be worked each day.

d. Sequence of operations.

e. Location of access shafts and work sites.

f. Method of spoil transportation from face, surface storage, and disposal location.

g. Method of installing pipe.

h. Identification of critical utility crossings and special precautions proposed.

i. Manufacturer and type of chemical grout proposed.

2. Drawings and Calculations. Submit for record purposes, drawings and calculations for tunnel support system designed by Contractor. Drawings shall be adequate for construction, and include installation details. Documents must be signed and sealed by Professional Engineer registered in State of Texas. Include calculations with clear statement of criteria used for design, as described in Paragraph 1.07, Design Criteria.

3. Quality Control. Submit for review brief description of quality control methods including:

a. Method and frequency of survey control.

b. Example of tunnel daily log.

c. Instrumentation plan showing location and frequency of monitoring relative to <u>C</u>~~c~~ritical <u>S</u>~~s~~tructures within <u>Z</u>~~z~~one of <u>A</u>~~a~~ctive <u>E</u>~~e~~xcavation.

d. Settlement survey plan (may be included in instrumentation plan).

4. Geotechnical Investigation. When geotechnical investigations are conducted by Contractor, submit results to Project Manager for record purposes.

5. Monitoring Plans:

a. Instrumentation Monitoring Plan. Submit for review, prior to construction, monitoring plan that includes schedule of instrumentation design, layout of instrumentation points, equipment installation details, manufacturer's catalog literature, and monitoring report forms.

b. Surface Settlement Monitoring Plan. Submit settlement monitoring plan for review prior to construction. Identify location of settlement monitoring points, reference benchmarks, survey frequency and procedures, and reporting formats on plan.

6. Structures Assessment. Submit preconstruction and post-construction assessment reports for <u>C</u>~~c~~ritical <u>S</u>~~s~~tructures, namely those located within <u>Z</u>~~z~~one of <u>A</u>~~a~~ctive <u>E</u>~~e~~xcavation from proposed tunnel centerline. Include photographs or video of existing damage to structures in vicinity of sewer alignment in assessment reports.

7. Submit monitor readings to Project Manager.

8. Daily Reports. Maintain shift log as defined in Paragraph 3.04, Tunneling Data, and make available to Project Manager on request.

1.07 DESIGN CRITERIA

A. Provide primary liner designed by Contractor's Professional Engineer for appropriate loading conditions and deflection criteria, including but not limited ~~to:~~<u>to</u> overburden and lateral earth pressures; handling and installation stresses; loads imposed by tunnel shield or <u>T</u>~~t~~unnel <u>B</u>~~b~~oring <u>M</u>~~m~~achine thrust jacks; subsurface soil and water loads; grouting; and other conditions of service. Assume responsibility for design of primary liner to carry construction loads in combination with overburden, earth and hydrostatic loads.

B. At railroad crossings conform to Cooper E-80 locomotive loading distributions in accordance with AREMA specifications for culverts. In design, account for additive loadings due to multiple tracks. Provide liner type for railroad crossings as specified or as shown on Drawings.

C. For truck loading use HL-93vehicle loading distributions in accordance with AASHTO

D. Use liner system compatible with special requirements shown on Drawings.

PART 2 PRODUCTS

2.01 STEEL LINER PLATES

A. In locations shown on Drawings, manufacture liner plate (2-flange or 4-flange) certified by manufacturer for compliance with Specifications.

B. Provide bolts and nuts conforming to ASTM A 307, Grade A.

C. Punch plates for bolting on both longitudinal and circumferential seams and fabricate to permit complete erection from inside tunnel. Provide plates of uniform fabrication. Plates intended for one size tunnel shall be interchangeable.

D. Material used for construction of liner plates shall be in good condition.

E. Provide sufficient number of bolted steel liner plates with approximately 2-inch diameter grout holes furnished with plugs. Locate holes near plate center.

PART 3 EXECUTION

3.01 PREPARATION

A. Install liner types as shown on Drawings. Use techniques and liner methods appropriate for prevailing ground conditions, unless otherwise indicated.

B. Use methods for tunneling operations that will minimize ground settlement. Select method which will control flow of water, prevent loss of soil into tunnel, and provide stability of face under anticipated conditions.

C. Conduct tunneling operations in accordance with applicable safety rules and regulations, OSHA standards, and Contractor's safety plan. Use methods which include due regard for safety of workmen, adjacent structures, utilities, and public.

D. Maintain clean working conditions inside tunnel and shafts.

E. For tunneling under railroad embankments, highways, or streets, perform installation so as to avoid interference with operation of railroads, highways, or streets, except as approved by owner of facility.

F. Support ground continuously in manner to prevent loss of ground and keep perimeters and faces of tunnel stable.

G. Completed primary tunnel lining shall have full bearing against ground. Grout peripheral space between support elements and excavated surface or close by expanding support elements against ground to achieve full bearing as tunnel advances.

H. Ground Conditions. Perform additional exploration by geotechnical borings in advance of construction to define necessary parameters for design of primary tunnel liner, planning and designing ground water control system, and for selection of tunneling method and equipment to successfully complete each tunnel reach.

I. Be aware that various existing soil borings, piezometers, or instrument wells, where indicated on Drawings, may coincide with proposed tunnel alignment. These may or may not have been backfilled with grout and, therefore, caution should be used in tunneling through these locations. Contractor shall take mitigating measures to counter effect these boreholes, piezometers, or instrument wells may have on tunneling operations.

3.02 GROUND WATER CONTROL

A. Provide necessary ground water control measures to perform work and to provide safe working conditions. Comply with provisions of Section 01578 - Control of Ground and Surface Water.

B. Anticipate that portions of tunnel excavation may be below ground water table and in cohesionless soils, even when not indicated on soil borings, and in conditions which may require ground water control system for tunneling operations. Install filter fabrics, backer rods and other means as necessary to prevent piping of fines into tunnel.

C. When Contractor chooses pumping installations to control ground water level or installs pervious liner through water bearing layers, install and maintain instrumentation system to monitor water level and to detect movement in adjacent structures and property.

D. Operate dewatering system for tunnels until C~~c~~arrier P~~p~~ipe has been installed and annular space is fully grouted, or until watertight liner designed for hydrostatic pressures is installed.

E. Do not proceed with tunneling for which ground water control is necessary until monitoring data indicates that ground water control system is operating in accordance with Contractor's plan.

3.03 EQUIPMENT

A. Assume responsibility for selection of tunneling equipment which, based on past experience, has proven to be satisfactory for excavation of soils to be encountered.

B. Employ tunneling equipment that will be capable of handling various anticipated ground conditions and which minimizes loss of soil ahead of face and allows satisfactory support of excavated face.

C. TBM or S~~s~~hield shall conform to shape of tunnel with uniform perimeter that is free of projections that could produce over excavation or voids. An appropriately sized over cutting bead may be provided to facilitate steering. In addition it shall:

1. Be capable of full directional guidance.

2. Be capable of full face closure, or permit ready installation of breasting boards.

3. Be equipped with appropriate tail in which liner is erected.

4. Be capable of correcting roll.

5. Be designed to handle adverse ground conditions including ground water ingress.

6. Be equipped with visual display to show operator actual position of TBM or S~~s~~hield relative to design reference.

D. Air Quality. Provide equipment to maintain proper air quality of tunnel operations during construction in accordance with OSHA requirements.

E. Enclose light fixtures in watertight enclosures with suitable guards. Provide separate circuits for lighting and other equipment.

F. Conform to requirements of National Electrical Code - NFPA70 for Electrical S~~s~~ystems.

3.04 TUNNELING DATA

A. Maintain shift logs of construction events and observations. Project Manager shall have access to Contractor's logs with regard to the following information:

1. Location of face by station and progress of tunnel drive during shift.

2. Hours worked per shift on tunneling operations.

3. Completed field forms for checking line and grade of tunneling operation, showing achieved tolerance relative to design alignment. Steering control logs will generally be acceptable for S~~s~~hield or TBM driven tunnels.

4. Location, elevation and brief soil descriptions of soil strata and strata boundaries.

5. Ground water control operations and piezometric levels, ground water inflow location and rates.

6. Observation of lost ground or other ground movement.

7. Unusual conditions or events.

8. Reasons for operational shutdown in event drive are halted.

B. Clearly mark primary liner with paint every 20 feet along tunnel with distance in feet from centerline of preceding shaft.

3.05 TUNNEL EXCAVATION AND PRIMARY LINER INSTALLATION

A. Tunnel Excavation.

1. Conduct tunneling operations in accordance with applicable safety rules and regulations, and Contractor's safety plan. Use methods which include due regard for safety of workmen, adjacent structures, utilities, and public.

2. Maintain tunnel excavation within easements and rights-of-way indicated on Drawings, to lines and grades shown on Drawings. Excavation shall be of sufficient size to allow installation of sewer pipe to lines and grades indicated on Drawings.

3. Open-face excavations:

a. Keep face breasted or otherwise supported and prevent falls, excessive raveling, or erosion. Maintain standby face supports for immediate use when needed.

b. During shut-down periods, support face of excavation by positive means; do not rely solely on hydraulic pressure for support.

4. Closed-face excavation:

a. Control volume of spoil removed. Determine that advance rate and excavation rate are compatible to avoid over excavation or loss of ground.

b. When cutting head is withdrawn, keep excavated face supported and stabilized.

c. When face of machine is open for maintenance, monitor conditions that might threaten stability of heading. Take appropriate action to prevent or limit influx of soils and water which would threaten stability of heading.

5. Whenever condition is identified which could endanger tunnel excavation or adjacent structures, operate continually for 24 hours day, including weekends and holidays, without intermission until condition no longer exists.

B. Determination of primary liner size and section shall be sole responsibility of Contractor, to match construction methods and equipment described in tunneling methodology submittal. Provide tunnels of sufficient size to permit efficient excavation operations, sufficient working space for placing primary tunnel liner, and to allow for installation of sewer pipe.

C. Primary Liner Installation:

1. Provide method to ensure full bearing of soil against <u>P</u>~~p~~rimary <u>L</u>~~l~~iner without significant settlement or movement of surrounding soil. To fill void behind <u>P</u>~~p~~rimary <u>L</u>~~l~~iner, either expandable liner (e.g., ring beams and timber lagging) or non-expandable liner (e.g., bolted steel liner plates) may be used provided grout is placed behind non-expandable liner. Box tunnel where ground is excavated to true shape may be ungrouted.

2. When using TBM or tunnel shield, advance equipment only far enough to permit construction of one <u>P</u>~~p~~rimary <u>L</u>~~l~~iner set, entirely within equipment <u>S</u>~~s~~hield.

3. Install filter fabric around exterior of <u>P</u>~~p~~rimary <u>L</u>~~l~~iner when using steel ribs and lagging. Install backer rods at ribs as required to control migration of fines. Close windows in lagging.

4. After grouting, ensure deflection of liner is no more than allowable, nor liner is distorted by excessive pressure.

D. Seal blind headings with temporary bulkhead.

E. Grouting: Requirements pertaining to grout mix design and tunnel grouting are provided in Section 02431 - Tunnel Grout.

3.06 CONTROL OF TUNNEL LINE AND GRADE

A. Construction Control.

1. Project Manager will establish baselines and benchmarks indicated on Drawings. Check baselines and benchmarks at beginning of Work and report errors or discrepancies to Project Manager.

2. Use baselines and benchmarks established by Project Manager to establish and maintain construction control points, reference lines, and grades for locating tunnel.

3. Establish control points sufficiently far from face so as not to be affected by tunneling operations.

B. Benchmark Movement. Ensure that when settlement of ground surface occurs during construction which affects accuracy of temporary benchmarks, detect and report such movement and reestablish temporary bench~~-~~marks. Locations of permanent City of Houston monumentation benchmarks are indicated on Drawings. Advise Project Manager of settlement affecting permanent monumentation benchmarks. Upon completion, submit field books pertaining to monitoring of permanent monumentation benchmarks to Project Manager.

C. Line and Grade.

1. Maintain means sufficient to check alignment and grade continuously.

2. Check survey control for tunneling against aboveground undisturbed reference at least once each week and once for each 250 feet of tunnel constructed.

3. When excavation is off line or grade, make alignment corrections to avoid reverse grades in gravity sewers.

4. Construct P~~p~~rimary L~~l~~iner to such tolerances that permit installation of sewer pipe to be completed to tolerances given in Section 02426 - Sewer Line in Tunnels.

D. Earth Movement. Assume responsibility for damages due to settlement from construction- induced activities or occurrences.

1. Survey crown, invert, and springline on each side of P~~p~~rimary L~~l~~iner at 50-foot intervals or minimum of once per shift or more frequently when line and grade tolerances have been exceeded, to ensure alignment is within tolerances specified. Conduct survey immediately behind tunnel excavation to allow immediate correction of misalignment.

3.07 MONITORING

A. Instrumentation Monitoring. Instrumentation requirements are shown on Drawings. Ensure instrumentation specified is accessible to Project Manager. Submit readings promptly to Project Manager.

1. Install and maintain instrumentation system to monitor and detect movement of ground surface and adjacent structures. Establish vertical control points at distance from construction areas that avoid~~s~~ disturbance due to ground settlement.

2. Installation of instrumentation shall not preclude Project Manager, through independent C~~c~~ontractor or consultant, from installing instrumentation in, on, near, or adjacent to construction work. Provide access to work for such independent installations.

3. Install instruments in accordance with Drawings and manufacturer's recommendations.

B. Surface Settlement Monitoring

1. Establish monitoring points on all C~~c~~ritical S~~s~~tructures.

2. Record location of settlement monitoring points with respect to construction baselines and elevations. Record elevations to accuracy of 0.01 feet for each monitoring point location. Monitoring points should be established at locations and by methods that protect them from damage by construction operations, tampering, or other external influences.

3. Ground surface elevations must be recorded on centerline ahead of tunneling operations at minimum of 100-foot intervals or at least three locations per tunnel drive. For primary lined tunnels greater than 60 inches cut diameter also record similar data at approximately 20 feet each side of centerline. Clearly mark settlement monitoring points by studs or paint for ease of locating.

4. Railroads. Monitor ground settlement of track subbase at centerline of each track.

5. Utilities and Pipelines. Monitor ground settlement directly above and 10 feet before and after utility or pipeline intersection.

C. Reading Frequency and Reporting. Submit to Project Manager, records of readings from various instruments and survey points.

1. Instrumentation monitoring results to be read at frequency specified, unless otherwise specified. Start monitoring before Z~~z~~one of A~~a~~ctive E~~e~~xcavation is passed and until no further detectable movement occurs.

2. Record surface settlement monitoring readings:

a. Prior to Z~~z~~one of A~~a~~ctive E~~e~~xcavation reaching that point,

b. When tunnel face reaches monitoring point (in plan), and

c. When Z~~z~~one of A~~a~~ctive E~~e~~xcavation has passed and no further movement is detected.

3. Submit monitoring readings promptly to Project Manager.

4. Immediately report to Project Manager movement, cracking, or settlement which is detected.

5. Following substantial completion, but prior to final completion, perform final survey of monitoring points.

3.08 DISPOSAL OF EXCESS MATERIAL

A. Remove spoil from job site and dispose in accordance with Section 01576 - Waste Material Disposal.

END OF SECTION

SECTION 02426

SEWER LINE IN TUNNELS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Handling, transporting, and installing sanitary and storm sewer lines in primary lined tunnels.

1.02 RELATED SECTIONS

A. Section 01270 – Measurement and Payment

~~A.~~B. Section 01330 – Submittal Procedures

~~B.~~C. Section 02427 – Plastic Liner for Large-Diameter Concrete Sewers and Structures

~~C.~~D. Section 02431 – Tunnel Grout

~~D.~~E. Section 02501 – Ductile Iron Pipe and Fittings

~~E.~~F. Section 02504 – Fiberglass Reinforced Pipe

~~F.~~G. Section 02505 – High Density Polyethylene (HDPE) Solid and Profile Wall Pipe

~~G.~~H. Section 02506 – Polyvinyl Chloride Pipe

~~H.~~I. Section 02508 – Extra Strength Clay Pipe

~~I.~~J. Section 02533 – Acceptance Testing for Sanitary Sewers

~~J.~~K. Section 02611 – Reinforced Concrete Pipe

1.03 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. Length of sewer installed in primary lined tunnels will be measured by linear foot along center line of completed sewer, center line to center line of manholes, as designated on Drawings, and to end of stubs or termination of pipe; and to inside face of lift stations and treatment plant works. Installation of sewer within limits of structure other than manholes will not be considered for measurement and payment at unit price bid.

2. Payment for installation of sewer in primary lined tunnels is on a linear foot basis.

3. Refer to Section 01270 - Measurement and Payment for unit price procedures.

B. Stipulated Price (Lump Sum): If Contract is Stipulated Price Contract, payment for work in this Section is included in Total Stipulated Price.

1.04 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

B. Provide brief description of method of transporting carrier pipe into tunnel; method of hoisting and positioning pipe; method of jointing and aligning pipe; and blocking plan.

C. Submit buoyant force calculations, bulkhead design, and blocking details. Include in calculations analysis of stresses and deformation induced on carrier pipe. Submittal must be signed and sealed by Professional Engineer registered in State of Texas.

D. Submit as-built survey as described in Document 02533 - Acceptance Testing for Sanitary Sewers to Project Manager prior to substantial completion.

PART 2 PRODUCTS

2.01 PIPE MATERIAL AND FITTINGS

A. Sewer pipe may consist of fiberglass pipe (FRP), vitrified clay pipe (VCP), polyvinyl chloride (PVC) pipe, high density polyethylene (HDPE) pipe, plastic-lined reinforced concrete pipe (RCP), plastic-lined or epoxy lined ductile iron pipe (DIP) or combinations of these. Storm sewers do not require lining.

B. Assume responsibility for selecting appropriate pipes and pipe joints to safely carry loads imposed during construction.

2.02 FIBERGLASS PIPE

A. Provide fiberglass pipe, joints, and fittings in accordance with Section 02504 - Fiberglass Reinforced Pipe.

2.03 VITRIFIED CLAY PIPE

A. Provide vitrified clay pipe, joints and fittings in accordance with Section 02508 - Extra Strength Clay Pipe.

2.04 POLYVINYL CHLORIDE PIPE

A. Provide Polyvinyl chloride pipe, joints and fittings in accordance with Section 02506 - Polyvinyl Chloride Pip~~e.~~

2.05 HIGH DENSITY POLYETHYLENE PIPE

A. Provide High Density Polyethylene (HDPE) Solid and Profile Wall pipe, joints and fittings in accordance with Section 02505 - High Density Polyethylene (HDPE) Solid and Profile Wall Pipe.

2.06 DUCTILE IRON PIPE

A. As approved for pipe jacking applications, ductile iron pipe lined with polyethylene, polyurethane, or ceramic epoxy, and fittings to be in accordance with Section 02501 - Ductile Iron Pipe and Fittings.

2.07 REINFORCED CONCRETE PIPE

A. Provide reinforced concrete pipe, joints, and fittings in accordance with Section 02611 - Reinforced Concrete Pipe.

B. Provide plastic-liner for sanitary sewers in accordance with Section 02427 - Plastic Liner for Large-Diameter Concrete Sewers and Structures.

2.08 ANNULAR GROUT

A. Provide for grouting of annular space between pipe and tunnel liner as specified in Section 02431 - Tunnel Grout.

PART 3 EXECUTION

3.01 INSTALLATION TOLERANCES

A. Prior to installing sewer pipe, verify that primary liner has been constructed so that sewer pipe may be placed in conformance with specified tolerances.

B. Tolerances from lines and grades shown on Drawings for sewer pipe installed in primary liner are plus or minus 6 inches in horizontal alignment and plus or minus 1-1/2 inches in elevation. Should misalignment of primary liner preclude installation of sewer pipe to tolerances specified, notify Project Manager.

3.02 PIPE HANDLING

A. Handle and transport pipe into tunnel in manner that prevents damage to pipe, joints, gaskets, and plastic liner. Do not install pipe damaged during placement operations. Propose repair procedures for review and approval of Project Manager.

3.03 TUNNEL CLEANUP

A. Prior to pipe placement in tunnel, remove temporary tunnel utilities, such as electrical and ventilation. Remove loose material, dirt, standing water, and debris prior to pipe placement.

B. Temporary steel construction tracks or steel pipe skids may be left in place when they do not interfere with alignment of sewer pipe or interfere with final placement of annular grout.

3.04 INVERT PIPE SUPPORT

A. Provide support adequate to establish final pipe grade. Support may include screeded concrete, steel beam, or other method as designated by Contractor's Engineer. Secure pipe support to pipe or primary liner. When concrete is used for pipe support, cure it minimum of 12 hours prior to setting pipe.

3.05 JOINING PIPE IN TUNNELS

A. Join pipe segments to properly compress gaskets and allow for correct final positioning of pipe for line and grade. Closely align pipes by bringing them loosely together by means of hydraulic jacks, locomotives, pipemobiles, or winches. Once pipes have been loosely joined, pull them home by means of hydraulic tugger or other similar method suitably protecting pipe and joints against damage. Impact jointing such as ramming with locomotives or other mechanical equipment is not permitted.

3.06 BLOCKING PIPE IN TUNNEL AND BULKHEADS

A. Install pipe blocking system. Use pipe blocking to position sewer pipe in tunnel to allow minimum of 4 inches of grout to be placed between sewer pipe and tunnel primary liner or casing.

B. Secure blocking rigidly in place without dependence on wedges to prevent dislodging during pipe placement and grouting operations.

C. Construct bulkheads to withstand imposed grout pressure without leakage. Provide adequate venting for bulkheads.

3.07 ACCEPTANCE TESTING

A. Perform as-built survey on installed sewer pipe. Take invert elevations at each pipe joint. Take two diameter readings, at right angles, randomly at average of 20 feet spacing or less in non-rigid pipe.

B. Test for leakage by low pressure air methods in accordance with Section 02533 - Acceptance Testing for Sanitary Sewers.

END OF SECTION

SECTION 02431

TUNNEL GROUT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Mix design requirements, testing, furnishing and production of grout for:

1. Pressure ~~g~~Grouting of bolted liner plates for shafts.
2. Pressure ~~g~~Grouting of primary tunnel liner.
3. Pressure ~~g~~Grouting of jacked-pipe.
4. Annular ~~g~~Grouting of cased or uncased sewer pipe.
5. Grouting of annular space between carrier pipe and primary tunnel liner.
6. Grouting voids in ground resulting from caving, loss of ground, or settlement.
7. Grouting of manholes constructed in shafts.

B. Compaction grouting is not part of this specification.

1.02 ~~REALTED~~ RELATED SECTIONS

A. Section 01270 – Measurement and Payment

B. Section 01330 – Submittal Procedures

C. Section 02517 – Water Line in Tunnels

D. Section 03315 – Concrete for Utility Construction

1.03 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. No separate payment will be made for work performed under this Section. Include cost of such work in contract unit prices for work of which it is component part.
2. Refer to Section 01270 - Measurement and Payment for Unit Price procedures.

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

1.04 DEFINITIONS

A. Pressure Grouting. Filling void behind liner or pipe with grout under pressure sufficient to ensure void is properly filled but without overstressing temporary or permanent ground support, or causing ground heave to occur.

B. Back Grouting. Secondary ~~p~~Pressure ~~g~~Grouting to ensure that voids have been filled between primary tunnel or shaft liners and surrounding ground.

C. Annular Grouting. Filling annular space between ~~c~~Carrier ~~p~~Pipe and primary tunnel liner, casing, or ground, by pumping.

D. Ground Stabilization Grouting. Filling of voids, fissures, or under-slab settlement due to caving or loss of ground by injecting grout under gravity or pressure to fill void.

E. Carrier Pipe. Sanitary or storm sewer or water line installed inside primary tunnel support.

1.05 REFERENCES ~~STANDARDS~~

A. ASTM C 138 - Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.

B. ASTM C 144 - Standard Specification for Aggregate for Masonry Mortar.

C. ASTM C 150 - Standard Specification for Portland Cement.

D. ASTM C 494 - Standard Specification for Chemical Admixture for Concrete.

E. ASTM C 618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.

F. ASTM C 869 - Standard Specification for Foaming Agents Used in Making Preformed Foam for Cellular Concrete.

G. ASTM C 937 - Standard Specification for Grout Fluidifier for Pre~~-~~placed-~~-~~Aggregate Concrete.

H. ASTM C 942 - Standard Test Method for Compressive Strength of Grouts for Preplaced-Aggregate Concrete in the Laboratory.

~~I. ASTM C 1017 - Standard Specification for Chemical Admixture for Use in Producing Flowing Concrete.~~

1.06 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

B. Submit description of materials, grout mix, equipment and operational procedures to accomplish each grouting operation. Description may include sketches as appropriate, indicating type and location of mixing equipment, pumps, injection points, venting method, flow lines, pressure measurement, volume measurement, grouting sequence, schedule, and stage volumes. Tests and certifications shall have been performed within last 12 months prior to date of submittal.

C. Submit grout mix design report, including:

1. Grout type and designation

2. Grout mix constituents and proportions, including materials by weight and volume

3. Grout densities and viscosities, including wet density at point of placement

4. Initial set time of grout

5. Bleeding, shrinkage/expansion

6. Compressive strength

7. Detailed description of grout pressure limiting equipment

8. For annular space grouting, buoyant force calculations and bulkhead designs (See Section 02517 - Water Line in Tunnel for further requirements)

D. For cellular grout, also submit the following:

1. Foam concentrate supplier's certification of dilution ratio for foam concentrate.

2. A description of proposed cellular grout production procedures.

E. Maintain and submit logs of grouting operations indicating pressure, density, and volume for each grout placement.

PART 2 PRODUCTS

2.01 MATERIALS

A. Grouting materials: Conform to Section 03315 - Concrete for Utility Construction, except as modified in the following paragraphs.

B. Grout Type Applications.

1. Grout for ~~p~~Pressure ~~g~~Grouting, ~~b~~Backfill ~~g~~Grouting and ~~a~~Annular ~~g~~Grouting: Sand-cement mortar mix or cellular grout with minimum 1,500 psi compressive strength and pH in alkaline region.

2. Grout for ~~a~~Annular ~~g~~Grouting of sanitary sewer: Low density (cellular) grout, unless otherwise approved by Project Manager.

3. Grout for filling space around manholes in shafts: Sand-cement mortar mix.

4. Ground ~~s~~Stabilization: Sand-cement mortar mix.

C. Do not include toxic or poisonous substances in grout mix or otherwise inject such substances underground.

2.02 GROUT

A. Employ and pay for commercial testing laboratory, acceptable to Project Manager, to prepare and test grout mix design. Develop one or more mixes based on following criteria as applicable:

1. Size of annular void between sewer pipe and liner, or size of void between primary liner and surrounding soil

2. Absence or presence of groundwater

3. Adequate retardation

4. Non-shrink characteristics

5. Pumping distances

B. Prepare mixes that satisfy required application. Provide materials conforming to the following standards:

1. Cement: ASTM C 150

2. Fly Ash: ASTM C 618

3. Water: Potable

4. Foam: ASTM C 869

5. Slurry: ASTM C 138

6. Cellular Grout: ASTM C 138

7. Sand for sand-cement mortar mix: ASTM C 144

C. Provide grout meeting the following minimum requirements:

1. Minimum 28-day unconfined compressive strength: 1500 psi for water lines, 1000 psi for other carrier pipes for mortar grout and 300 psi for cellular grout.

2. Determine strength by ASTM C 942.

3. Maximum allowable density: Less than 130 pcf.

D. Fluidifier. Provide fluidifier, meeting ASTM C 937 that holds solid constituents of grout in colloidal suspension and is compatible with cement and water used in grouting operations.

E. Admixtures.

1. Use admixtures meeting ASTM C 494 ~~and ASTM C 1017~~ as required, to improve pump ability, control time of set, hold sand in suspension and reduce segregation and bleeding.

2. For cellular grout, do not use foam or admixtures that promote steel corrosion.

3. Ensure that admixtures used in mix are compatible. Provide written confirmation from admixture manufacturers of their compatibility.

PART 3 EXECUTION

3.01 PREPARATION

A. Notify Project Manager at least 24 hours in advance of grouting operations.

B. Select and operate grouting equipment to avoid damage to new or existing underground utilities and structures.

C. In selection of grouting placement consider pipe flotation, length of pipe, length of tunnel, depth from surface, and type of sewer pipe, type of pipe blocking and bulkheading, grout volume and length of pipe to be grouted between bulkheads.

D. Operate dewatering systems until grouting operations are complete and grout has reached initial set.

3.02 EQUIPMENT

A. Batch and mix grout in equipment of sufficient size and capacity to provide necessary quality and quantity of grout for each placement stage.

B. Use equipment for grouting of type and size generally used for work, capable of mixing grout to homogeneous consistency, and providing means of accurately measuring grout component quantities and accurately measuring pumping pressures. Use pressure grout equipment which delivers grout to injection point at steady pressure.

3.03 PRESSURE GROUTING FOR PRIMARY TUNNEL AND SHAFT LINER

A. Perform grouting operations to fill voids outside of primary tunnel or shaft liner.

B. For nonexpendable primary liners installed behind shield or tunnel boring machine (TBM), fill voids with sand-cement grout promptly after each ring of liner is out of shield. Keep grout pressure below value that may cause damage or distortion to installed liner plate rings. Provide seals on tail of shield or TBM which will prevent grout from spilling.

C. For nonexpendable primary liners installed by hand mining or in shafts, grout once every 4 feet or more frequently when conditions dictate.

D. Control grout pressures so that tunnel or shaft liner is not overstressed, and ground heave is avoided.

E. For liner requiring grout, perform back grouting once each shift, or more often when required to ensure that all voids are filled.

3.04 ANNULAR GROUTING FOR SEWER LINE IN TUNNELS AND IN CASED OR UNCASED AUGERS

A. Fill annular space between sewer pipe and tunnel primary liner, casing or ground, with grout.

B. Placement

1. Placement Limits: Predetermine limits of each grout placement stage by size and capacity of batching equipment and initial set time of proposed grout. Under no circumstances shall placement continue at grout port longer than that period of time for mix to take initial set. Locate grout hole spacing and locations according to number of stages necessary to grout tunnel liners. Stage or lift cannot be installed on another lift until proper set has been attained. Have placement procedures approved by admixture or additive manufacturer.

2. Limit pressure on annular space to prevent damage or distortion to pipe or liner. Define limiting and estimated required pressure range. Provide an open ended, high point tap or equivalent vent and monitor it at bulkhead opposite to point of grouting.

3. Pump grout until material discharging is similar in consistency to that at point of injection.

4. In primary lined tunnel, limit length of pipe installed to 200 feet or less before grouting same length of sewer line. Repeat this cycle until all pipe is installed and grouted.

C. Remove temporary bulkheads installed for grouting.

D. Batch and mix cellular grout mechanically to ensure consistency of mix. Wet solids thoroughly before introduction of foaming agent. Operate batching system to maintain slurry weight within 3 percent of design density. Introduce foam into slurry in accordance with manufacturer's recommendations.

3.05 PRESSURE GROUTING FOR JACKED PIPE

A. For jacked pipe 60 inches in diameter or greater, pressure grout annulus after installation, displacing bentonite lubrication. Jacked pipes less than 60-inch diameter may be left ungrouted unless excavated diameter exceeds external pipe diameter by more than one inch.

B. Inject grout through grout holes in sewer pipe. Drilling holes from surface or through ~~c~~Carrier ~~p~~Pipe walls is not allowed. Perform grouting by injecting it at pipe invert with bentonite displacement occurring through high point tap or vent.

C. Control ground water as necessary to permit completion of grouting without separation of grout materials.

D. Limit pressures to prevent damage or distortion to pipe or to keep flexible pipe within acceptable tolerances.

E. Pump grout until material discharging is similar in consistency to that at point of injection.

3.06 GROUND STABILIZATION GROUTING

A. Completely fill voids outside limits of excavation caused by caving or collapse of ground. Fill with gravity or pressure injected sand-cement grout as necessary to fill void.

B. Take care in grouting operations to prevent damage to adjacent utilities or public or private property. Grout at pressure that will not distort or imperil portion of work or existing installations or structures.

C. Verify that void has been filled by volumetric comparisons and visual inspection. In case of settlement under existing slabs, take cores as directed by Project Manager, at no additional cost to City, to demonstrate that void has been filled.

3.07 FIELD QUALITY CONTROL

A. Pressure Grouting for Primary Tunnel and Shaft Liners.

1. For each shaft, make one set of four compressive test specimens for each 30-foot depth and one set for remaining portion less than 30-foot increment.

2. Make one set of four compressive test specimens for every 200 feet of primary lined, (non-expandable) tunnel requiring grout.

B. Annular Grouting for Sewer Line in Tunnels and in Cased or Uncased Augers.

1. Make one set of four compressive test specimens for every 200 feet of sewer pipe installed in primary lined tunnel.

2. For cased or uncased augers, make one set of four compressive test specimens for each grouting operation, or for each 100 feet of pipe installed, whichever is more frequent.

3. For cellular grout, check slurry density both at point of batching and placement at least twice each hour in accordance with ASTM C 138. Record density, time, and temperature. Density must be within 3 percent of design density at point of batching and 5 percent of design density at point of placement.

C. Pressure Grouting for Jacked Pipe. Make one set of four compressive test specimens for every 400 feet of jacked pipe pressure grouting.

D. Ground Stabilization Grouting. Make one set of four compressive test specimens for every location where ~~g~~Ground ~~s~~Stabilization ~~g~~Grouting is performed.

END OF SECTION

Section 02441

MICROTUNNELING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Tunnel construction of pipes by Microtunneling. Construction method involves jacking pipe following a micro-tunnel boring machine (MTBM), with jacking pipe serving as tunnel liner.

1.02 RELATED SECTIONS

A. Section 01270 – Measurement and Payment

~~A.~~B. Section 01330 – Submittal Procedures

~~B.~~C. Section 01576 – Waste Material Disposal

~~C. Section 01578 – Control of Ground and Surface Water~~

D. Section 02400 – Tunnel Shafts

E. Section 02401 – Common Tunnel Shafts

~~F. Section 02426 – Sewer Line in Tunnels~~

~~G.~~F. Section 02427 – Plastic Liner for Large-Diameter Concrete Sewers and Structures

~~H.~~G. Section 02431 – Tunnel Grout

~~I.~~H. Section 02504 – Fiberglass Reinforced Pipe

~~J.~~I. Section 02508 – Extra Strength Clay Pipe

~~K.~~J. Section 02517 – Water Line in Tunnels

~~L.~~K. Section 02533 – Acceptance Testing for Sanitary Sewers

~~M.~~L. Section 02611 – Reinforced Concrete Pipe

1.03 MEASUREMENT AND PAYMENT

A. Unit Prices

1. Length of sewer installed will be measured by linear foot along center line of completed sewer from center line to center line of manholes, as designated on Drawings; and to end of stubs or termination of pipe; and to inside face of lift station and treatment plant works. Installation of sewer within limits of structure other than manholes will not be considered for measurement and payment at unit price bid.

2. Payment will include and be full compensation for labor, equipment, materials, and supervision for construction of sewer and excavation, complete in place including disposal of excess materials, sheeting, shoring or bracing, dewatering, utility adjustments, connections to existing sewers, grouting when required, tests, backfilling, clean-up, and other related work necessary for construction as specified or as shown on Drawings.

3. Payment for installation of sewer will be authorized by Project Manager in two parts. Pay estimates for partial payments will be made as measured above according to following schedule:

   a. 95 percent payment will be made for jacked pipe on linear foot basis for amount of jacked pipe installed but not yet grouted, in cases where grouting is specified.

   b. 100 percent payment will be authorized on a linear foot basis for amount of jacked pipe installed, including grouting when specified.

4. No separate payment will be made for water lines in casing under this Section. Refer to Section 02517 – Water Line in Tunnels for measurement and payment.

5. Refer to Section 01270 - Measurement and Payment for Unit Price procedures.

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

1.04 REFERENCES ~~STANDARDS~~

A. American Railway Engineering and Maintenance-of-Way Association (AREMA) Manual for Railway Engineering.

B. American Association of State Highway and Transportation Officials (AASHTO).

C. ASTM A 36 – Standard Specification for Carbon Structural Steel.

D. ASTM A 139 – Standard Specification for Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and Over).

E. ASTM A 515 – Standard Specification for Pressure Vessel Plates, Carbon Steel, for Intermediate-and Higher-Temperature Service.

F. ASTM A 572 – Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.

G. ASTM A 1097 – Standard Specification for Steel Casing Pipe, Electric-Fusion (Arc)-Welded (Outside Diameter of 10 in. and Larger).

H. AWWA C200 – Steel Water Pipe-6 ~~i~~In. and Larger.

I. National Electrical Code - (NFPA 70).

J. NSF/ANSI 60 – Drinking Water Chemicals – Health Effects.

~~J.~~K. ANSI/AWS D1.1 – Structural Welding Code-Steel.

~~K.~~L. Occupational Safety and Health Administration (OSHA).

1.05 DEFINITIONS

A. Conditioners: Bentonite, foam, polymers and/or other materials added to the excavated materials (cuttings) to modify them. Conditioners are required to form earth paste and an appropriate support medium in the excavation chamber, and to reduce the abrasive nature of the excavated materials.

B. Critical Structure: Building, structure, bridge, pier, or similar construction partially or entirely located within Zone of Active Excavation, unless otherwise defined in Contract Documents.

C. Earth Pressure Balance (EPB) MTBM System: A Microtunneling system that incorporates a screw conveyor to facilitate forming of ground controlling plug and removal of excavated soil into muck car. Face and ground water pressure is balanced by pressure of excavated material held back by the plug. Earth pressure balance systems may utilize ground Conditioners to assist in maintaining pressure balance and enhance controllability and operation of system.

D. Intermediate Jacking Station: Supplementary jacking system installed between two Jacking Pipe sections without use of an additional shaft.

E. Jacking Pipe: Pipe or casing installed by Microtunneling process that is capable of carrying installation jacking loads in addition to normal pipe loads.

F. Microtunneling: Method of installing by jacking pipe or casing behind Microtunnel Boring Machine that is connected to and jacked forward by pipe or casing being installed, generally precluding man entry for routine operation.

G. Microtunnel Boring Machine (MTBM): Mechanized excavating equipment incorporating Pressurized Head that is remotely-controlled, steerable, laser/gyroscope navigational system guided, articulated, with controlled face that fully supports excavation face with fluid and/or earth pressure balance at all times and connected to and shoved forward by pipe or casing being installed, usually precluding man entry for routine operation.

H. Pressurized Head: Bulkhead within MTBM designed to be watertight.

I. Slurry Pressure Balance MTBM System: A Microtunneling system that uses a low-pressure fluid to balance ground and water pressure at face of tunnel and to transport excavated spoils to surface.

J. Work Plan: Written description together with supporting documentation that defines plans and procedures for Microtunneling operations.

K. Zone of Active Excavation: Area located within radial distance centered about surface point immediately above face of excavation and with radius equal to depth from ground surface to bottom of excavation, or as otherwise indicated in Drawings.

1.06 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

B. The following submittals are required:

1. Work Plan: Submit brief description of proposed tunnel methodology for record purposes. Description should be sufficient to convey the following:

a. Type of face support.

b. Manufacturer and type of tunneling equipment proposed.

c. Cutter head details.

d. Locations of access shafts and work sites.

e. Proposed method of machine launch, exit and retrieval.

f. Capacity of jacking equipment and type of cushioning.

g. Planned use of Intermediate Jacking Stations, if applicable, and closure of Intermediate Jacking Stations upon completion of drive.

h. System of alignment monitoring and steering control and activation.

i. Lubrication system.

j. Slurry system for slurry Microtunneling.

k. Soil conditioning, if necessary, for EPB Microtunneling.

l. Number and duration of shifts planned to be worked each day.

m. Sequence of operations.

n. Spoil surface storage, separation, and disposal.

o. Contingency plan and emergency procedures, including but not limited to machine maintenance and/or component repair, and Jacking Pipe failure.

p. Supplementary alignment surveying.

q. Lubrication mixing and injection.

r. Source of water used in slurry, lubricant, and grout.

2. Drawings and Calculations: Submit drawings and calculations for tunnel support. Provide adequate drawings and installation details for construction. Show pipe and pipe joint detail. Documents must be signed and sealed by Professional Engineer registered in State of Texas. Calculations shall include clear statement of criteria used for design as described in Article 1.07.A, Design Requirements.

a. Calculations to demonstrate that the maximum jacking loads will not exceed the maximum allowable jacking forces of the MTBM and the Jacking Pipe selected.

b. Calculations to demonstrate pipe selected is designed to support maximum anticipated earth loads and superimposed live loads, both static and dynamic, which may be imposed on pipe and additional stresses imposed on the pipe during jacking operations.

c. Calculations of estimated operating pressure at the tunnel face.

d. Calculations demonstrating that jacking shaft and backstop arrangement can safely accommodate maximum calculated jacking load without excessive or detrimental movement.

3. Personnel: Submit for record purposes, résumés for project manager, field superintendent and Microtunneling machine operators.

a. Experience: Minimum of 3 previous successful Microtunneling installations of similar size and scope.

b. Detailed descriptions of Microtunneling projects.

4. Quality Control: Description of quality control methods including:

a. Method and frequency of survey control.

b. Example of tunnel daily log.

5. Geotechnical Investigation: When geotechnical investigations are conducted, submit results to Project Manager for record purposes.

6. Monitoring Plans.

a. Instrumentation Monitoring Plan: Submit for review, prior to construction, instrumentation monitoring plan that includes schedule of instrumentation design, layout of instrumentation points, equipment installation details, manufacturer's catalog literature, and monitoring report forms.

b. Surface Settlement Monitoring Plan: Submit surface settlement monitoring plan for review prior to construction. Plan shall identify the location of settlement monitoring points, reference benchmarks, survey frequency and procedures, and reporting formats.

7. Structures Assessment: Provide preconstruction and post construction assessment reports for Critical Structures. Include pre- and post-construction survey and assessment (including photographs or video).

8. Monitoring readings shall be submitted to Project Manager.

9. Daily Reports: Maintain shift log as defined in Article 3.0~~4~~3.B, Tunneling Data and make available to Project Manager on request.

1.07 SYSTEM DESCRIPTION

A. Design Requirements.

1. Assume responsibility for selection of appropriate pipe and pipe joints to carry thrust of any jacking forces or other construction loads in combination with overburden, earth and hydrostatic loads. Design of any pipe or casing indicated on Drawings considers in-place loads only and does not take into account any construction loads. Criteria for longitudinal loading (jacking forces) on pipe and joints shall be determined, based on selected method of construction.

2. Jacking Pipe shall be designed to withstand thrust from MTBM advance without damage or distortion. Configure main jacking frame so thrust is uniformly distributed and will not damage or distort pipe or casing.

3. Take into account loads from handling and storing.

4. Criteria to be used at railroad crossings shall be Cooper E-80 locomotive loading distributions in accordance with AREMA specifications for culverts. In design, account for additive loadings due to multiple tracks.

5. Criteria to be used for truck loading shall be in accordance with the AASHTO LRFD Bridge Design Specification.

6. Provide pipes and casing of diameter shown on Drawings. Substitution of larger diameter to suit MTBM equipment availability for sewer lines will only be permitted if demonstrated to satisfaction of Project Manager that design flows and velocities can be achieved.

PART 2 PRODUCTS

2.01 JACKING PIPE

A. Assume responsibility for selecting appropriate pipes and pipe joints to safely carry loads imposed during construction, including jacking forces. Pipe joints shall be flush with outside pipe face when pipes are assembled. Pipe materials shall be as indicated on Drawings or selected from the following if not indicated on Drawings:

1. Fiberglass Reinforced pipe, joints, and fittings to be in accordance with Section 02504 - Fiberglass Reinforced Pipe.

2. Vitrified clay pipe, joints and fittings to be in accordance with Section 02508 - Extra Strength Clay Pipe.

3. Plastic-lined reinforced concrete pipe with joints and fittings to be in accordance with Section 02611 - Reinforced Concrete Pipe and Section 02427 - Plastic Liner for Large-Diameter Concrete Sewers and Structures. Plastic liner is not required for storm sewers.

4. Steel casing pipe: Provide new, uncoated steel pipe manufactured in accordance with ASTM A 1097 for sewer line applications and ASTM A 1097 and AWWA C200 for water line applications. Joints may be field-welded butt joints or interlocking joints and shall be watertight.

   a. For field-welded butt-joint casing, manufacture in accordance with ASTM A 139 Grade E, or ASTM A 572 Grade 50. Provide full circumferential welds at butt joints.

   b. For steel casing pipe with interlocking joints, provide in accordance with the following:

      (1) Provide ASTM A 36, ASTM A 515, Grade 60, or ASTM A 572, Grade 42 for pipe, and provide minimum ASTM A 36 for connections.

(2) Maintain pipe roundness to within 1 percent of specified diameter.

(3) Maintain outside circumference to within 1% of nominal specified circumference, or 3/4 inches, minimum.

(4) Maintain wall thickness to within 5% of specified thickness.

(5) Provide rolled and welded cylinder method utilizing the double submerged arc welding (DSAW) process in sections not less than 8 feet long, except as needed to achieve the final finished length of pipe.

(6) Provide complete penetration butt-welded connectors square to ends of pipe sections.

(7) Perform welding in accordance with ANSI/AWS D1.1.

(8) Examine connections at time of shipment. Reject sections with defects.

(9) Mark all sections with manufacturer's name, job number, customer name, outside diameter, wall thickness, and weight per foot.

(10) Ship pipe with protective wax coating over machined surfaces.

(11) Provide Permalok or approved equal.

c. Design stress in pipe wall shall be 50 percent of minimum yield point of steel or 18,000 psi, whichever is less when subjected to loading conditions.

d. Design deflection to be used in determining wall thickness shall not exceed 3 percent of nominal casing pipe size.

e. Bedding constant to be used in determining wall thickness shall be 0.10. Lag factors shall be 1.0 for all live loads.

f. Casing pipe design shall also include stresses due to jacking forces.

B. Use pipe that is round with smooth, even outer surface, and has joints that allow for easy connections between pipes. Design pipe ends so jacking loads are evenly distributed around entire pipe joint and point loads will not occur when pipe is installed. Pipe used for pipe jacking shall be capable of withstanding all forces imposed by process of installation, as well as final in-place loading conditions. Protect driving ends of pipe and joints against damage.

C. A list of approved jacking pipes is included in the City of Houston Wastewater Pre-Approved Products List (Reference COHWW02441-). This list is not applicable for casing pipe.

2.02 GROUT

A. Grout shall be in accordance with requirements defined in Section 02431 – Tunnel Grout.

2.03 ANNULAR SPACE LUBRICATION

A. Lubricants shall be NSF 60 approved.

B. Water used for pipe lubrication shall be clean, fresh, and free from oil, organic matter, or other deleterious matter and of neutral pH.

2.04 CONDITIONERS

A. Conditioners shall be inert or biodegradable, accompanied by the manufacturers' certificate of compliance with Safety Data Sheets (SDS).

B. Water is no acceptable as a soil conditioner.

2.05 WATER

A. Water used in slurry, lubricant, and grout shall be obtained from potable water source. Soda ash or accepted equal, with submittal of a Safety Data Sheet (SDS), shall be used to adjust pH of water as required in mix design.

PART 3 EXECUTION

3.01 CONSTRUCTION OPERATIONS CRITERIA

A. Use methods for Microtunneling operations that will minimize ground settlement. Select a method that controls flow of water, prevents loss of soil into the tunnel and provides stability of the face under anticipated conditions.

B. Conduct tunneling operations in accordance with applicable safety rules and regulations, OSHA standards and Contractor's safety plan. Use methods that include due regard for safety of workmen, adjacent structures, utilities, and public and safe means of ingress and egress.

C. Maintain clean working conditions wherever there is man access.

D. Perform installation so as to avoid interference with operation of railroads, highways, or streets, except as approved by owner of facility.

E. Shafts required for microtunnel construction shall be in conformance with Section 02400 – Tunnel Shafts and Section 02401 – Common Tunnel Shafts.

3.02 EQUIPMENT

A. Full directional guidance of MTBM is prerequisite of this method of construction.

B. Assume responsibility for selection of tunneling equipment which, based on past experience, has proven to be satisfactory for excavation of soils to be encountered.

C. Employ tunneling equipment that is capable of handling various anticipated ground conditions, is capable of minimizing loss of soil ahead of and around machine and provides satisfactory support of excavated face.

D. Microtunneling Equipment.

1. Slurry Pressure Balance MTBM System shall be capable of adjustments required to maintain face stability for particular soil condition and shall monitor and continuously balance soil and ground water pressure to prevent loss of slurry or uncontrolled soil and ground water inflow, or, in case of slurry spoil transportation system:

   a. Provides pressure at excavation face by use of slurry pumps, pressure control system, and flow meter.

   b. Includes slurry bypass unit in system to allow direction of flow to be changed and isolated, as necessary.

2. Earth Pressure Balance MTBM System shall be capable of adjustments required to maintain face stability for particular soil condition to be encountered. Monitor and continuously balance soil and ground water pressure to prevent loss of soil or uncontrolled ground water inflow.

   a. The spoil transportation system shall be capable of managing pressure at the excavation face by controlling volume of spoil removal with respect to advance rate. Monitor speed of rotation of screw conveyor, and addition of water.

3. Remote Control System: Provide MTBM that includes remote control system with following features:

   a. Allows for operation of system without need for personnel to enter tunnel for routine operations. Has display available to operator, at remote operation console, showing position of shield in relation to design reference together with other information such as face pressure, roll, pitch, steering attitude, valve positions, thrust force, and cutter head torque; rate of advance and installed length.

   b. Integrates system of excavation and removal of spoil and its simultaneous replacement by pipe. As each pipe section is jacked forward, remote control system shall synchronize all of operational functions of system.

4. Active Direction Control System: Provide MTBM that includes active direction control system with the following features:

   a. Controls line and grade by a guidance system that remotely relates actual position of MTBM to design reference.

   b. Provides active steering information that is monitored and transmitted to operating console.

   c. Provides positioning and operation information to operator on control console.

E. Pipe Jacking Equipment: Provide pipe jacking system with the following features:

1. Has main jacks mounted in jacking frame located in starting shaft.

2. Has jacking frame which successively pushes string of connected pipes following tunneling excavation equipment towards receiving shaft.

3. Has sufficient jacking capacity to push tunneling excavation equipment and string of pipe through ground. Incorporates Intermediate Jacking Stations, if required.

4. Has capacity at least 20 percent greater than calculated maximum jacking load.

5. Develops uniform distribution of jacking forces on end of pipe by use of spreader rings and packing.

6. Provides and maintains pipe lubrication system at all times to lower friction developed on surface of pipe during jacking.

7. Jack Thrust Reactions. Use reaction/thrust walls for pipe jacking that are adequate to support jacking pressure developed by main jacking system. Special care shall be taken when setting pipe guide rails in jacking shaft to ensure correctness of alignment, grade, and stability.

F. Slurry Separation Equipment: If slurry MTBM is being used, provide a slurry separation system meeting the following requirements:

1. Provide adequate separation of the spoil from the slurry so that slurry content within the limits set by the Contractor’s Work Plan can be returned to the cutting face for reuse.

2. Use a mechanical separation plant, including scalping screens, shaker screens, de-sanding and de-silting cones, and centrifuge as deemed necessary by the Work Plan.

3. Appropriately contain spoil at the site before disposal.

4. The type of separation process is suited to the size of the tunnel being constructed, the ground type being excavated, the volume of expected flow generated by the slurry circuit, and the workspace available at each jacking shaft location for operating the plant.

5. Monitor the composition of the slurry to maintain the slurry weight, gel strength, and viscosity limits defined by the Contractor's Work Plan.

G. Air Quality: Provide equipment to maintain proper air quality assuming manned tunnel operations during construction in accordance with OSHA requirements.

H. Where used, enclose lighting fixtures in watertight enclosures with suitable guards. Provide separate circuits for lighting, and other equipment.

I. Electrical systems shall conform to requirements of National Electrical Code - NFPA70.

3.03 TUNNELING DATA

A. Utilize a real-time data collection system and make available to the Project Manager on request.

B. Maintain shift logs of construction events and observations. Project Manager shall have access to all logs containing the following required information:

1. Location of boring machine face by station and progress of tunnel drive during shift.

2. Hours worked per shift on tunneling operations.

3. Completed field forms, such as steering control logs, for checking line and grade of tunneling operation, showing achieved tolerance relative to design alignment.

4. Maximum pipe jacking pressures per drive.

5. Lubricant pressures and estimated quantities.

6. Observation of any lost ground or other ground movement.

7. Any unusual conditions or events.

8. Reasons for operational shutdown in event drive are halted.

3.04 EXCAVATION AND JACKING OF PIPE

A. Tunnel Excavation.

1. Keep tunnel excavation within easements and rights-of-way indicated on Drawings and to lines and grades designated on Drawings.

2. Perform tunneling operations in a manner that will minimize movement of ground in front of and surrounding tunnel. Prevent damage to structures and utilities above and in vicinity of tunneling operations.

3. Pressurized Head Excavation

   a. Carefully control volume of spoil removed. Advance rate and excavation rate to be compatible to avoid over excavation, loss of ground or ground heave.

   b. When cutting head is withdrawn or is open for any purpose, keep excavated face supported and stabilized.

4. Whenever a condition is encountered which could endanger tunnel excavation or adjacent structures, operate without intermission including 24-hour working, weekends and holidays, until condition no longer exists. Such conditions shall be brought to the attention of Project Manager within 24 hours.

5. Assume responsibility for damage due to settlement from any construction-induced activities.

B. Pipe Jacking.

1. Cushion pipe joints as necessary to transmit jacking forces without damage to pipe or pipe joints, in accordance with pipe manufacturer’s recommendations.

2. Maintain envelope of bentonite slurry around exterior of pipe during jacking and excavation operation to reduce exterior friction and possibility of pipe seizing in place.

3. If a recovery access shaft is needed, obtain approval from Project Manager prior to excavation. Coordinate traffic control measures and utility adjustments as necessary prior to commencing work.

4. If a section of pipe is damaged during jacking operation, or joint failure occurs, as evidenced by inspection, visible ground water inflow or other observations, submit for approval Contractor’s proposed methods for repair or replacement of pipe. Document repairs by providing repair locations (station numbers), pictures/videos showing condition of the pipe or joint before and after repairs are done, and a certification from manufacturer’s representative that repairs have been inspected and are considered acceptable.

C. Grouting: Grouting requirements are defined in Section 02431 - Tunnel Grout.

3.05 CONTROL OF LINE AND GRADE

A. Construction Control.

1. Project Manager will establish baselines and benchmarks indicated on Drawings. Check baselines and benchmarks at beginning of Work and report any errors or discrepancies to Project Manager.

2. Use baselines and benchmarks established by Project Manager to establish and maintain construction control points, reference lines and grades for locating tunnel, sewer pipe, and structures.

3. Establish construction control points sufficiently far from work so as not to be affected by ground movement caused by pipe-jacked tunneling operations.

B. Benchmark Movement: If settlement of ground surface occurs during construction which affects accuracy of temporary benchmarks, detect and report such movement and reestablish temporary benchmarks. Locations of permanent City of Houston monumentation benchmarks are indicated on Drawings. Advise Project Manager of any settlement affecting permanent monumentation benchmarks.

C. Guidance System and Alignment Control.

1. Provide the Project Manager access to the guidance system readings at all times to be able to verify alignment and grade.

2. Initial alignment of equipment and final pipe/casing alignment shall be documented.

D. Line and Grade.

1. Check and record alignment for tunnel against above-ground undisturbed reference after installation of each Jacking Pipe.

2. Record exact position of MTBM after each shove to ensure alignment is within specified tolerances. Make immediate correction to alignment before allowable tolerances are exceeded.

3. When excavation is off line or grade, make alignment corrections to avoid reverse grades in gravity sewers.

4. Acceptance criteria for jacking pipe shall be plus or minus 6 percent of the MTBM diameter in horizontal alignment or 2 inches, whichever is greater, and plus or minus 3 percent of the MTBM diameter in elevation or 1 inch, whichever is greater, from the design line and grade, unless otherwise indicated on the Drawings.

5. If it is determined that the pipe cannot be used, pipe installed outside tolerances shall be fully grouted and abandoned.

3.06 MONITORING

A. Instrumentation Monitoring: Instrumentation requirements are shown on Drawings. Instrumentation specified shall be accessible at all times to Project Manager.

1. Install and maintain instrumentation system to monitor and detect movement of ground surface and adjacent structures. Establish vertical control points at a distance from construction areas that avoids disturbance due to ground settlement.

2. Installation of instrumentation shall not preclude Project Manager, through independent contractor or consultant, from installing instrumentation in, on, near, or adjacent to construction work. Access shall be provided to work for such independent installations.

3. Instruments shall be installed in accordance with Drawings and manufacturer's recommendations.

B. Surface Settlement Monitoring.

1. Establish monitoring points on all Critical Structures.

2. Record location of settlement monitoring points with respect to construction baselines and elevations. Record elevations to accuracy of 0.01 feet for each monitoring point location. Monitoring points should be established at locations and by methods that protect them from damage by construction operations, tampering, or other external influences.

3. Ground surface elevations shall be recorded on centerline ahead of tunneling operations at minimum of 100-foot intervals or at least three locations per tunnel drive. For sewers greater than 60-inch diameter, also record similar data at approximately 20 feet each side of centerline. Settlement monitoring points must be clearly marked by studs or paint for ease of locating.

4. Railroads. Monitor ground settlement of track subbase at centerline of each track. Follow American Railway Engineering and Maintenance-of-Way Association (AREMA) crossing requirements.

5. Utilities and Pipelines. Monitor ground settlement directly above and at least 10 feet or two excavation diameter, whichever is greater, before and after utility or pipeline intersection as shown on the Drawings.

C. Reading Frequency and Reporting: Submit to Project Manager, records of readings from various instruments and survey points.

1. Readings shall be taken:

a. Prior to Zone of Active Excavation reaching that point.

b. When tunnel face reaches monitoring point (in plan).

c. When Zone of Active Excavation has passed and no further movement is detected.

2. All monitoring readings shall be submitted daily to Project Manager.

3. Immediately report to Project Manager any movement, cracking, or settlement detected.

4. Following substantial completion but prior to final completion, make final survey of remaining monitoring points and submit to Project Manager.

3.07 DISPOSAL OF EXCESS MATERIAL

A. Remove spoil in accordance with Section 01576 - Waste Material Disposal.

3.08 ACCEPTANCE TESTING FOR SEWERS

A. Acceptance testing is to be carried out by methods described in Section 02533 - Acceptance Testing for Sanitary Sewer.

END OF SECTION

SECTION 02445

JACK AND BORE/JACK AND MINE/PILOT TUBE GUIDED BORING TUNNELS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Furnishing and installation of pipes by Jack and Bore, Jack and Mine or Pilot Tube Guided Boring.

1.02 RELATED SECTIONS

A. Section 01330 – Submittal Procedures

B. Section 01576 – Waste Material Disposal

C. Section 01578 - Control of Ground and Surface Water

~~D. Section 02400 – Tunnel Shafts~~

~~E. Section 02401 – Common Tunnel Shafts~~

~~F. Section 02426 – Sewer Line in Tunnels~~

~~G.~~D. Section 02427 – Plastic Liner for Large-Diameter Concrete Sewers and Structures

~~H.~~E. Section 02431 – Tunnel Grout

~~I.~~F. Section 02504 – Fiberglass Reinforced Pipe

~~J.~~G. Section 02508 – Extra Strength Clay Pipe

~~K.~~H. Section 02511 – Water Lines

~~L.~~I. Section 02517 – Water Line in Tunnels

~~M.~~J. Section 02533 – Acceptance Testing for Sanitary Sewers

~~N.~~K. Section 02611 – Reinforced Concrete Pipe

~~O.~~L. Section 02612 – Precast Reinforced Concrete Box Sewers

1.03 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. Length of sewer installed will be measured by linear foot along center line of completed sewer from center line to center line of manholes, as designated on Drawings; and to end of stubs or termination of pipe; and to inside face of lift station and treatment plant works. Installation of sewer within limits of structure other than manholes will not be considered for measurement and payment at unit price bid.

2. Payment will include and be full compensation for labor, equipment, materials, and supervision for construction of sewer or casing and excavation, complete in place including disposal of excess materials, sheeting, shoring or bracing, dewatering, utility adjustments, connections to existing sewers, grouting when required, tests, backfilling, clean-up, and other related work necessary for construction as specified or as shown on Drawings.

3. Payment for installation of sewer or casing will be authorized by the Project Manager in two parts. Pay estimates for partial payments will be made as measured above according to following schedule:

    a. 95 percent payment will be made for jacked pipe on linear foot basis for amount of jacked sewer pipe installed but not yet grouted, in cases where grouting is specified.

    b. Remaining 5 percent payment will be made for jacked pipe on linear foot basis for amount of jacked sewer pipe installed and grouted, in cases where grouting is specified. A 100 percent payment will be made for jacked pipe on linear foot basis for amount of jacked sewer pipe installed, in cases where grouting is not specified.

4. No separate payment will be paid for water lines in tunnel under this Section. Refer to Section 02511 – Water Lines or Section 02517 – Water Line in Tunnel for measurement and payment.

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

1.04 REFERENCE STANDARDS

A. American Railway Engineering and Maintenance-of-Way Association (AREMA) Manual for Railway Engineering.

B. American Association of State Highway and Transportation Officials (AASHTO)- LRFD Bridge Design Specification.

C. ASTM A 36 – Standard Specification for Carbon Structural Steel.

D. ASTM A 139 – Standard Specification for Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and Over).

E. ASTM A 515 – Standard Specification for Pressure Vessel Plates, Carbon Steel, for Intermediate and Higher Temperature Service.

F. ASTM A 572 – Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.

G. ASTM A 1097 – Standard Specification for Steel Casing Pipe, Electric-Fusion (Arc)-Welded (Outside Diameter of 10 in. and Larger).

H. AWWA C200 – Steel Water Pipe-6 in. and Larger.

I. National Electrical Code - (NFPA 70).

J. NSF/ANSI 60 – Drinking Water Chemicals – Health Effects.

K. Occupational Safety and Health Administration (OSHA).

1.05 DEFINITIONS

A. Critical Structure: Buildings, structures, bridges, piers, or similar construction partially or entirely located within Zone of Active Excavation, or otherwise identified in Drawings.

B. Jack and Bore: Pipe or casing is installed by jacking process with system that has limited steering capability and does not have continuous face support. Excavation is performed using open face auger.

C. Jack and Mine: Pipe or casing is installed by jacking it into place from jacking shaft to receiving shaft, using hydraulic jacks while excavation takes place at the face by hand mining or mechanical excavation.

D. Jacking Pipe: Pipe or casing installed by jacking process and that is capable of carrying installation jacking loads in addition to normal pipe loads.

E. Pilot Tube Guided Boring: Multi-stage method of installing pipe or casing to line and grade by use of guided pilot tube and followed by enlargement to install pipe or casing.

F. Work Plan: Written description together with supporting documentation that defines plans and procedures for tunneling operations.

G. Zone of Active Excavation: Area located within the radial distance centered about surface point immediately above the face of excavation and with radius equal to depth from ground surface to bottom of excavation, or as otherwise indicated in Drawings.

1.06 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

B. The following submittals are required:

1. Work Plan: Written description together with supporting documentation that defines plans and procedures for tunneling operations. Description should be sufficient to convey the following:

   a. Proposed method of pipe or casing installation and type of face support.

   b. Installation of jacking or boring supports or back stop. Installation of pipe jack or Pilot Tube Guided Boring thrust block.

   c. Jack and Bore system manufacturer's literature describing equipment and proposed jacking system including machine:

      (1) Dimensions

      (2) Weight

      (3) Power and torque capabilities

      (4) Arrangement and position of jacks and pipe guides

      (5) Cutterhead configuration details including cutterhead teeth

      (6) Mucking system

      (7) Auger size

   d. Type of lighting and description of ventilation systems when person entry is required.

   e. Pilot Tube Guided Boring tooling and reaming equipment.

   f. System of alignment monitoring and steering control and activation.

   g. Number and duration of shifts planned to be worked each day.

   h. Sequence of operations.

   i. Locations of boring and receiving shafts.

   j. Method of spoil transportation from face, surface storage and disposal location.

   k. Jacking mechanism including maximum jacking capacity.

   l. Jacking force monitoring and recording details.

   m. Capacity of jacking equipment and type of cushioning. Anticipated jacking forces for each drive. Safe jacking capacity of Jacking Pipe.

n. Identify critical utility crossings and special precautions proposed.

o. Description and details of any temporary underground facility proposed for operation including lights, sump pits, and mud slabs.

p. If a thrust block is used, thrust block design calculations and safe capacity.

q. Calibration table correlating jacking pressure ~~gage~~ gauge readings and applied load in tons.

r. Provisions for injecting slurry for Pilot Tube Guided Boring. Slurry mix design, volume and measurement procedures, pumps, piping, valve arrangements, and pressure ~~gages~~gauges.

s. Provisions for injecting pipe lubricants. Pipe jacking lubricant mix design, including lubricant type, injection volume and measurement procedures, pumps, piping, valve arrangements, and pressure gages.

2. Drawings and Calculations.

a. Submit D~~d~~rawings and calculations for tunnel support system. Provide adequate drawings and installation details for construction. Shop Drawings shall identify proposed Jack and Bore, Jack and Mine or Pilot Tube Guided Boring method complete in assembled position including locations of equipment, staging, and storage areas, and emergency access around the construction operations. Drawings shall show pipe seals, pipe joint, collars, cushioning materials, and reinforcing details. Calculations shall include clear statement of criteria used for design as described in Article 1.07.A, Design Requirements.

b. Drawings for hydraulic jacking system, including hydraulic jack configuration and frame dimensions.

c. Provide signed and sealed by a Professional Engineer registered in the State of Texas the following calculations:

(1) Confirming maximum allowable loads on pipe will not be exceeded by maximum jacking capacity of the jacking system during Jack and Bore, Jack and Mine, or Pilot Tube Guided Boring operations.

(2) Demonstrate pipe selected has been designed to support maximum anticipated earth loads and superimposed live loads, both static and dynamic, which may be imposed on pipe and additional stresses imposed on pipe during jacking operations.

(3) Showing maximum expected jacking loads and confirm these are not greater than maximum jacking capacity of jacking system. Calculations should indicate if lubrication is being accounted for.

(4) Demonstrating that the jacking shaft and backstop arrangement can safely accommodate the maximum calculated jacking load without excessive or detrimental movement.

3. Personnel – Submit for record purposes, résumés for ~~p~~Project ~~m~~Manager, field superintendent and tunneling machine operators.

a. Experience: Minimum of 3 previous successful pipe-jacked tunnel installations of similar size and scope.

b. Detailed descriptions of pipe-jacked tunnel projects.

4. Quality Control: Description of quality control methods including:

a. Method and frequency of survey control.

b. Example of daily report.

5. Geotechnical Investigation: When geotechnical investigations are conducted, submit results to the Project Manager for record purposes.

6. Monitoring Plans:

a. Instrumentation Monitoring Plan: Submit for review, prior to construction, monitoring plan that includes schedule of instrumentation design, layout of instrumentation points, equipment installation details, manufacturer's catalog literature, and monitoring report forms.

b. Surface Settlement Monitoring Plan. Submit surface settlement monitoring plan for review prior to construction. Plan shall identify the location of settlement monitoring points, reference benchmarks, survey frequency and procedures, and reporting formats.

7. Structures Assessment. Provide preconstruction and post construction assessment reports for Critical Structures (including photographs or video).

8. Monitoring readings shall be submitted to Project Manager at the frequency indicated in Article 3.07.C.2.

9. Daily Reports: Maintain a shift log as defined in Article 3.04 - Tunneling Data and make available to Project Manager on request.

1.07 SYSTEM DESCRIPTION

A. Design Requirements.

1. Assume responsibility for selection of appropriate pipe and pipe joints to carry thrust of any jacking forces or other construction loads in combination with overburden, earth and hydrostatic loads. Design of pipe indicated on Drawings considers in-place loads only and does not take into account any construction loads. Criteria for longitudinal loading (jacking forces) on pipe and joints shall be determined, based on selected method of construction.

2. Jacking Pipe shall be designed to withstand thrust without damage or distortion. Configure main jacking frame so thrust is uniformly distributed and will not damage or distort pipe.

3. Take into account loads from handling and storing.

4. Criteria to be used at railroad crossings shall be Cooper E-80 locomotive loading distributions in accordance with AREMA specifications for culverts. Account for additive loadings due to multiple tracks.

5. Criteria for non-railroad crossings to be in accordance with the AASHTO LRFD Bridge Design Specification.

6. Provide pipes and casing of diameter shown on Drawings. Substitution of pipe with larger diameter to suit equipment availability for sewer lines will only be permitted if demonstrated to satisfaction of the Project Manager that design flows and velocities can be achieved.

PART 2 PRODUCTS

2.01 JACKING PIPE

A. Pipe joints shall be flush with outside pipe face when pipes are assembled. Pipe materials shall be as indicated on Drawings or selected from the following if not indicated on the Drawings:

1. Fiberglass Reinforced pipe, joints, and fittings in accordance with Section 02504 - Fiberglass Reinforced Pipe.

2. Vitrified clay pipe, joints and fittings in accordance with Section 02508 - Extra Strength Clay Pipe.

3. Plastic-lined reinforced concrete pipe with joints and fittings in accordance with Section 02611 - Reinforced Concrete Pipe and Section 02427 - Plastic Liner for Large-Diameter Concrete Sewers and Structures. Plastic liner is not required for storm sewers.

4. Steel casing pipe: Provide new, uncoated steel pipe manufactured in accordance with ASTM1097 for sewer line applications and AWWA C200 for water line applications. Joints may be field-welded butt joints or interlocking joints and shall be watertight.

   a. For field-welded butt-joint casing, manufacture in accordance with ASTM A139 Grade E, or ASTM A572 Grade 50. Provide full circumferential welds at butt joints.

   b. For steel casing pipe with interlocking joints, provide in accordance with the following:

      (1) Provide ASTM A36, ASTM A515, Grade 60, or ASTM A572, Grade 42 for pipe, and provide minimum ASTM A36 for connections.

      (2) Maintain pipe roundness to within 1 percent of specified diameter.

      (3) Maintain outside circumference to within 1% of nominal specified circumference, or 3/4 inches, minimum.

      (4) Maintain wall thickness to within 5% of specified thickness.

      (5) Provide rolled and welded cylinder method utilizing the double submerged arc welding (DSAW) process in sections not less than 8 feet long, except as needed to achieve the final finished length of pipe.

      (6) Provide complete penetration butt-welded connectors square to ends of pipe sections.

      (7) Perform welding in accordance with ANSI/AWS D1.1.

      (8) Examine connections at time of shipment. Reject sections with defects.

      (9) Mark all sections with manufacturer's name, job number, customer name, outside diameter, wall thickness, and weight per foot.

      (10) Ship pipe with protective wax coating over machined surfaces.

      (11) Provide Permalok joints or approved equal.

   c. Design stress in pipe wall shall be 50 percent of minimum yield point of steel or 18,000 psi, whichever is less when subjected to loading conditions.

d. Design deflection to be used in determining wall thickness shall not exceed 3 percent of nominal casing pipe size.

e. Bedding constant to be used in determining wall thickness shall be 0.10. Lag factors shall be 1.0 for all live loads.

f. Casing pipe design shall also include stresses due to jacking forces when pipe is to be installed by jacking method.

B. Use pipe that is round with smooth, even outer surface, and has joints that allow for easy connections between pipes. Design pipe ends so jacking loads are evenly distributed around entire pipe joint and point loads will not occur when pipe is installed. Jacking Pipe shall be capable of withstanding all forces imposed by process of installation, as well as final in-place loading conditions. Protect driving ends of pipe and joints against damage.

C. Precast reinforced box with joints and fittings shall be in accordance with Section 02612– Precast Reinforced Concrete Box Sewers. Precast concrete box is not acceptable for sanitary sewers. Precast concrete box is not used for Jack and Bore or Pilot Tube Guided Boring.

D. For sewer pipe installation, a list of approved jacking pipes is included in the City of Houston Wastewater Pre-Approved Product List (Reference COHWW02441-). This list is not applicable for casing pipe.

2.02 GROUT

A. Grout shall be in accordance with requirements defined in Section 02431 – Tunnel Grout.

2.03 ANNULAR SPACE LUBRICATION

A. Lubricants shall be NSF 60 approved.

B. Water used for pipe lubrication shall be clean, fresh, and free from oil, organic matter, or other deleterious matter and of neutral pH.

2.04 WATER

A. Water used in slurry, lubricant, and grout shall be obtained from potable water source. Soda ash or accepted equal, with submittal of Safety Data Sheet (SDS), shall be used to adjust pH of water as required in mix design.

PART 3 EXECUTION

3.01 CONSTRUCTION OPERATIONS CRITERIA

A. Use methods that minimize ground settlement. Select method that controls flow of water and prevents loss of soil into tunnel and provides stability of face under anticipated conditions.

B. For Jack and Bore, at minimum use a level manometer (dDutch level) for guidance. Free boring is not an acceptable method.

C. For Jack and Mine, use surveying or other means for guidance.

D. Pilot Tube Guided Boring system shall utilize a two or three phase system as described below:

1. Three Pass System.

a. Phase 1 – Rigid steel pilot tube in approximately 3-foot lengths shall be installed through ground from boring shaft to receiving shaft by earth displacement with jacking frame. Alignment of pilot tube shall be established with theodolite mounted at rear of boring shaft and set to desired line and grade. Theodolite shall view lighted target in lead or steering pilot tube. Camera shall be fitted to theodolite and transmit image of crosshair and target onto monitor screen to be viewed in boring shaft by operator. As operator advances pilot tube through ground, center of target will drift from crosshair as a result of biased or slanted leading tip of the pilot tube. Operator shall rotate pilot tube as required to orient slanted steering tip toward crosshair and continue to advance pilot tube until it reaches receiving shaft. Check line and grade of bore at the receiving shaft.

b. Phase 2 – An enlargement casing with an outside diameter up to 1 ½” larger than Jacking Pipe shall be rigidly connected to final pilot tube and advanced into earth behind pilot tube. Auger shall be used inside enlargement casing to remove material being excavated. Auger shall be contained inside limits of enlargement casing as it progresses along proposed alignment. A train of temporary steel casings with an outside diameter very similar to the enlargement casing shall be used to move enlargement casing from the boring shaft to receiving shaft. Enlargement casing will cut bore hole from boring shaft to receiving shaft and temporary casings will case hole as it is cut. Fit each temporary casing with internal auger to transport excavated material to boring shaft to be removed from shaft and disposed at an approved location. Recover pilot tubes in receiving shaft as temporary casings are installed.

c. Phase 3 – Jacking Pipe shall be installed directly behind final temporary casing pipe with jacking frame. Casing pipes and augers shall be recovered in receiving shaft as Jacking Pipe is installed.

2. Two Pass System.

a. Phase 1 – Install pilot tube in same manner described in Phase 1 of Three Pass System.

b. Phase 2 – Install enlargement casing in same manner described in Phase 2 of Three Phase System. Fit each Jacking Pipe with internal protective-casing pipe to house auger and prevent damage to Jacking Pipe. Install Jacking Pipe directly behind enlargement casing with internal casing rigidly connected to auger chamber of enlargement casing. Manufacture internal casing such that excavated material does not leak excessively into Jacking Pipe. Fit internal casing with protective shoe to protect Jacking Pipe from damage and to support casing and auger at centerline of pipe. Advance Jacking Pipe along proposed alignment with jacking frame thus progressing enlargement casing from boring shaft to receiving shaft with pilot tubes being recovered in receiving shaft. Excavated material shall be funneled into and conveyed through internal casing to boring shaft where it shall be removed from shaft and disposed at approved location. Upon reaching receiving shaft remove enlargement casing and internal casings and augers retracted and recovered at boring shaft.

E. Conduct operations in accordance with applicable safety rules and regulations, OSHA standards, and Contractor's safety plan. Use methods which include due regard for safety of workmen, adjacent structures, utilities, and public and safe means of ingress and egress.

F. Maintain clean working conditions wherever there is man access.

G. Perform installation to avoid interference with operation of railroads, highways, or streets, except as approved by owner of facility.

3.02 GROUND WATER CONTROL

A. Provide ground water control measures in conformance with Section 01578 - Control of Ground and Surface Water, when necessary to perform Work.

3.03 EQUIPMENT

A. Assume responsibility for selection of equipment which, based on past experience, has proven to be satisfactory for excavation of soils to be encountered.

B. Employ equipment that will be capable of handling various anticipated ground conditions and is capable of minimizing loss of soil and shall provide satisfactory support of excavated face.

C. Tunnel Shield. If hand shield is used for Jack and Mine (with or without attached mechanized excavating equipment), shield must be capable of handling various anticipated ground conditions. In addition, shield shall:

1. Conform to shape of tunnel with uniform perimeter that is free of projections that could produce over-excavation or voids. Appropriately sized overcutting bead may be provided to facilitate steering.

2. Be designed to allow face of tunnel to be closed by use of gates or breasting boards without loss of ground.

D. The following are minimum requirements for Pilot Tube Guided Boring:

1. Line and Grade Control System: Control system shall include but not be limited to a theodolite, lighted target, camera, and monitor screen. The equipment must be capable of installing the pipe to the desired line and grade.

2. Jacking Frame: The jacking frame shall possess adequate strength to advance the pilot tube, the enlargement casing and the string of Jacking Pipe from the boring shaft to the receiving shaft. The jacking force shall be easily regulated down to the safe working load rating of the Jacking Pipe. The frame shall develop a uniform distribution of jacking forces on the end of the pipe. The auger motor shall possess adequate torque to steer the pilot tube and adequate torque and speed to effectively auger the excavated material from the face of the bore to the boring shaft.

3. Pilot Tube: The pilot tubes shall be constructed of steel in rigid but short sections to accommodate the boring and receiving shafts. The tubes shall rigidly connect to each other, the steering tip and the enlargement casing and have a clear inside diameter large enough to adequately view the lighted target. The tubes shall withstand the torque encountered in the steering process.

4. Enlargement Casing: The enlargement casing shall be constructed of steel to a diameter just larger than the Jacking Pipe and have a leading connection compatible with the pilot tube. The leading face of the enlargement casing shall possess several large openings for the soil to enter as it advances along the proposed alignment. An internal auger chamber shall funnel the excavated material into the temporary full diameter casings of the Three-Phase Process or into the internal auger casings of the Two-Phase Process. Structural members shall connect the leading edge of the casing to the pilot tube connections.

5. Soil Transportation System: The soil transportation system shall consist of an auger train operating inside the full diameter temporary steel casing of the Three-Phase System and an internal casing and auger train operating inside the Jacking Pipe. The internal casings of the Two-Phase Process shall be manufactured to minimize leakage of the excavated material into the Jacking Pipe.

6. Soil Removal: A soil removal system shall be provided to safely remove the excavated material from the boring shaft to the surface.

7. Hydraulic Power Unit: The hydraulic power unit shall rest on the surface and be connected to the jacking frame by hoses

8. Lubrication System: A lubrication system shall be employed to minimize pipe friction to ensure that pipe can be installed from the boring shaft to the receiving shaft within the shaft working load rating of the Jacking Pipe. The system may also be required to minimize the torque required to transport the excavated material to the boring shaft.

E. Jacking Equipment: Provide jacking system with the following features:

1. Has main jacks mounted in jacking frame located in boring shaft. Jacks shall have individual actuation, synchronized actuation, and maximum thrust control. Jacks shall not exert forces when idle but shall resist displacements.

2. Control gauges shall be accessible to allow the Project Manager's representative to check readings during excavation.

3. The maximum thrust on the jacked pipe shall not exceed the safe jacking capacity of the pipe at any point or time.

4. Has jacking frame which successively pushes a string of connected pipes following tunneling excavation equipment towards the receiving shaft.

5. Has sufficient jacking capacity to push the tunneling excavation equipment and string of pipe through ground.

6. Has capacity at least 20 percent greater than calculated maximum jacking load.

7. Develops uniform distribution of jacking forces on end of pipe by use of spreader rings and packing.

8. Provides and maintains pipe lubrication system at all times to lower friction developed on surface of pipe during jacking.

9. Jack Thrust Reactions: Use reaction/thrust walls for pipe jacking that are adequate to support jacking pressure developed by main jacking system. Special care shall be taken when setting pipe guide rails in jacking shaft to ensure correctness of alignment, grade, and stability.

F. Air Quality: Provide equipment to maintain proper air quality of manned tunnel operations during construction in accordance with OSHA requirements.

G. Where used, enclose lighting fixtures in watertight enclosures with suitable guards. Provide separate circuits for lighting, and other equipment

H. Electrical systems shall conform to requirements of National Electrical Code - NFPA70.

3.04 TUNNELING DATA

A. Maintain shift logs of construction events and observations. Project Manager shall have continuous access to all logs containing the following required information:

1. Location of bore face by station and progress during shift.

2. Hours worked per shift on tunneling operations.

3. Completed field forms, such as steering control logs, for checking line and grade of tunneling operation, showing achieved tolerance relative to design alignment.

4. Maximum jacking pressures per drive.

5. Lubricant pressures and estimated quantities.

6. Ground ~~-~~water control operations and piezometric levels.

7. Observation of any lost ground or other ground movement.

8. Any unusual conditions or events.

9. Reasons for operational shutdown in the event a drive is halted or stopped.

3.05 EXCAVATION AND JACKING OF PIPE

A. Excavate material just ahead of Jacking Pipe and remove material through Jacking Pipe as it is forced through ground by jacking, into the space thus provided. In general, excavated material shall be removed as jacking progresses and no accumulation of excavated material within Jacking Pipe will be permitted. Should appreciable loss of ground occur in installations where face of excavation is accessible, voids shall be backpacked promptly to the extent practicable with approved soil cement.

B. The distance that excavation shall extend beyond end of Jacking Pipe depends on character of material encountered but shall not exceed 2 feet.

C. Boring for Jack and Bore and Pilot Tube Guided Boring.

1. Boring shall proceed from shaft provided for boring equipment and workers. Boring shall be done mechanically using either a pilot tube or auger method.

2. For auger method, J~~j~~acking P~~p~~ipe of appropriate diameter equipped with cutter head to mechanically perform excavation shall be used. Augers shall be of sufficient diameter to convey excavated material to shaft.

3. Remove excavated material from shaft and dispose of properly. Use of water or other fluids in connection with boring operation will be permitted only to the extent needed to lubricate cuttings. Water jetting will not be permitted.

D. Excavation for Jack and Mine.

1. Perform excavation operations in a manner to minimize movement of ground in front of and surrounding tunnel. Prevent damage to structures and utilities above and in vicinity of tunneling operations.

2. Keep face breasted or otherwise supported to prevent falls, excessive raveling, or erosion. Maintain standby face supports for immediate use when needed.

3. During shut-down periods, support face of excavation by positive means; no support shall rely solely on hydraulic pressure.

E. Assume responsibility for damage due to settlement from any construction-induced activities.

F. Jacking Operation.

1. Provide a suitable jacking frame or backstop.

2. Set pipe to be jacked on guides properly braced together, to support section of pipe and to direct proper line and grade. Place complete jacking assembly to line up with direction and grade of pipe.

3. Cushion pipe joints as necessary to transmit jacking forces without damage to pipe or pipe joints, in accordance with pipe manufacturer's recommendations. For plywood cushioning material, use ½-inch minimum thickness for pipe diameter 30 inches or less and use ¾-inch minimum thickness for pipe diameter greater than 30 inches.

4. Maintain envelope of bentonite slurry around exterior of pipe during jacking and excavation operation to reduce exterior friction and possibility of pipe seizing in place.

5. If a recovery access shaft is needed, obtain approval from Project Manager prior to excavation. Coordinate traffic control measures and utility adjustments as necessary prior to commencing work.

6. If a section of pipe is damaged during jacking operation, or joint failure occurs, as evidenced by inspection, visible ground water inflow or other observations, submit for approval methods for repair or replacement of pipe. Proposed repair methods shall follow pipe manufacturer's recommendations.

G. Grouting: Grouting requirements are defined in Section 02431 – Tunnel Grout.

3.06 CONTROL OF LINE AND GRADE

A. Construction Control.

1. Project Manager will establish baselines and benchmarks indicated on Drawings. Check baselines and benchmarks at beginning of w~~W~~ork and report any errors or discrepancies to Project Manager.

2. Use baselines and benchmarks established by Project Manager to establish and maintain construction control points, reference lines and grades for locating tunnel, sewer pipe, and structures.

3. Establish construction control points sufficiently far from work so as not to be affected by ground movement caused by pipe-jacked tunneling operations.

B. Benchmark Movement: If settlement of ground surface occurs during construction which affects accuracy of temporary benchmarks, detect and report such movement and reestablish temporary benchmarks. Locations of permanent City of Houston monumentation benchmarks are indicated on Drawings. Advise Project Manager of any settlement affecting permanent monumentation benchmarks.

C. Guidance System and Alignment Control for Jack and Mine and Jack and Bore.

1. A laser guidance system shall be used to determine location at front of jacked pipe relative to laser.

2. Guidance system shall include target to indicate deviations in line and grade.

3. Equip system with means by which Project Manager can verify casing alignment and grade, such as access to laser guidance system.

4. Initial alignment of equipment and final alignment shall be documented.

D. Line and Grade.

1. Check and record alignment for tunnel against above-ground undisturbed reference after installation of each Jacking Pipe.

2. Record exact face location after each shove to ensure alignment is within specified tolerances. Make immediate correction to alignment before allowable tolerances are exceeded.

3. When excavation is off~~-~~-line or grade, make alignment corrections to avoid reverse grades in gravity sewers.

~~4. Acceptance criteria for sewer pipe shall be plus or minus 6 inches in horizontal alignment from theoretical at any point between manholes, including receiving end, and plus or minus 1 1/2 inches in elevation from theoretical, unless otherwise indicated on Drawings.~~

4. Acceptance criteria for sewer pipe shall be plus or minus 6 percent of the tunnel diameter in the horizontal alignment or 2 inches, whichever is greater, and plus or minus 3 percent of the tunnel diameter in elevation or 1 inch, whichever is greater, from the design line and grade, unless otherwise indicated on Drawings.

5. If it is determined that pipe cannot be used, pipe installed outside tolerances shall be fully grouted and abandoned.

3.07 MONITORING

A. Instrumentation Monitoring: Instrumentation requirements are shown on Drawings. Instrumentation specified shall be accessible at all times to Project Manager.

1. Install and maintain instrumentation system to monitor and detect movement of ground surface and adjacent structures. Establish vertical control points at a distance from construction areas that avoids disturbance due to ground settlement.

2. Installation of instrumentation shall not preclude Project Manager, through independent contractor or consultant, from installing instrumentation in, on, near, or adjacent to construction work. Access shall be provided to work for such independent installations.

3. Instruments shall be installed in accordance with Drawings and manufacturer's recommendations.

B. Surface Settlement Monitoring.

1. Establish monitoring points on all Critical Structures.

2. Record location of settlement monitoring points with respect to construction baselines and elevations. Record elevations to accuracy of 0.01 feet for each monitoring point location. Monitoring points should be established at locations and by methods that protect them from damage by construction operations, tampering, or other external influences.

3. Ground surface elevations shall be recorded on centerline ahead of tunneling operations at minimum of 100-foot intervals or at least three locations per tunnel drive. For Jacking Pipe greater than 60-inch diameter, also record similar data at approximately 20 feet each side of centerline. Settlement monitoring points must be clearly marked by studs or paint for ease of locating.

4. Railroads: Monitor ground settlement of track subbase at centerline of each track. Follow American Railway Engineering and Maintenance-of-Way Association (AREMA) crossing requirements.

5. Utilities and Pipelines: Monitor ground settlement directly above and at least 10 feet or two excavation diameters, whichever is greater, before and after utility or pipeline intersection as shown on the Drawings.

C. Reading Frequency and Reporting: Submit to Project Manager records of readings from various instruments and survey points.

1. Readings shall be taken:

   a. Prior to Zone of Active Excavation reaching that point.

   b. When tunnel face reaches monitoring point (in plan).

   c. When Zone of Active Excavation has passed, and no further movement is detected.

2. All monitoring readings shall be submitted daily to Project Manager.

3. Immediately report to Project Manager any movement, cracking, or settlement which is detected.

4. Following substantial completion but prior to final completion, make final survey of remaining monitoring points and submit to Project Manager.

3.08 DISPOSAL OF EXCESS MATERIAL

A. Remove spoil in accordance with Section 01576 - Waste Material Disposal.

3.09 ACCEPTANCE TESTING FOR SEWERS

A. Acceptance testing is to be carried out by methods described in Section 02533 - Acceptance Testing for Sanitary Sewer.

END OF SECTION

SECTION 02448

PIPE AND CASING AUGERING FOR SEWERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Installation of casing for sewer pipe by ~~d~~Dry ~~a~~Augering or slurry boring methods, together with installation of sewer pipe in casing.

B. Installation of sewer pipe by slurry boring methods. Construction casing may be used at Contractor's option.

1.02 RELATED SECTIONS

A. Section 01270 – Measurement and Payment

B. Section 01330 – Submittal Procedures

C. Section 01576 – Waste Material Disposal

D. Section 02260 – Trench Safety System

E. Section 02431 – Tunnel Grout

F. Section 02502 – Steel Pipe and Fittings

G. Section 02531 – Gravity Sanitary Sewers

H. Section 02533 – Acceptance Testing for Sanitary Sewers

1.03 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. Casing, including sewer pipe, installed by augering methods in mid-run of open cut segments where shown on Drawings, will be measured and paid by linear foot from end to end of casing. Casing may be installed, at Contractor's option, at locations other than shown on Drawings, at no additional cost to City.

2. Sewer pipe installed by augering method in mid-run of open-cut segments where shown on Drawings, will be measured and paid by linear foot from end to end of augered section.

3. Pipe or casing segments installed by augering methods in locations other than mid-run of open cut segments and shown on Drawings, will be measured and paid by linear foot along centerline of completed sewer from centerline to centerline of manholes to ends of stubs or termination of pipe, and to inside face of lift stations and other structures.

4. Payment will include and be full compensation for labor, equipment, materials and supervision for excavation and construction of sewer, complete in place including disposal of excess materials, shoring, dewatering, utility adjustments, grouting, backfill, clean-up, and other related work necessary for construction as indicated on Drawings and specified in this Section.

5. Cost for pits and other excavations are included in unit price for pipe with or without casing.

6. Trench safety systems for pits are paid as specified in Section 02260 - Trench Safety Systems.

7. Refer to Section 01270 - Measurement and Payment for unit price procedures.

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

1.04 DEFINITIONS

A. Augering means either "~~d~~Dry ~~a~~Augering" or "slurry augering".

B. Dry ~~a~~Augering is jacking casing while excavating soil at heading and transporting spoil back through casing by otherwise uncased auger.

C. Slurry Auger Method: Installation of casing or pipe by first drilling small diameter pilot hole from shaft to shaft, followed by removing excess soil and installing pipe or conduit by pull back or jacking method.

1.05 REFERENCES ~~STANDARDS~~

A. American Railway Engineering and Maintenance-of-Way Association (AREMA) Manual for Railway Engineering.

B. American Association of State Highway and Transportation Officials (AASHTO).

~~B.~~C. Texas State Department of Highways and Public Transportation.

1.06 REGULATORY REQUIREMENTS

A. Conform to Texas State Department of Highways and Public Transportation for installations under state highways. City will obtain required permits for State Highway crossings.

B. Installations under Railroads:

1. Secure and comply with requirements of right-of-entry for crossing railroad company's easement or right-of-way from railroad companies affected. Comply with railroad permit requirements.

2. Use ~~d~~Dry ~~a~~Auger method only.

3. Damages due to delays caused by railroad requesting work to be done at hours which will not inconvenience the railroad will be at no additional cost to City.

4. Maintain minimum 35-foot clearance from centerline of tracks.

1.07 SUBMITTAL

A. Conform to requirements of Section 01330 - Submittal Procedures.

B. For installation by ~~a~~Augering, submit for review:

1. Description of mechanized excavating equipment.

2. Method of controlling line and grade.

3. Grouting techniques to be used for filling annular void between sewer pipe and casing, and void between sewer pipe or casing and ground, including equipment, pumping and injection procedures, pressure grout types, and mixes.

4. Locations and dimensions of pits.

5. Pit design and construction drawings.

6. Identification of casings required and paid under Contract and casings installed at Contractor's option.

7. Design of casings.

8. Copy of railroad company permits and right-of-entry.

C. Prepare auger pit and casing design submittals that are site specific. Have auger pit and casing design submittals signed and sealed by qualified Professional Engineer registered in State of Texas.

D. Include in construction phase submittals:

1. Daily logs of ~~a~~Augering and boring operations.

2. Settlement monitoring data to meet requirements of paragraph 3.05, Settlement Monitoring.

3. Submit daily logs and settlement monitoring data within 5 days after day of observation.

1.08 CRITERIA FOR DETERMINING CASING INSTALLATION LOADS

A. Select and design casing pipe and pipe joints to carry thrust of jacks or loads due to pulling mechanism in combination with overburden, earth and hydrostatic loads. Select casings for dry ~~a~~Augering to withstand action of auger without damage.

B. Use Professional Engineer to determine design stresses, design deflections and factors of safety for design of casing. Present such determination as part of design submittal. Apply the following maximum casing pipe stresses and deflections to casings shown on Drawings:

1. Design stress in pipe wall: 50 percent of minimum yield point of steel or 18,000 psi, whichever is less, when subjected to applicable loading conditions.

2. Wall thickness: Maximum allowable deflection which does not exceed 3 percent of nominal casing diameter.

C. Use Cooper E-80 locomotive loading distributions as criteria for railroad crossings in accordance with AREMA specifications for culverts. In design, account for additive loadings due to multiple tracks.

D. Use HL-93 vehicle loading distributions as criteria for truck loading in accordance with AASHTO.

E. When not specifically indicated on Drawings, select casing diameter to permit practical installation (including skids when applicable) and grouting.

PART 2 PRODUCTS

2.01 MATERIALS

A. Provide casing pipe which is straight, circular in section, uncoated, welded steel pipe, in accordance with Section 02502 - Steel Pipe and Fittings.

B. Provide sewer pipe in accordance with Section 02531 - Gravity Sanitary Sewers. Do not use high density polyethylene pipe for augering.

C. Provide restrained-joint sewer pipe when installing sewer pipe in slurry bored holes by pull- back method.

D. Supply grout as specified in Section 02431 - Tunnel Grout.

PART 3 EXECUTION

3.01 LOCATION AND SIZE OF AUGER PITS

A. Show location of auger pits on auger pit construction drawings. Locate auger pits for slurry boring so that distance between pits is no greater than 80 feet; and for dry augering not more than 120 feet apart.

B. Locate auger pits and associated work areas to avoid blocking driveways and cross streets and to minimize disruption to business and commercial interests. Avoid auger pit locations near areas identified as potentially contaminated.

C. Make size adequate for construction of structures indicated on Drawings. Provide adequate room to meet Contractor's operational requirements for ~~a~~Augering.

D. Provide portable concrete traffic barrier around periphery of pit, meeting applicable safety standards. Properly maintain barrier throughout period pit remains open. Angle traffic barriers in direction of lane flow; do not place barriers perpendicular to on-coming traffic.

E. Provide full cover or other security fencing for each access pit in which there is no construction activity or which is unattended by Contractor's personnel.

3.02 DRY AUGERING OF CASING

A. Provide jacks, mounted on frame or against backstop, of capacity suitable for forcing excavating auger and casing through soil conditions to be encountered. Operate jacks so that even pressure is applied to casing.

B. Provide steerable front section of casing to allow vertical grade adjustments. Provide water level or other means to allow monitoring of grade elevation of auger casing.

C. Bentonite slurry may be used to lubricate casing during installation. Use of water to facilitate removal of spoil is permitted; however, water jetting for excavation of soil is not allowed when jacking casing.

D. Tolerances from lines and grades shown on Drawings for gravity sewer pipe installed in casing are plus or minus 6 inches in horizontal alignment, and plus or minus 1-1/2 inches in elevation.

3.03 SLURRY BORING OF CASING OR PIPE

A. Drill small diameter pilot hole and check for line and grade at receiving end. Redrill pilot hole when bored pipe does not meet specified tolerances.

B. Using pilot hole as guide bore larger diameter hole of sufficient size for pipe or casing installation. Water jetting is not permitted.

C. Bentonite slurry may be used to maintain stable hole and furnish lubrication for pipe or casing installation.

D. Tolerances from lines and grades shown on Drawings for installed sewer pipe are plus or minus 6 inches in horizontal alignment and plus or minus 1-1/2 inches in elevation.

E. Completely fill annular space between sewer pipe and surrounding soil or casing with grout, without displacing pipe during grouting operation.

3.04 SEWER PIPE IN CASING

A. Grout annular void between sewer pipe and casing from end to end of casing. Block and brace sewer pipe to prevent movement during grout placement and to maintain specified line and grade. Grout as specified in Section 02431 - Tunnel Grout.

3.05 SETTLEMENT MONITORING

A. Monitor ground surface elevation along length of augering operation. Locate and record settlement monitoring points with respect to construction baseline and elevations. Record elevations to accuracy of 0.01 feet for each monitoring point location. Establish monitoring points at locations and by methods that protect them from damage by construction operations, tampering, or other external influences. As minimum, locate survey points as follows:

1. For road crossings: Centerline and each shoulder

2. Railroads: Track subbase at centerline of each track

3. Utilities and Pipelines: Directly above and 10 feet before and after utility or pipeline intersection

4. Long bores under improved areas such as pavements: Ground surface elevations must be recorded on centerline ahead of ~~a~~Augering operations at locations not to exceed 50 feet apart (including points located for roads, railroads, utilities, and pipelines), or at least three locations per augering drive

B. Reading Frequency and Reporting. Take settlement survey readings:

1. Prior to auger excavation reaching point

2. After auger reaches monitoring point in plan

3. After grouting of ground supporting pipe or casing is complete

C. Immediately report to Project Manager movement, cracking, or settlement which is detected.

D. Following substantial completion but prior to final completion, make final survey of monitoring points.

3.06 DISPOSAL OF EXCESS MATERIAL

A. Remove and dispose of spoil from job site in accordance with Section 01576 - Waste Material Disposal.

3.07 LEAKAGE TESTING

A. Test sanitary sewers for leakage by low pressure air methods in accordance with Section 02533 - Acceptance Testing for Sanitary Sewer.

END OF SECTION

SECTION 02465

DRILLED SHAFT FOUNDATIONS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Construction of foundations consisting of reinforced concrete drilled shafts.

1.02 RELATED SECTIONS

A. Section 01270 – Measurement and Payment

B. Section 01330 – Submittal Procedures

C. Section 01454 – Testing Laboratory Services

D. Section 01504 – Temporary Facilities and Controls

E. Section 01576 – Waste Material Disposal

F. Section 01785 – Project Record Documents

G. Section 03211 – Reinforcing Steel

H. Section 03310 – Structural Concrete

1.03 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. No separate payment will be made for drilled shaft foundations under this Section. Include cost in lump sum payment for structure requiring drilled shaft foundations.

2. Refer to Section 01270 - Measurement and Payment for unit price procedures.

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

1.04 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

B. Submit work plan for each structure with complete written description which identifies details of proposed method of construction and sequence of operations for construction relative to drilled shaft activities. Descriptions, with supporting illustrations, shall be sufficiently detailed to demonstrate to Project Manager that procedures meet requirements of Specifications and Drawings.

C. Submit project record documents under provisions of Section 01785 - Project Record Documents. Record locations of drilled shafts, as installed referenced to survey benchmarks. Include location of utilities encountered or rerouted. Give horizontal dimensions, elevations, inverts and gradients.

1.05 REFERENCE STANDARDS

A. ACI 336.1 - Standard Specification for Construction of Drilled Piers.

B. TxDOT Standard Specification Item 416 - Drilled Shaft Foundations.

PART 2 PRODUCTS

2.01 EQUIPMENT

A. Perform excavation with equipment suitable for achieving requirements of this Specification.

2.02 MATERIAL

A. For cast-in-place concrete, use Class A concrete. Refer to Section 03310 - Structural Concrete.

B. For reinforcing steel, refer to Section 03211 - Reinforcing Steel.

PART 3 EXECUTION

3.01 PREPARATION

A. Conduct an inspection to determine condition and locations of existing structures and other permanent installations, prior to commencing work.

3.02 EXCAVATION

A. Perform excavation required for drilled cylindrical shafts, at locations shown on Drawings through whatever materials encountered, to dimensions and elevations shown or required by site conditions. When satisfactory material is not encountered at plan depth, bottom of shaft will be adjusted or foundation altered, as determined by Project Manager, to satisfactorily comply with design requirements.

B. Do not make shaft excavations within 3 shaft diameters (edge to edge) of shafts which have been concreted within previous 24 hours.

C. Inspect drilled shaft excavations for verticality and side sloughing. Verticality is specified at one inch in 10 feet of shaft length. Check to full depth of dry auguring prior to introducing drilling mud. Straighten or add suitable reinforcing steel to shafts not meeting specified tolerance.

D. Slurry is to contain 4 to 8 percent by weight of bentonite additive and satisfy slurry specifications set forth in ACI 336.1, Section 2.3.5.2e. These requirements are more stringent than TxDOT Standard Specification Item 416.3.1. Stricter slurry specifications are required to assure suspension of detritus from drilling operations, and to ensure adequate cleaning of slurry prior to concreting. Cleaning of slurry is important to prevent deposition of detritus on reinforcement cages and ensure that inclusions of detritus will not be formed within concrete mass.

E. At final bearing elevation, clean bottom of each shaft and remove seepage water for examination by Project Manager before reinforcing steel and concrete is placed. Suitable access and lighting for proper inspection of completed excavation is to be provided. Reinforcing steel and concrete is to be placed in drilled shaft without delay after approval of excavation by Project Manager.

3.03 DRILLED SHAFT CONSTRUCTION

A. Drilled shaft construction and installation is to follow TxDOT Standard Specification Item 416 (with exceptions noted below) and ACI 336.1.

B. Before placing concrete, clean out shaft bottom with drilling bucket in order to remove sediments which may not be displaced by concrete. Clean shaft bottom with "clean-out" bucket until rotation on bottom without crowd (i.e., penetration under force) produces little spoil. Probing after cleaning out is essential to verify condition of base of shaft.

C. Concrete is to conform to requirements of ACI 336.1 Section 2.3.5.5.

D. Concrete is to be placed continuously in shaft to construction joint indicated on Drawings or as directed in TxDOT Standard Specification Item 416.3.3. Concrete is to be placed through suitable tube or tremie to prevent segregation of materials. Tremie pipe diameter is to be at least 8 times as large as largest concrete aggregate size.

E. Computation of final concrete volume for each shaft is to be made. Core and check the integrity of shafts taking an unreasonably high or low volume of concrete.

F. If caving soil conditions or excessive groundwater is encountered, use of temporary casing is permitted to prevent caving of material around shaft and to control seepage of groundwater into excavation.

G. Casing material is to be metal of ample strength to withstand handling stresses, pressure of concrete and of surrounding earth or backfill materials and is to be water-tight. Casing shall be smooth, clean and free of accumulations of hardened concrete. Outside diameter of casing is not to be less than specified diameter of drilled shaft.

H. Elapsed time is not to exceed one hour from beginning of concrete placement in cased portion of shaft, until extraction of casing is begun.

I. Withdraw temporary casings as shaft is filled with concrete, or immediately following concreting operation. Bottom of casing is to always remain at least one foot below level of concrete during placement to overcome hydrostatic pressure. Smoothly extract casing with vibratory hammer. Casing extraction is to be at slow, uniform rate with pull in line with vertical axis of shaft. Leave no casing in place.

J. If upward movement of concrete or reinforcing steel occurs inside casing at beginning of pulling operation or at anytime during pulling, stop pulling immediately and leave casing in place.

K. If casing must be left in place, Project Manager is to be informed to determine shaft capacity calculations.

3.04 FIELD QUALITY CONTROL

A. Testing will be performed under provisions of Section 01454 - Testing Laboratory Services.

3.05 DISPOSAL OF EXCESS MATERIAL

A. Dispose of excess materials in accordance with requirements of Section 01504 - Temporary Facilities and Control or Section 01576 - Waste Material Disposal.

END OF SECTION

SECTION 02501

DUCTILE IRON PIPE AND FITTINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Ductile iron pipe and fittings for water lines, wastewater force mains, and gravity sanitary sewers~~, and storm sewers~~.

1.02 RE~~A~~LATED SECTIONS

A. Section 01270 – Measurement and Payment

B. Section 01330 – Submittal Procedures

C. Section 02105 – Chemical Sampling and Analysis

D. Section 02511 – Water Lines

E. Section 02515 – Hydrostatic Testing of Pipelines

F. Section 02531 – Gravity Sanitary Sewers

G. Section 02532 – Sanitary Sewer Force Mains

H. Section 02553 – Point Repairs and Obstruction Removals

~~I. Section 02631 – Storm Sewers~~

~~J.~~I. Section 16640 – Cathodic Protection for Pipelines

1.03 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. No separate payment will be made for ductile iron pipe and fittings under this Section, with the exception of extra fittings in place. Include cost in unit prices for work as specified in the following Sections, as applicable:

a. Section 02511 - Water lines

b. Section 02531 - Gravity Sanitary Sewers

c. Section 02532 - Sanitary Sewer Force Mains

~~d. Section 02631 - Storm Sewers~~

~~2. Refer to Section 01270 - Measurement and Payment for unit price procedures.~~

2. Payment for ~~E~~extra Ductile Iron Compact Fittings in ~~P~~place is per ton. This shall be for additional fittings required to complete job. This is not to exclude extension of pipe across driveway or intersection for purpose of terminating line in more advantageous position. This determination shall be at discretion of Project Manager. This bid item includes additional fittings as may be necessary to complete job in conformance with intent of Drawings.

3. Refer to Section 01270 - Measurement and Payment for unit price procedures.

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

1.04 REFERENCES

~~A. ANSI A 21.4 (AWWA C 104) - Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings.~~

~~B. ANSI A 21.10 (AWWA C 110) - Standard for Ductile-Iron and Gray-Iron Fittings, 3-in. through 48-in.~~

~~C. ANSI A 21.11 (AWWA C 111) - Standard for Rubber Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.~~

~~D. ANSI A 21.15 (AWWA C 115) - Standard for Flanged Ductile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges.~~

~~E. ANSI A 21.16 (AWWA C 116) - Protective Fusion Bonded Epoxy Coating for the Interior and Exterior Surfaces of Ductile Iron and Grey Iron Fittings.~~

~~F. ANSI A 21.50 (AWWA C 150) - Standard for Thickness Design of Ductile-Iron Pipe.~~

~~G. ANSI A 21.51 (AWWA C 151) - Standard for Ductile-Iron Pipe, Centrifugally Cast .~~

~~H. ANSI A 21.53 (AWWA C 153) - Standard for Ductile Iron Compact Fittings, 3 inches through 24 inches and 54 inches through 64 inches for Water Service.~~

~~I.~~A. ANSI/AWS D11.2 –Guide for Welding Iron Castings.

~~J.~~B. ASME B 16.1 - ~~Cast~~ Gray Iron Pipe Flanges and Flanged Fittings.

~~K.~~C. ASTM D 1248 - Standard Specification Polyethylene Plastics Molding and Extrusion Materials for Wire and Cable.

~~L.~~D. ASTM F 477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

~~M.~~E. ASTM G 62 - Standard Test Methods for Holiday Detection in Pipeline Coatings.

~~N.~~F. AWWA C 104/ANSI A 21.4 - Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings.

~~O.~~G. AWWA C 110/ANSI A 21.10 - Standard for Ductile-Iron and Gray-Iron Fittings, 3-~~i~~In. through 48-~~i~~In.

~~P.~~H. AWWA C 111/ANSI A 21.11 - Standard for Rubber - Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

~~Q.~~I. AWWA C 115/ANSI A 21.15 - Standard for Flanged Ductile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges.

~~R.~~J. AWWA C 116/ANSI A21.16 - Protective Fusion-Bonded Epoxy Coating for the Interior and Exterior Surfaces of Ductile-Iron and Grey-~~i~~Iron Fittings.

~~S.~~K. AWWA C 150/ANSI A 21.50 - Standard for Thickness Design of Ductile-Iron Pipe.

~~T.~~L. AWWA C 151/ANSI A 21.51 - Standard for Ductile-Iron Pipe, Centrifugally Cast.

~~U.~~M. AWWA C 153/ANSI A 21.53 - Standard for Ductile Iron Compact Fittings.~~, 3 inches through 24 inches and 54 inches through 64 inches for Water Service.~~

~~V.~~N. AWWA C 105 - Polyethylene Encasement for Ductile-Iron Pipe Systems.

~~W. AWWA C 300301 - Standard for Prestressed Concrete Pressure Pipe, Steel-Cylinder Type, for Water and other Liquids.~~

~~X.~~O. AWWA C 600 - Standard for Installation of Ductile-Iron Water Mains and Their Appurtenances.

~~Y.~~P. AWWA M 41 – Ductile-Iron Pipe and Fittings.

~~Z.~~Q. SSPC-SP 6 - Steel Structures Painting Council, Commercial Blast Cleaning.

~~AA.~~R. American Railway Engineering and Maintenance-of-Way Association (AREMA)-E-80- Manual for Railway Engineering.

~~BB.~~S. American Association of State Highway Transportation Officials (AASHTO)-HL-93.

~~CC.~~T. DIPRA – Thrust Restraint Design for Ductile Iron Pipe.

~~DD.~~U. NSF/ANSI 61 – Drinking Water System Components – Health Effects.

1.05 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

B. For pipes 16 inches and greater submit shop drawings signed and sealed by Professional Engineer registered in State of Texas showing the following:

1. Manufacturer's pipe design calculations.

2. Provide lay schedule of pictorial nature indicating alignment and grade, laying dimensions, fitting, flange, and special details, with plan view of each pipe segment sketched, detailing pipe invert elevations, horizontal bends, restrained joints, and other critical features. Indicate station numbers for pipe and fittings corresponding to Drawings. Do not start production of pipe and fittings prior to review and approval by Project Manager. Provide final approved lay schedule on CD-ROM in Adobe portable document format (*.PDF).

3. Calculations and limits of thrust restraint shall be based on AWWA M41 or DIPRA Thrust Restraint for Ductile Iron Pipe, latest edition.

4. Class and length of joint.

C. Submit manufacturer's certifications that ductile iron pipe and fittings meet provisions of this Section and have been hydrostatically tested at factory and meet requirements of ANSI A 21.51.

D. Submit certifications that pipe joints have been tested and meet requirements of ANSI A 21.11.

E. Submit affidavit of compliance in accordance with ANSI A 21.16 for fittings with fusion bonded epoxy coatings or linings.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Use pre-approved manufacturers listed in City of Houston approved products.

2.02 DUCTILE IRON PIPE

A. Ductile Iron Pipe Barrels: Shall conform to AWWA C115, C150 and C151 and bear mark of Underwriters' Laboratories approval. Provide minimum thickness Class 52 for sanitary sewers. Unless otherwise shown on Drawings, use a minimum Pressure Class 250 for water lines less than or equal to 20-inch diameter. For 24-inch and larger, design for project specific hydraulics as per AWWA C150. Use minimum Pressure Class 350 for water lines in casing or trenchless construction and for flanged pipe.

B. Provide pipe sections in standard lengths, not less than 18 feet long, except for special fittings and closure sections as indicated on shop drawings.

C. For 24-inch and larger water lines, furnish and install cathodic protection in accordance with Section 16640 - Cathodic Protection for Pipelines

D. For sanitary sewer lines, modify pipe for cathodic protection in accordance with Section 16640 - Cathodic Protection for Pipelines. In lieu of furnishing ductile iron pipe with cathodic protection system, furnish ductile iron pipe with polyethylene encasement, provided the following criteria is met:

1. Provide minimum thickness class.

2. Provide polyethylene encasement material and installation in accordance with AWWA C105, and backfill as specified. Minimum of two complete wraps of 8-mil-thick polyethylene.

3. Use polyethylene encasement for open cut installations only. For aug~~e~~ured sections or sections installed inside a casing, provide coating in accordance with paragraph 2.0~~5~~6 D.~~1~~2.

4. Adhere to other requirements specified herein (e.g., insulation kits, etc.).

E. For use of pressure class pipe for water lines, design pipe and fittings to withstand most critical simultaneous application of external loads and internal pressures. Base design on minimum of AASHTO HL-93 loading, AREMA E-80 loads and depths of bury as indicated on Drawings. Design pipes with Marston's earth loads for a transition width trench for zero to 16 feet of cover. Use Marston's earth loads for a trench width of O.D. (of pipe) + 4 feet for pipe greater than 16 feet of cover. Use Marston's equations for a trench condition in both open-cut and tunnel applications. Design for most critical groundwater level condition. Pipe design conditions:

1. Working pressure = 150 psi.

2. Hydrostatic field test pressure = 150 psi.

3. Maximum pressure due to surge = 225 psi.

4. Minimum Pressure due to surge = -10 psi.

5. Design tensile stress due to surge or hydrostatic test pressure: No greater than 50% minimum yield.

6. Design bending stress due to combined earth loads and surge or hydrostatic test pressure: No greater than 48,000 psi.

7. Unit weight of fill 2' 120 pcf.

8. Deflection lag factor (Dl) = 1.2.

9. Bedding constant (K) = 0.1.

10. Moment coefficient = 0.16.

11. Fully saturated soil conditions hw=h=depth of cover above top of pipe.

F. Hydrostatic Test of Pipe: AWWA C 151, Section 5.2.1, at point of manufacture. Hold test for a minimum 2 minutes for thorough inspection of pipe. Repair or reject pipe revealing leaks or cracks.

G. Pipe Manufacturer for large diameter water lines: Minimum of 5 years of successful pipe installations in continuous service. Manufacturer must maintain on site or in plant enough fittings to satisfy the following requirements:

Line Diameter	Required Bends*
20 and 24 inches	Four 45° bends per 5,000 LF of water line
> 24 inches	Four 22.5° bends per 10,000 LF of water line
*Based on total length of contract (minimum of four). Any combination of bends may be substituted at manufacturer's option (i.e. two 22.5° bends are equivalent to one 45° bend) and will be counted as one fitting.	

Manufacturer or supplier must be capable of delivering bends to job site within 12 hours of notification. Use fittings at direction of Project Manager where unforeseen obstacles are encountered during construction. These fittings are in addition to any fittings called out in construction documents and must be available at all times.

H. Provide flange adapter with insulating kit as required when connecting new piping to existing piping and piping of different materials, unless otherwise approved by Project Manager.

I. Clearly mark pipe section to show location and thickness/pressure class color coded.

J. No welding will be permitted on Ductile Iron Pipe except at restrained joint spigots or fittings as per ANSW/AWS D11.2. No field welding is allowed.

2.03 JOINTS

A. Joint Types: ANSI A 21.11 push-on; ANSI A 21.11 mechanical joint; or ANSI A 21.16 flanged end. Provide push-on joints unless otherwise indicated on the Drawings or required by these specifications.

1. For sanitary sewer lines with bolted joints, conform to requirements of AWWA C111; provide minimum 304 stainless steel for restraint joints.

2. For water lines with bolted joints, conform to requirements of AWWA C111; provide Denso or approved equal petrolatum-based tape coating system for exposed portion of nuts and bolts.

B. Where required by Drawings, provide approved restrained joints for buried service. Refer to City’s List of Approval Products for approved joint restraint mechanisms.

C. Threaded or grooved-type joints which reduce pipe wall thickness below minimum required are not acceptable.

D. Provide for restrained joints designed to meet test pressures required under Section 02515 - Hydrostatic Testing of Pipelines or Section 02532 - Sanitary Sewer Force Mains, as applicable. Provide restrained joints for test pressure or maximum surge pressure as specified, whichever is greater for water lines. Do not use passive resistance of soil in determining minimum restraint lengths.

E. Electrical Bond Wires: Bond Wires; use stranded, copper cable furnished with high molecular weight polyethylene insulation (HMWPE). Use wire gauge (AWG) as shown on Drawings.

F. Make curves and bends by deflecting joints. Do not exceed maximum deflection recommended by pipe manufacturer for pipe joints or restraint joints. Submit details of other methods of providing curves and bends for consideration by Project Manager. When other methods are deemed satisfactory, install at no additional cost to City.

2.04 GASKETS

A. Furnish, when no contaminant is identified, plain rubber (SBR) gasket material in accordance with ANSI A21.11 or ASTM F 477; for flanged joints 1/8-inch-thick gasket in accordance with ANSI A 21.15.

B. For pipes to be installed in potentially contaminated areas, see Specification Section 02105 – Chemical Sampling and Analysis.

C. For Pipes to be installed in any other contaminated areas, use gaskets as recommended by the Pipe Manufacturer, Engineer of the Record and approved by City Engineer prior to installation.

2.05 FITTINGS

A. Use fittings of same size as pipe. Reducers are not permitted to facilitate an off-size fitting. Reducing bushings are also prohibited. Make reductions in piping size by reducing fittings. Line and coat fittings as specified for pipe they connect to.

B. Push-on Fittings: ANSI A 21.10; ductile iron ANSI A 21.11 joints, gaskets, and lubricants; pressure rated at 250 psig.

C. Flanged Fittings: ANSI 21.10; ductile iron ANSI A 21.11 joints, gaskets, and lubricants; pressure rated at 250 psig.

D. Mechanical Joint Fittings: ANSI A 21.11; pressure rated at 250 psi.

E. Ductile Iron Compact Fittings: Shall conform to AWWA C153 and shall be:

1. Fusion bonded epoxy lined or

2. Cement mortar lined.

F. For tangential flanged outlets shown on Drawings, substitute with a tee with an equivalent sized outlet unless otherwise approved by Project Manager.

2.06 COATINGS AND LININGS

A. Water line Interiors: ANSI A21.4, cement lined with seal coat; ANSI A 21.16 fusion bonded epoxy coating for interior; comply with NSF 61.

B. Sanitary Sewer and Force Main Interiors:

1. Preparation: Commercial blast cleaning conforming to SSPC-SP6.

2. Liner thickness: Nominal 40 mils, for pipe barrel interior; minimum 6 to 10 mils at gasket groove and outside spigot end to 6-inches back from end.

3. Testing: ASTM G 62, Method B for voids and holidays; provide written certification.

4. Acceptable Lining Materials:

a. Provide approved virgin polyethylene conforming to ASTM D 1248, with inert fillers and carbon black to resist ultraviolet degradation during storage; heat bonded to interior surface of pipe and fittings.

b. Ceramic Epoxy – Protecto 401 or approved equal.

C. Sanitary Sewer Point Repair Pipe: For pipes which will be lined with high density polyethylene liner pipe or cured-in-place liner, provide cement-lined with seal coat in accordance with ANSI A 21.4. For pipes which will not be provided with named liner, provide pipe as specified in Paragraph 2.05B, Sanitary Sewer and Force Main Interiors.

D. Exterior:

1. Encasement requirement for water lines.

a. Open cut construction method: Provide double wrap polyethylene encasement in accordance with AWWA C105.

b. Auger or casing construction method:

(1) Double wrap with polyethylene encasement in accordance with AWWA C105. Place circumferential wraps of tape or plastic tie straps at two-foot intervals along the barrel of the pipe, and thoroughly seal each end of the polyethylene tube.

2. Sanitary Sewers: Prime coat and outside asphaltic coating conforming to ANSI A21.10, ANSI A21.15, or ANSI A21.51 for pipe and fittings in open cut excavation and in casings.

E. For buried sanitary sewer pipes not cathodically protected, provide polyethylene wrap unless otherwise specified or shown. Conform to requirements of AWWA C105.

F. For flanged joints in buried service, provide petrolatum wrapping system, Denso, or equal, for the complete joint and alloy steel fasteners. Alternatively, sanitary sewer lines may use bolts made of Type 304 stainless steel.

G. Pipe to be installed in potentially contaminated areas shall have coatings and linings recommended by the manufacturer for maximum resistance to the contaminants identified in the Phase II Environmental Site Assessment Report. If no alternative coating is specified for water lines, provide polyethylene wrap in potentially contaminated areas.

PART 3 EXECUTION

3.01 INSTALLATION

A. Conform to installation requirements of Sections 02511 - Water Lines, 02531 - Gravity Sanitary Sewers, 02532 - Sanitary Sewer Force Mains ~~02631 - Storm Sewers~~ and 02553 - Point Repairs and Obstruction Removal, except as modified in this Section.

B. Install in accordance with AWWA C 600 and manufacturer's recommendations.

C. Install double wrap polyethylene encasement in conformance with requirement of AWWA C105.

D. Holiday Testing.

1. Fusion Bonded Epoxy: Conform to requirements for new fittings in ANSI A 21.16.

E. Provide electrical continuity bonding across buried mechanical and push-on joint assemblies, except where insulating flanges are required by Drawings.

1. Provide minimum number of bond wires shown on Drawings. Remove one inch of HMWPE insulation from each of bond wire prior to attaching.

2. Secure wire onto pipe using approved Thermite Welding procedures.

3. Coat bare metal and weld metal after weld is secure. Use coal-tar compound or other compatible coating. For polyurethane coated pipe, use compatible polyurethane coating.

4. Visually inspect Thermite Weld connections for electrical continuity, strength and suitable coating prior to backfilling or placing pipe in augered hole or casing.

3.02 FIELD REPAIR OF COATINGS

A. Fusion Bonded Epoxy: Conform to requirements for new fittings in ANSI A 21.16.

END OF SECTION

SECTION 02504

FIBERGLASS REINFORCED PIPE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Fiberglass reinforced (FRP) pipe for sanitary sewers.

1.02 RELATED SECTIONS

A. Section 01270 – Measurement and Payment

B. Section 01330 – Submittal Procedures

C. Section 02081 – Cast-In-Place Concrete Manholes

D. Section 02082 – Precast Concrete Manholes

E. Section 02105 – Chemical Sampling and Analysis

F. Section 02317 – Excavation and Backfill for Utilities

G. Section 02441 – Microtunneling

H. Section 02445 – Jack and Bore/Jack and Mine/Pilot Tube Guided Boring Tunnels

I. Section 02531 – Gravity Sanitary Sewers

J. Section 02532 – Sanitary Sewer Force Mains

K. Section 02533 – Acceptance Testing for Sanitary Sewers

L. Section 02550 – Sliplining Sanitary Sewers

1.03 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. No separate payment will be made for fiberglass pipe under this Section. Include cost in unit price for Work, as specified in Section 02531 - Gravity Sanitary Sewers, Section 02532 - Sanitary Sewer Force Mains, or Section 02550 - Sliplining Sanitary Sewers.

2. Refer to Section 01270 - Measurement and Payment for unit price procedures.

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

1.04 REFERENCES

A. ASTM D 3262 - Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting- Resin) Sewer Pipe.

B. ASTM D 3681 ~~-~~– Standard Test Method for ~~Determining~~ Chemical Resistance of "Fiberglass" (Glass-Fiber- Reinforced Thermosetting-Resin) Pipe in a Deflected Condition.

C. ASTM D 3754 - Standard Specification for "Fiberglass" (Glass-Fiber Reinforced Thermosetting- Resin) Sewer and Industrial Pressure Pipe.

~~D. ASTM D 3839 – Standard Guide for Underground Installation of "Fiberglass" (Glass-Fiber Reinforced Thermosetting-Resin) Pipe~~

~~E.~~D. ASTM D 4161 - Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting- Resin) Pipe Joints Using Flexible Elastomeric Seals.

~~F.~~E. ASTM F 477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

F. AWWA Manual of Practices M45 Fiberglass Pipe Design.

G. AASHTO LRFD Bridge Design Specifications

H. TAC Texas Administrative Code. 30 TAC Chapter 317.20.

1.05 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

B. Provide sufficient data for the Project Manager to properly evaluate the pipe.

C. Product data submittals shall include the following, as a minimum:

1. Details of the proposed pipe.

2. Properties and strengths of the pipe.

3. Details of pipe joint.

4. Pipe design calculations per AASHTO LRFD Bridge Design Specifications or AWWA Manual of Practice M45 are required for each pipe location and are to be signed and sealed by a licensed engineer.

5. Instruction on storage, handling, transporting, and installation.

6. Standard catalog sheets.

D. Test Reports: Provide test reports upon request, certifying that the pipe has been tested in accordance with and exceeds minimum requirements of ASTM D 3262 and ASTM D 3681.

E. Submit manufacturer technical catalog.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide fiberglass reinforced pipe per the City of Houston Pre-Approved Product List.

2.02 MATERIALS

A. 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.

B. 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.

C. Fillers: Silica sand or other suitable materials may be used.

D. 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.

E. 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. When pipe is to be installed in potentially contaminated areas, especially where free product is found near the elevation of the proposed sewer, provide 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, Engineer of the Record and approved by City Engineer prior to installation

1. If required gasket material is not available for use, pipe other than fiberglass pipe must be used in potentially contaminated areas in accordance with specification section 02105 - Chemical Sampling and Analysis in PPCA.

F. 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.

2.03 MANUFACTURE AND CONSTRUCTION

A. Pipes

1. Furnish pipes in the diameters specified and within the tolerances specified below.

2. Manufacture pipe by the centrifugal casting process or filament winding to result in a dense, nonporous, corrosion-resistant, consistent composite structure to meet the operating conditions as shown on the Drawings.

3. Do not use stiffening ribs or rings.

B. 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.

C. 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.

D. Manhole Connections: Provide a water stop flange (wall pipe) for connection to manhole base or other structure in accordance with Section 02081 - Cast-I~~i~~n-Place Concrete Manholes, or Section 02082 - Precast Concrete Manholes.

E. 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.

2.04 DIMENSIONS

A. Diameters: The actual outside diameter of the pipes shall be in accordance with Table 3 of ASTM D 3262 for gravity sewers, or ASTM D 3754 for force mains.

B. 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.

C. 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.

D. End Squareness: Pipe ends shall be square to the pipe axis.

E. 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.

2.05 STIFFNESS CLASSES

A. 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.

B. 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.

1. Pipe stress calculations based on jacking loads shall be performed to conform to Section 02441 – Microtunneling and or Section 02445 - Jack and Bore/Jack and Mine/Pilot Tube Guided Boring Tunnels.

2. Ring deflection calculations shall conform to design requirements of 30 TAC Chapter 317.20 pertaining to flexible pipe used in gravity 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.

2.06 TESTING

A. 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.

B. Joints: Coupling joints shall be qualified per the tests of Section 7 of ASTM D 4161.

2.07 INSPECTION

A. The Project Manager shall be entitled to inspect pipes or witness the pipe manufacturing. Such inspection shall not relieve the manufacturer of the responsibilities to provide products that comply with the applicable standards and these Specifications.

B. Manufacturer's Notification: Should the Project Manager wish to see specific pipes during any phase of the manufacturing process, the manufacturer must provide the Project Manager with adequate advance notice of when and where the production of those pipes will take place.

C. Failure to Inspect: Should the Project Manager elect not to inspect the manufacturing, testing, or finished pipes, it in no way implies approval of products or tests.

2.08 PACKAGING, HANDLING, AND SHIPPING

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

PART 3 EXECUTION

3.01 INSTALLATION

A. Install pipe and fittings in accordance with requirements of Section 02531 - Gravity Sanitary Sewers, 02532 - Sanitary Sewer Force Mains, or Section 02550 - Sliplining Sanitary Sewers.

B. The manufacturer must supply a suitable qualified field service representative to be present periodically during the installation of pipe.

C. Pipe Bedding and backfill: Conform to requirements of Section 02317 - Excavation and Backfill for Utilities.

D. Pipe Handling: Use textile slings.

E. Jointing

1. Clean ends of pipe and coupling components.

2. Check pipe ends and couplings for damage. Correct any damage found.

3. Coupling grooves must be completely free of dirt.

4. Apply joint lubricant to pipe ends and rubber seals of coupling. Use only lubricants approved by the pipe manufacturer.

5. Use suitable auxiliary equipment, such as a wire rope puller, to pull joints together.

6. 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.

7. In the process of jointing the pipe, do not allow the deflection angle to exceed the deflection permitted by the manufacturer.

F. 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.

G. Tests: Conform to requirements of Section 02533 - Acceptance Testing for Sanitary Sewers.

END OF SECTION

SECTION 02505

HIGH DENSITY POLYETHYLENE (HDPE) SOLID AND PROFILE WALL PIPE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. High density polyethylene (HDPE) pipe for gravity sanitary sewers and drains, including fittings.

B. High density polyethylene (HDPE) pipe for sanitary sewer force mains, including fittings.

C. High density polyethylene (HDPE) pipe for gravity storm sewers and drains, including fittings.

D. High density polyethylene (HDPE) pipe for storm sewers culverts.

1.02 RELATED SECTIONS

A. Section 01270 – Measurement and Payment

B. Section 01330 – Submittal Procedures

C. Section 02317 – Excavation and Backfill for Utilities

D. Section 02531 – Gravity Sanitary Sewers

E. Section 02532 – Sanitary Sewer Force Mains

F. Section 02533 – Acceptance Testing for Sanitary Sewers

G. Section 02550 – Sliplining Sanitary Sewers

H. Section 02571 – Pipe Bursting/Crushing Sanitary Sewers

I. Section 02631 – Storm Sewers

1.03 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. No separate payment will be made for HDPE pipe under this Section. Include cost in unit prices for work, as specified in following sections:

a. Section 02531 - Gravity Sanitary Sewers.

b. Section 02532 - Sanitary Sewer Force Mains.

c. Section 02550 - Sliplining Sanitary Sewers.

d. Section 02571 - Pipe Bursting/Crushing Sanitary Sewers.

e. Section 02631 - Storm Sewers.

2. Refer to Section 01270 - Measurement and Payment for unit price procedures.

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

1.04 DEFINITIONS

A. AASHTO - American Association of State Highway and Transportation Officials.

B. AASHTO's Product Evaluation and Audit Solutions – AASHTO's program to evaluate materials, products, and devices of common interest for use in highway and bridge construction.

C. Soil-tight Joints: Joints meeting the definition in AASHTO Standard Specifications for Highway Bridges, Section 26.4.2.4.

~~C.~~D. Watertight Joints: Joints meeting the requirements of ASTM D 3212.

~~1.04~~1.05 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO), AASHTO LRFD Bridge Design Specifications, current edition.

B. AASHTO M 294 - Standard Specification for Corrugated Polyethylene Pipe, 300- to 1500-mm (12- to 60-in.) Diameter

C. AASHTO, Standard Specifications for Highway Bridges, current edition.

~~A.~~D. ASTM D 618 - Standard Practice for Conditioning Plastics for Testing.

~~B.~~E. ASTM D 1248 - Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable.

~~C.~~F. ASTM D 2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.

~~D.~~G. ASTM D 2657 - Standard Practice for Heat Fusion Joining Polyolefin Pipe and Fittings.

~~E.~~H. ASTM D 2774 - Standard Practice for Underground Installation of Thermoplastic Pressure Piping.

~~F. ASTM D 2837 - Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products.~~

~~G. ASTM D 3035 - Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter.~~

~~H.~~I. ASTM D 3212 - Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.

~~I.~~J. ASTM D 3350 - Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.

~~J.~~K. ASTM F 477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

~~K. ASTM F 714 - Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter.~~

~~L. ASTM F 894 - Standard Specification for Polyethylene (PE) Large-Diameter Profile Wall Sewer and Drain Pipe.~~

~~M.~~L. ASTM F 2306 - Standard Specification for 12 to 60 in. [300 to 1500 mm] Annular Corrugated Profile-Wall Polyethylene (PE) Pipe and Fittings for Gravity-Flow Storm Sewer and Subsurface Drainage Applications.

~~N. ASTM F 2487 - Standard Practice for Infiltration and Exfiltration Acceptance Testing of Installed Corrugated High Density Polyethylene and Polypropylene Pipelines.~~

~~O. ASTM F 2510 - Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures and Corrugated Dual- and Triple-Wall Polyethylene and Polypropylene Pipes.~~

~~P.~~M. AWWA C 906 - Polyethylene (PE) Pressure Pipe and Fittings, 4 In. Through 65 In. (100 mm Through 1,650 mm), for Waterworks.

~~1.05~~1.06 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

B. Submit shop drawings showing design of pipe and fittings indicating alignment and grade, pipe length, laying dimensions, fabrication, fittings, flanges, gasket material, and special details.

C. Submit detailed calculations for pipe design per AASHTO LRFD Bridge Design Specifications. Refer to Section 02631 – Storm Sewers submittal requirements for more details.

D. Submit details of Pipe Joints and jointing procedure for HDPE pipe.

E. Submit manufacturer technical catalog.

F. Submit manufacturer's installation specifications before beginning work. Include maximum fill depth and backfill requirements in manufacturer's installation specifications.

G. Submit a certificate of compliance with each shipment stating that the materials and assemblies fully comply with the requirements of the Contract.

1. Ensure that manufacturer's Certification of Compliance contains the following information:

a. Project Name.

b. Name of the Contractor.

c. Material description.

(1) Manufacturing plant

(2) Date of manufacture

(3) Pipe dimensions

(4) Pipe stiffness

(5) Pipe flattening

(6) Brittleness

(7) ASTM Resin Cell classification

(8) Workmanship

d. Typed or printed name of the person who signed the certification.

2. Provide the date and method of shipment from the product origin within the transmittal.

~~1.06~~1.07 QUALITY ~~CONTROL~~ASSURANCE

A. Provide manufacturer's certificate of conformance to Specifications.

B. 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.

C. Project Manager reserves right to inspect pipes or witness pipe manufacturing. Inspection shall in no way relieve manufacturer of responsibilities to provide products that comply with applicable standards and these Specifications.

1. Manufacturer's Notification: Should Project Manager wish to witness manufacture of specific pipes, manufacturer shall provide Project Manager with minimum three weeks notice of when and where production of those specific pipes will take place.

2. Failure to Inspect. Approval of products or tests is not implied by Project Manager's decision not to inspect manufacturing, testing, or finished pipes.

D. Manufacturer Qualifications: ~~Company~~ Manufacturer shall specialize~~ing~~ in manufacturing the products specified in this section with documented experience of minimum 5 years of pipe installations that have been in successful, continuous service for same type of service as proposed Work.

E. Manufacturers shall be AASHTO- Product Evaluation and Audit Solutions certified. Qualified manufacturers must also maintain and submit a current AASHTO- Product Evaluation and Audit Solutions certificate of compliance.

1. For a list of AASHTO-Product Evaluation and Audit Solutions certified manufacturers, see the following webpage: https://transportation.org/product-evaluation-and-audit-solutions/.

~~1.07 QUALIFICATIONS~~

1.08 STORAGE

A. ~~Do not store pipe uncovered direct in direct sunlight.~~Store HDPE pipes out of direct sunlight unless manufacturer's specifications allow.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide ~~products manufactured by companies~~ approved products listed on the City of Houston ~~Standard Product List~~ Approved Products List or approved equal.

B. Furnish solid wall pipe with plain end construction for heat joining (butt fusion) conforming to ASTM D 2657. Utilize controlled temperatures and pressures for joining to produce fused leak-free joint.

C. Furnish profile-wall gravity sanitary sewer pipe with bell-and-spigot end construction conforming to ASTM D 3212. Joining will be accomplished with elastomeric gasket in accordance with manufacturer's recommendations. Use integral bell-and-spigot gasketed joint designed so that when assembled, elastomeric gasket, contained in machined groove on pipe spigot, is compressed radially in pipe bell to form positive seal. Design joint to avoid displacement of gasket when installed in accordance with manufacturer's recommendations.

D. Furnish solid wall pipe for sanitary sewer force mains with minimum working pressure rating of 150 psi, and with inside diameter equal to or greater than nominal pipe size indicated on Drawings.

E. Furnish corrugated profile-wall polyethylene (CPE~~P~~) pipe for gravity storm sewer and storm sewer culvert pipe. Joints shall be installed such that connection of pipe sections will form continuous line free from irregularities in flow line. ~~Suitable joints are:~~

F. Jointing:

1. Provide joints and fittings meeting the following requirements:

a. Integral Bell and Spigot with dual elastomeric gaskets. Bell shall overlap minimum of two corrugations of spigot end when fully engaged. Provide the spigot end with an O-ring gasket in accordance with 2.01.F.2.

b. Exterior Bell and Spigot. Bell shall be fully welded to exterior of pipe and overlap spigot end so that flow lines and ends match when fully engaged. Provide the spigot end with an O-ring gasket in accordance with 2.01.F.2.

~~b.~~c. Split Couplers. Used for gravity storm sewer Soil-Tight Joint connections only. Join pipe with coupling bands covering at least two full corrugations on the ends of each pipe being joined.

2. Gaskets:

a. Meet requirements of ASTM F 477. Use gasket molded into circular form or extruded to proper section and then spliced into circular form. When no contaminant is identified, use gaskets of properly cured, high-grade elastomeric compound. Basic polymer shall be natural rubber, synthetic elastomer, or blend of both.

b. HDPE Pipes are Not allowed to be installed in potentially contaminated areas, unless approved by City Engineer.

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

3. Lubricant. Use lubricant for assembly of gasketed joints which has no detrimental effect on gasket or on pipe, in accordance with manufacturer's recommendations.

4. Diameters 12-inch through 48-inch storm sewer shall have a reinforced bell with a polymer composite band installed by the manufacturer.

2.02 MATERIALS FOR SANITARY SEWER

A. Pipe and Fittings: High density, high molecular weight polyethylene pipe material meeting requirements of Type III, Class C, Category 5, Grade P34, as defined in ASTM D 1248. Material meeting requirements of cell classification 345434D or E, in accordance with ASTM D 3350, are also suitable for making pipe products under these specifications. Inner wall of pipe shall be of light color for television inspection purposes.

B. Other Pipe Materials: Materials other than those specified in Paragraph 2.02A, Pipe and Fittings, may be used as part of profile construction, e.g., as core tube to support shape of profile during processing, provided that these materials are compatible with base polyethylene material and are completely encapsulated in finished product and in no way compromise performance of pipe products in intended use. Examples of suitable material include polyethylene and polypropylene.

2.03 MATERIALS FOR GRAVITY STORM SEWERS AND STORM SEWER CULVERTS

A. Pipe and Fittings:

1. High density, high molecular weight polyethylene HDPE virgin compound material meeting requirements of cell class outlined in ASTM D 3350.

2. Provide Type S pipes (outer corrugated wall with smooth inner liner).

3. Section Properties shall meet the following requirements:

a. Provide the minimum wall thickness of the inner walls for Type S pipe as specified in AASHTO M 294, Section 7.2.2. Meet the pipe stiffness at 5% deflection requirement as specified in AASHTO M 294, Section 7.4. The minimum section properties must meet the 75- yr. design life requirements in the AASHTO LRFD Bridge Design Specifications, Section 12.

4. Pipe size shall not exceed 48-inches in diameter.

~~A.~~B. Manufacturing shall meet requirements of ASTM F 2306.

2.04 TEST METHODS FOR SANITARY SEWER

A. Conditioning. Conditioning of samples prior to and during tests is subject to approval by Project Manager. When referee tests are required, condition specimens in accordance with Procedure A in ASTM D 618 at 73.4 degrees F plus or minus 3.6 degrees F and 50 percent relative humidity plus or minus 5 percent relative humidity for not less than 40 hours prior to test. Conduct tests under same conditions of temperature and humidity unless otherwise specified.

B. Flattening. Flatten three specimens of pipe, prepared in accordance with Paragraph 2.05A, in suitable press until internal diameter has been reduced to 40 percent of original inside diameter of pipe. Rate of loading shall be uniform and at 2 inches per minute. Test specimens, when examined under normal light and with unaided eye, shall show no evidence of splitting, cracking, breaking, or separation of pipe walls or bracing profiles.

C. Joint Tightness. Test for joint tightness in accordance with ASTM D 3212, except replace shear load transfer bars and supports with 6-inch-wide support blocks that can be either flat or contoured to conform to pipe's outer contour.

D. Purpose of Tests. Flattening and joint tightness tests are not intended to be routine quality control tests, but rather to qualify pipe to a specified level of performance.

2.05 TEST METHODS FOR GRAVITY STORM SEWERS AND STORM SEWER CULVERTS

A. All testing and material requirements shall be in accordance with ASTM F 2306.

B. MANDREL TESTING: use a mandrel to test flexible pipe for deflection. Refer to Section 02533 – Acceptance Testing for Sanitary Sewers for a mandrel and test requirements.

2.06 MARKING

A. Mark each standard and random length of pipe in compliance with these Specifications with following information:

1. Pipe size.
2. Pipe class.
3. Production code.
4. Material designation.

PART 3 EXECUTION

3.01 INSTALLATION

A. Conform to requirements of following Sections:

1. Section 02550 - Sliplining Sanitary Sewers.
2. Section 02531 - Gravity Sanitary Sewers.
3. Section 02532 - Sanitary Sewer Force Mains.
4. Section 02533 - Acceptance Testing for Sanitary Sewers.
5. Section 02571 - Pipe Bursting/Crushing Sanitary Sewers.
6. Section 02631 - Storm Sewers.

B. Install pipe in accordance with the manufacturers recommended installation procedures and ASTM D 2774 for pressure pipe and ASTM D 2321 for gravity flow pipe.

C. Install the joints so that the connection of the pipe sections forms a continuous line free from irregularities in the flow line. For storm sewer applications only, if no joint type is specified in the Contract documents, provide a soil-tight joint meeting the requirements of this specification.

~~B.~~D. Unless otherwise authorized, start laying pipe on the bedding at the outlet end with the separate sections firmly joined together. Hoist and lower sections of pipe into the trench without damaging the pipe or disturbing the bedding or the sides of the trench. Remove and re-lay any pipe that is not in alignment or that shows excessive settlement after laying, at no expense to the City.

~~C.~~E. HDPE pipe is not approved in applications requiring augering of pipe.

F. Bedding and backfill:

1. Conform to requirements of Section 02317 - Excavation and Backfill for Utilities.
2. Inspect inside periphery of pipe for local or unequal deformation caused by improper construction methods during backfilling. Stop work and address backfilling technique if measured deflection of pipe exceeds 5% or there are other issues found effecting quality of pipe installation.
3. To validate pipe installation methods, perform an initial quality control inspection after first installation of each size of pipe is completed on the project. Notify the Engineer of Record and Project Manager when this inspection takes place.

~~D.~~G. Use only workmen trained in the installation of HDPE Pipe.

~~E.~~H. Allow pipe temperature to approach ground temperature before each individual pipe section is terminally connected.

~~F.~~I. Joints: Join sections of HDPE pipe into continuous lengths above ground by thermal butt fusion method in accordance with AWWA C 906 and pipe manufacturer's recommendations for specified service. Fusion joints: meeting minimum requirements of manufacturer for cool down time and other fusing requirements. Socket fusion and extrusion welding or hot gas welding will not be accepted.

J. Cutting pipe: Comply with pipe manufacturer's recommendations. After cutting, leave end pipe in accordance with manufacturer's recommendations.

K. Store pipe above ground on adequate blocking. Always keep pipe clean and fully drained during storage. Provide proper equipment for hoisting and lowering the pipe into the trench without damaging the pipe or disturbing the bedding or the walls of the trench. Any protective covering of gaskets should remain until the pipe is ready for installation.

L. Multi-barrel installations are not allowed.

3.02 MANUFACTURER SERVICES

A. Pipe manufacturer to provide services of experienced, competent, and authorized representative to visit site to advise and consult Contractor during jointing and installation of pipe.

END OF SECTION

SECTION 02506

POLYVINYL CHLORIDE PIPE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Polyvinyl chloride (PVC) pressure pipe for water distribution, in nominal diameters 4 inches through 20 inches.

B. Polyvinyl chloride sewer pipe for gravity sewers in nominal diameters 4 inches through 60 inches.

C. Polyvinyl chloride pressure pipe for gravity sewers and force mains in nominal diameters 4 inches through 20 inches.

D. Fusible PVC®, or FPVC®, pipe for pressure pipe in horizontal directional drilling applications up to 20 ~~-~~inches in diameter.

1.02 RELATED SECTIONS

A. Section 01270 – Measurement and Payment

B. Section 01330 – Submittal Procedures

C. Section 02317 – Excavation and Backfill for Utilities

D. Section 02501 – Ductile Iron Pipe and Fittings

E. Section 02511 – Water Lines

F. Section 02528 – Polyethylene Encasement/Wrap

G. Section 02531 – Gravity Sanitary Sewers

H. Section 02532 – Sanitary Sewer Force Mains

I. Section 02534 – Sanitary Sewer Service Stubs or Reconnections

J. Section 02631 – Storm Sewers

K. Section 16124 – Conductive Trace Wire for Non-Metallic Water Line Pipes

1.03 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. No separate payment will be made for PVC pipe under this Section. Include cost in unit price for work included as specified in the following sections:

   a. Section 02511 - Water Lines

   b. Section 02531 - Gravity Sanitary Sewers

   c. Section 02532 - Sanitary Sewer Force Mains

   d. Section 02631 - Storm Sewers

2. Refer to Section 01270 - Measurement and Payment for unit price procedures.

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

1.04 REFERENCES

~~A. ANSI A 21.16 (AWWA C 116) - Protective Fusion-Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile-Iron and Gray-Iron.~~

~~B.~~A. ASTM A 240 - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.

~~C.~~B. ASTM C 923 - Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals.

~~D.~~C. ASTM D 618 - Standard Practice for Conditioning Plastics for Testing.

~~E.~~D. ASTM D 1248 - Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable.

~~F.~~E. ASTM D 1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.

~~G. ASTM D 2122 – Standard Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings.~~

~~H.~~F. ASTM D 2241 - Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).

~~I.~~G. ASTM D 2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.

~~J.~~H. ASTM D 2412 – Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel Plate Loading.

~~K.~~I. ASTM D 2444 - Standard Practice for Determination of the Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tup (Falling Weight).

~~L. ASTM D 2680 - Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly (Vinyl Chloride) (PVC) Composite Sewer Piping.~~

~~M.~~J. ASTM D 3034 - Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

~~N.~~K. ASTM D 3139 - Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.

~~O.~~L. ASTM D 3212 - Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.

~~P.~~M. ASTM F 477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

~~Q. ASTM F 679 - Standard Specification for Poly (Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.~~

~~R.~~N. ASTM F 794 - Standard Specification for Poly (Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter.

~~S.~~O. ASTM F 949 - Standard Specification for Poly (Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings.

~~T.~~P. AWWA C 110 (ANSI A 21.10) - American National Standard for Ductile-Iron and Gray-Iron Fittings, 3 ~~inch~~ In. Through 48 ~~inch~~ In., for Water and Other Liquids.

~~U.~~Q. AWWA C 111 (ANSI A 21.11) - ~~American National Standard for~~ Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

~~V.~~R. AWWA C 153 (ANSI A 21.53) - Ductile-Iron Compact Fittings ~~for Water Service~~.

~~W.~~S. AWWA C900 - ~~Standard for~~ Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 60 In. (100 ~~MM~~ mmThrough 1,500 ~~MM~~mm).

~~X.~~T. AWWA C909 - Standard for Molecularly-Oriented Polyvinyl Chloride (PVCO) Pressure Pipe, 4 In. (100mm) and Larger.

~~Y.~~U. AWWA M23 – PVC Pipe – Design and Installation.

~~Z.~~V. PPI TR-3 - Policies and Procedures for Developing Hydrostatic Design Basis (HDB), Hydrostatic Design Stresses (HDS), Pressure Design Basis (PDB), Strength Design Basis (SDB), ~~and~~ Minimum Required Strength (MRS) Ratings, and Categorized Required Strength (CRS) for Thermoplastic Piping Materials or Pipe.

~~AA.~~W. ASTM F1674 - Standard Test Method for Joint Restraint Products for Use with PVC Pipe~~UNI-B-13 - Recommended Standard Performance Specification for Joint Restraint Devices for Use with Polyvinyl Chloride Pipe~~.

1.05 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

B. Submit shop drawings showing design of new pipe and fittings indicating alignment and grade, laying dimensions, fabrication, fittings, flanges, and special details.

C. Contractor to review and submit PVC pipe manufacturers recommended installation procedures.

D. Calculations and limits of thrust restraint shall be based on AWWA M23, latest edition.

E. For Fusible PVC® Pipe, submit qualifications of Fusion Technician to be used on the project.

F. Provide manufacturer's product data for bell insertion protection system.

G. Submit manufacturer technical catalog.

1.06 QUALITY ~~CONTROL~~ASSURANCE

A. Submit manufacturer's certifications that PVC pipe and fittings meet requirements of this Section and AWWA C900, and AWWA C909 for pressure pipe applications, or appropriate ASTM standard specified for gravity sewer pipe.

B. Submit manufacturer's certification that PVC pressure pipe for water lines and force mains has been hydrostatically tested at factory in accordance with AWWA C900 and AWWA C909, 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 other source is not acceptable. Furnish copies of test reports to Project Manager for review. Cost of testing paid by Contractor.

D. Fusible PVC®

1. Fusion Technician shall be fully qualified by the pipe supplier to install type(s) and sizes(s) being used. Qualification shall be current as of the actual date of fusion performance on the project.

2. Refer to approved product list for approved manufacturer.

1.07 STORAGE

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

PART 2 PRODUCTS

2.01 MATERIAL

A. Use PVC compounds in manufacture of pipe that contain no ingredient in amount that has been demonstrated to migrate into water in quantities considered to be toxic.

B. Furnish PVC pressure pipe manufactured from Class 12454 virgin PVC compounds as defined in ASTM D 1784. Use compounds qualifying for rating of 4000 psi for water at 73.4 F per requirements of PPI TR-3. 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 FPVC®, pipe shall be extruded with plain ends. The ends shall be square to the pipe and free of any bevel or chamfer. There shall be no bell or gasket of any kind incorporated into the pipe.

D. PVC Restrained Pipe: Must be listed on City's current Product Approval List.

1. Pipe Material:

a. Pressure Class 235 psi (DR 18): For restrained joints where shown on Drawings.

b. Pressure Class 305 psi (DR 14): For alternate to offset pipe sections shown on Drawings. Do not use PVC for offset sections with depth of cover greater than 20 feet or less than 4 feet. Do not use PVC in potentially petroleum contaminated areas.

E. Water Service.

1. 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.

2. Bear National Sanitation Foundation Seal of Approval (NSF-PW).

F. Gaskets:

1. Gasket materials shall meet requirements of ASTM F 477. Use elastomeric factory- installed gaskets to make joints flexible and watertight.

2. Flat Face Mating Flange: Full faces 1/8-inch-thick ethylene propylene (EPR) rubber.

3. Raised Face Mating Flange: Flat ring 1/8-inch ethylene propylene (EPR) rubber, with filler gasket between OD of raised face and flange OD to protect flange from bolting moment.

G. 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.

H. Bell Insertion Protection System: Refer to City of Houston’s Approved Product List.

I. Do not use PVC in potentially or known contaminated areas.

J. Do not use PVC in areas exposed to direct sunlight.

2.02 WATER SERVICE PIPE

A. Pipe 4 inchs through 20-inch: AWWA C900, Pressure Class 235 psi (DR 18); AWWA C900, ~~-~~Pressure Class 305 psi (DR 14) as alternate to offset pipe sections; nominal 20-foot lengths; cast-iron equivalent outside diameters.

B. Provide Polyvinyl Chloride Pipe from manufacturers listed on City of Houston’s Approved Products List.

C. Install trace wire with PVC pipe. Refer to Section 16124 – Conductive Trace Wire for Non-Metallic Water Line Pipes.

D. Make curves and bends by offsetting (i.e., deflecting joints). Do not exceed maximum offset recommended by pipe manufacturer or the City, whichever is less.

E. Hydrostatic Test: AWWA C900, ANSI A 21.10 (AWWA C 110); at point of manufacture; submit manufacturer's written certification.

2.03 GRAVITY SEWER PIPE

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

WALL CONSTRUCTION	ASTM DESIGNATION	SDR (MAX.)/ STIFFNESS (MIN.)	DIAMETER SIZE RANGE
Solid	D3034	SDR 26 / PS 115	6" to 10"
	D3034	SDR 35 / PS 46	12" & 15"
	~~F679~~D3034	SDR 35 / PS 46	18" to 60"
	AWWA C900	DR 18 / N/A	4" to 20"
	AWWA C909	DR 18 / N/A	4" to 12"

Note: Refer to City of Houston Approved Products List for list of manufacturers.

B. PVC storm sewer pipe shall be in accordance with provisions in following table:

WALL CONSTRUCTION	MANUFACTURER	ASTM DESIGNATION	SDR (MAX.)/ STIFFNESS (MIN.)	DIAMETER SIZE RANGE
Solid	J-M Pipe CertainTeed Diamond Uponor ETI North American	D3034	SDR 26 / PS 115	6" to 10"
		D3034	SDR 35 / PS 46	12" & 15"
		~~F679~~ D3034	SDR 35 / PS 46	18" to 27"
		AWWA C900	DR 18 / N/A	4" to 16"
		AWWA C909	DR 18 / N/A	4" to 12"
Truss (Gasketed)	Contech	D2680	N/A /200 psi	8" to 15"
Profile	Contech A-2000 Contech A-2026 ETI, Ultra-Rib ETI, Ultra-Corr	F949 F949 F794 F794	N/A / 46 psi N/A / 115 psi N/A / 46 psi N/A / 46 psi	12" to 36" 8" to 10" 8" to 30" 24" to 36"

C. When solid wall PVC pipe 18 inches to 27 inches in diameter is required in SDR 26, provide pipe conforming to ASTM~~ F 679~~ D 3034, except provide wall thickness as required for SDR 26 and pipe stiffness of 115 psi.

D. For sewers up to 12~~-~~inchs diameter crossing over water lines or crossing under water lines with less than 2-feet separation, provide minimum 150 psi pressure-rated pipe conforming to ASTM D 2241 with suitable PVC adapter couplings.

E. 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, or ASTM D 3139 and ASTM F 477. Gaskets shall be factory-assembled and securely bonded or otherwise held in place to prevent displacement. Manufacturer shall test 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.

1. Fittings for straight through and transition connections conform to requirements of Section 02534- Sanitary Sewer Service Stubs or Reconnections.

G. Conditioning. Conditioning of samples prior to and during tests is subject to approval by Project Manager. When referee tests are required, condition specimens in accordance with Procedure A in ASTM D 618 at 73.4 degrees F plus or minus 3.6 degrees F and 50 percent relative humidity plus or minus 5 percent relative humidity for not less than 40 hours prior to test. Conduct tests under same conditions of temperature and humidity unless otherwise specified. This is a brief summary of the test method, and the full current edition of the standard must be followed.

H. Pipe Stiffness. Determine pipe stiffness at 5 percent deflection in accordance with Test Method D 2412. Minimum pipe stiffness shall be 46 psi. For diameters 4 inches through 18 inches, test three specimens, each a minimum of 6 inches (152 mm) in length. For diameters 21 inchs through 36~~-~~inchs, test three specimens, each a minimum of 12 inchs (305 mm) in length. This is a brief summary of the test method, and the full current edition of the standard must be followed.

I. Flattening. Flatten three specimens of pipe, prepared in accordance with Paragraph 2.03F, in suitable press until internal diameter has been reduced to 60 percent of original inside diameter of pipe. Rate of loading shall be uniform. Test specimens, when examined under normal light and with unaided eye, shall show no evidence of splitting, cracking, breaking, or separation of pipe walls or bracing profiles. Perform the flattening test in conjunction with pipe stiffness test. This is a brief summary of the test method, and the full current edition of the standard must be followed.

J. Joint Tightness. Test for joint tightness in accordance with ASTM D 3212, except that joint shall remain watertight at minimum deflection of 5 percent. Manufacturer will be required to provide independent third party certification for joint testing each diameter of storm sewer pipe. This is a brief summary of the test method, and the full current edition of the standard must be followed

K. Purpose of Tests. Flattening and pipe stiffness tests are intended to be routine quality control tests. Joint tightness test is intended to qualify pipe to specified level of performance.

L. Saddle for pipe with 0.5~~-~~inch width and greater: Connect side sewer by drilling proper size round hole in wall of the main sewer pipe, inserting an approved pipe compression saddle. The Saddle shall meet requirements of ASTM C 923. Saddles will accept 4", 6", and 8" pipe. The lateral pipe shall be held in place by one stainless steel compression band with stainless steel nut and bolt (any AISI Series 300) type tightening device and meeting requirements of ASTM A 240. A stainless steel shear band shall wrap around the pipe a minimum of 380 degrees. Saddle may not protrude into mainline pipe.

2.04 SANITARY SEWER FORCE MAIN PIPE

A. Provide approved PVC pressure pipe conforming to requirements for water service pipe and conforming to minimum working pressure rating specified in Section 02532 - Sanitary Sewer Force Mains.

B. Acceptable pipe joints are integral bell-and-spigot, containing a bonded-in elastomeric sealing ring meeting requirements of ASTM F 477. In designated areas requiring restrained joint pipe and fittings, use approved joint restraint device conforming to ~~UNI-B-13~~ASTM F 1674, for PVC pipe 12~~-~~inchs diameter and less.

C. Fittings: Provide approved ductile iron fittings as per Section 02501 - Ductile Iron Pipe and Fittings, Paragraph 2.04, except furnish fittings with one of following approved internal linings:

1. Nominal 40 mils (35 mils minimum) virgin polyethylene complying with ASTM D 1248, heat fused to interior surface of fitting

2. Nominal 40 mils (35 mils minimum) polyurethane

3. Nominal 40 mils (35 mils minimum) ceramic epoxy

4. Nominal 40 mils (35 mils minimum) fusion bonded epoxy

D. Exterior Protection: Provide polyethylene wrapping of ductile-iron fittings as required by Section 02528 - Polyethylene Encasement/Wrap.

E. Hydrostatic Tests: Hydrostatically test pressure rated pipe in accordance with Paragraph 2.02E.

2.05 BENDS AND FITTINGS FOR PVC PRESSURE PIPE

A. Bends and Fittings: ANSI A 21.10 or ANSI A 21.53, ductile iron; ANSI A 21.11 single rubber gasket push-on type joint; minimum 150 psi pressure rating. Approved restrained joints, 250 200 psi, may be provided for up to 12 inches in diameter (water or sanitary).

B. Provide approved restrained joint fittings: Integral restrained joint fittings and pipe do not require secondary restraint.

PART 3 EXECUTION

3.01 ~~PROTECTION~~

3.02 INSTALLATION

A. Conform to requirements of Section 02511 - Water Lines, Section 02531 - Gravity Sanitary Sewers, and Section 02532 - Sanitary Sewer Force Mains, as applicable.

B. Install PVC pipe in accordance with Section 02317 - Excavation and Backfill for Utilities, ASTM D 2321 for Sewer Pipe, and manufacturer's recommendations.

C. Install PVC water service pipe to clear utility lines with minimum 6-inch separation, unless otherwise shown on Drawings:

D. Avoid imposing strains that will overstress or buckle pipe when lowering pipe into trench.

E. Hand shovel pipe bedding under pipe haunches and along sides of pipe barrel and compact to eliminate voids and ensure side support. Ensure barrel is fully supported along entire length of pipe, prior to backfilling.

F. For PVC pipe installed by trenchless methods, provide integral restrained joints and pull pipe through hole or casing. For PVC pipe pushed through hole or casing, provide approved bell insertion protection system.

G. Store PVC pipe under cover out of direct sunlight. Protect pipe from excessive heat or harmful chemicals. Prevent damage by crushing or piercing.

H. Allow PVC pipe to cool to ground temperature before backfilling when assembled out of trench to prevent pullout due to thermal contraction.

I. Pipe Assembly Procedures

1. Do not remove gasket from pipe.

2. Lay pipe by inserting spigot end into bell flush with the insertion line or as recommended by pipe manufacturer.

3. Do not assemble joint by swinging or stabbing.

4. Do not assemble joint using machinery or equipment such as backhoe bucket.

5. At no time shall spigot go past insertion line or homing mark. Continuously observe and check each homing mark for proper length and install pipe with home mark visible.

3.03 INSTALLATION FOR FUSIBLE PVC® PIPE

A. General

1. Fusible PVC® pipe will be handled in a safe and non-destructive manner before, during, and after the fusion process and in accordance with this specification and pipe supplier's guidelines.

2. Fusible PVC® pipe will be fused by qualified fusion technicians, as documented by the pipe supplier.

3. Each fusion joint shall be recorded and logged by an electronic monitoring device (data logger) connected to the fusion machine.

4. Only appropriately sized and outfitted fusion machines that have been approved by the pipe supplier shall be used for the fusion process. Fusion machines must incorporate the following elements:

   a. HEAT PLATE – Heat plates shall be in good condition with no deep gouges or scratches. Plates shall be clean and free of any debris or contamination. Heater controls shall function properly; cord and plug shall be in good condition. The appropriately sized heat plate shall be capable of maintaining a uniform and consistent heat profile and temperature for the size of pipe being fused, per the pipe supplier's guidelines.

   b. CARRIAGE – Carriage shall travel smoothly with no binding at less than 50 psi. Jaws shall be in good condition with proper inserts for the pipe size being fused. Inset pins shall be installed with no interference to carriage travel.

   c. GENERAL MACHINE – Overview of machine body shall yield no obvious defects, missing parts, or potential safety issues during fusion.

   d. DATA LOGGING DEVICE – An approved datalogging device with the current version of the pipe supplier's recommended and compatible software shall be used. Datalogging device operations and maintenance manual shall be with the unit at all times. If fusing for extended periods of time, an independent 110V power source shall be available to extend battery life.

B. Pipe rollers shall be used for support of pipe to either side of the machine:

1. A weather protection canopy that allows for full machine motion of the heat plate, fusion assembly and carriage shall be provided for fusion in 1506-14 RSM – 50 Rev 3.5 2/12/13 inclement, extreme temperatures, and / or windy weather, per the pipe supplier's recommendations.

2. An infrared (IR) pyrometer for checking pipe and heat plate temperatures.

3. Fusion machine operations and maintenance manual shall be kept with the fusion machine at all times.

4. Facing blades specifically designed for cutting Fusible PVC® pipe shall be used.

C. Joint Recording

1. Each fusion joint shall be recorded and logged by an electronic monitoring device (data logger) connected to the fusion machine. The fusion data logging and join report shall be generated by software developed specifically for the butt-fusion of Fusible PVC® pipe. The software shall register and/or record the parameters required by the pipe supplier and these specifications. Data not logged by the data logger shall be logged manually and be included in the Fusion Technician's joint report.

D. Installation

1. Installation guidelines from the pipe supplier shall be followed for all installations.

2. The fusible PVC® pipe will be installed in a manner so as not to exceed the recommended bending radius.

3. Where fusible PVC® pipe is installed by pulling in tension, the recommended Safe Pulling Force established by the pipe supplier shall not be exceeded.

3.04 PVC RESTRAINED MECHANISM

A. For low-profile coupling with spline-type joints:

1. Do not apply lubricant to spline or pipe or coupling spline grooves.

2. Do not use excessive force while inserting the spline through coupling.

3. Insert spline until it is fully seated around circumference of pipe.

B. Field Cutting of Pipe Ends:

1. Perform by workers certified by manufacturer.

2. Use a PVC pipe cutter and provide square ends.

3. Follow manufacturer's recommendation to disassemble restrained joint after it has been locked in place.

4. For low-profile coupling with spline-type joints, use manufacturer approved power routing and grooving tool to field fabricate required pipe groove.

END OF SECTION

SECTION 02507

PRESTRESSED CONCRETE CYLINDER PIPE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Prestressed concrete cylinder pipe (PCCP) and fittings for buried water lines sizes 20 inches in diameter and larger.

1.02 RELATED SECTIONS

A. Section 01270 – Measurement and Payment

B. Section 01330 – Submittal Procedures

C. Section 02317 – Excavation and Backfill for Utilities

D. Section 02511 – Water Lines

E. Section 02518 – Steel Pipe and Fittings for Large Diameter Water Lines

1.03 MEASUREMENT AND PAYMENT

A. Unit Prices:

1. No separate payment will be made for PCCP under this Section. Include cost in unit price for work in Section 02511 – Water Lines.

2. Maintain on site minimum of two 3-degree and two 5-degree grade angle adapters. Adapters are considered “extra unit price.” When used during construction, adapter will be paid at unit price.

3. Refer to Section 01270 - Measurement and Payment for unit price procedures.

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

1.04 REFERENCES

A. AASHTO - Standard Specifications for Highway Bridges.

B. AREMA - Manual of Railway Engineering, Volume II, Chapter 15.

C. ASTM A 648 - Standard Specification for Steel Wire, Hard-Drawn for Prestressed Concrete Pipe.

D. ASTM A1032 – Standard Test Method for Hydrogen Embrittlement Resistance for Steel Wire Hard-Drawn Used for Prestressed Concrete Pipe.

E. ASTM C 33 - Standard Specification for Concrete Aggregates.

F. ASTM C 35 - Standard Specification for Inorganic Aggregates for Use in Gypsum Plaster.

G. ASTM C 150 - Standard Specification for Portland Cement.

H. ASTM C 497 - Standard Test Methods for Concrete Pipe, Concrete Box Sections, Manhole Sections, or Tile.

I. ASTM C 1107 (CRD C-621) - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-shrink).

J. ASTM D 512 - Standard Test Methods for Chloride Ion In Water.

K. ASTM D 1293 - Standard Test Methods for pH of Water.

L. ASTM E 165 - Standard Practice for Liquid Penetrant Testing for General Industry.

M. ASTM E 340 - Standard Test Methods for Macroetching Metals and Alloys.

N. ASTM E 709 - Standard Guide for Magnetic Particle Testing.

O. ASTM E 1032 - Standard ~~Test Methods~~ Practice for Radiographic Examination of Weldments Using Industrial X-Ray Film.

P. ANSI/AWS A3.0 - Standard Welding Terms and Definitions.

Q. AWWA C 200 - Standard for Steel Water Pipe 6 ~~i~~In. (150 mm) and Larger.

R. AWWA C 206 - Standard for Field Welding of Steel Water Pipe.

S. AWWA C 207 - Standard for Steel Pipe Flanges for Waterworks Service~~ –~~, Sizes 4 ~~i~~In. through 144 ~~i~~In. (100 mm Through 3,600 mm).

T. AWWA C 301 - Standard for Prestressed Concrete Pressure Pipe, Steel-Cylinder Type.

U. AWWA C 304 - Standard for Design of Prestressed Concrete Cylinder Pipe.

V. AWWA M 9 –Concrete Pressure Pipe.

W. NSF/ANSI -61 - Drinking Water System Components - Health Effects.

X. NACE No. 4/SSPC~~-~~-SP 7 ~~–~~ – Joint Surface Preparation Specification ~~No. 7~~ - Brush Off Blast Cleaning.

1.05 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

B. Submit shop drawings and certification signed and sealed by Professional Engineer registered in State of Texas showing following:

1. Manufacturer's pipe design and thrust restraint calculations in accordance with AWWA M9, latest edition.

2. Provide lay schedule of pictorial nature indicating alignment and grade, laying dimensions, welding procedures, fabrication, fitting, flange, and special details, with plan view of each pipe segment sketched, detailing pipe invert elevations, horizontal bends, welded joints, and other critical features. Indicate station numbers for pipe and fittings corresponding to Drawings. Do not start production of pipe and fittings prior to review and approval by Project Manager. Provide final approved lay schedule on CD-ROM in Adobe portable document format (*.PDF).

3. Include hot tapping procedure.

4. Submit certification from manufacturer that design was performed for project in accordance with requirements of this section.

C. Within 30 calendar days following Notice to Proceed and before initiation of manufacture of prestressing wire, submit following:

1. Name and location of prestressing wire manufacturer.

2. General description of quality control procedures used by wire manufacturer. Include physical and chemical property tests utilized, testing frequency and test records; and description of methods employed to assure compliance with AWWA C301 regarding wire surface temperature, type of thermometer, location of temperature measurement, frequency of temperature tests and test records.

3. Approximate dates when wire will be manufactured for use in pipe.

4. Hydrogen embrittlement sensitivity test report for wire.

D. Submit inspection procedures to be used by manufacturer and for quality control and assurance for materials and welding. Submit standard repair procedures that describe in detail shop and field work to be performed.

E. Submit following within 45 days after manufacturing of pipe and fittings:

1. Prestressing wire records.

a. ASTM A 648 for wire.

b. Steel reports as required in AWWA C301, Section 5.2.5.

c. Records of testing accomplished to measure wire surface temperature as required in ASTM A648.

d. Results of other tests of steel reinforcement required in AWWA C301, Section 4.4.7, 4.4.8, and 4.4.9.

e. Wire tension records required in AWWA C301, Section 4.6.7.1. Indicate heat and coil of prestressing wire used.

2. Test results.

a. Hydrostatic testing, acid etching, dye penetration, magnetic particle and x-ray weld test reports as required.

b. Compressive strength (28 day) test results for each type of coating, lining and core mix design.

3. Pipe manufacturer's certification that PCCP:

a. Cylinder assembly has been hydrostatically tested at factory for two (2) minutes minimum in accordance with Section 2.01 J and AWWA C301.

b. Mortar coatings and linings were applied or allowed to cure at temperature above 32 degrees F.

F. Submit following for non-shrink grout for special applications:

1. Manufacturer's technical literature including specifications for mixing, placing, and curing grout.

2. Results of tests performed by certified independent testing laboratory showing conformance to ASTM C 1107, Non-shrink Grout and requirements of this specification.

3. Certification product is suitable for use in contact with potable water.

G. Submit proof of certification for welders. Indicate certified procedures and position each welder is qualified to perform. Provide documentation of the most recent weld qualification test date and continuity of use in each process for which the welder or welding operator is required.

H. Submit certification showing calibration within last 12 months for equipment such as scales, measuring devices, and calibration tools used in manufacture of pipe. Each device used in manufacture of pipe is required to have tag recording date of last calibration. Devices are subject to inspection by Project Manager.

I. Submit manufacturer technical catalog.

1.06 QUALITY CONTROL

A. Manufacturer to have permanent quality control department and laboratory facility capable of performing inspection and testing required. Inspection procedures and manufacturing process are subject to inspection by Project Manager. Perform manufacturer tests and inspections required by AWWA C 301 as modified by these Specifications. Repair defects when as substandard welds, excessive radial offsets (misalignment), pitting, gouges, cracks, other nonconforming conditions.

1. Cylinder and Joint Ring Assembly:

a. Review mill certifications for conformance to requirements of Specifications.

b. Perform physical testing of each heat of steel for conformance to applicable ASTM standards.

c. Inspect physical dimensions and overall condition of joint rings and cylinder/joint ring assembly to verify compliance with requirements of AWWA C 301.

d. Test cylinder/joint ring weld for tensile strength. Test one specimen for each 500 cylinder/joint ring assemblies in addition to those tests required by AWWA C 301.

e. Reject dented steel cylinders.

2. Prestressing Wire:

a. Inspect wire spacing during wire placement on core.

b. Test wire splices for each production run or a minimum of once a week, whichever is less, for conformance with minimum strength criteria.

3. Pipe Cores and Coating:

a. Review mill certificates for each load of cement for conformance to ASTM C 150.

b. Perform sieve analysis weekly for each source of coarse and fine aggregate for conformance to ASTM C 33.

c. Inspect kiln recorder charts daily to confirm proper curing environment.

d. Prior to prestressing, inspect each core for voids, chips, cracks, deleterious surfaces and foreign matter.

e. Check mortar batch proportions, moisture content and slurry application rate. Check coating thickness over wire on each pipe.

f. Check physical integrity of cured mortar coating.

g. Reject pipe with cracks in mortar coating exceeding 0.01 inches wide.

4. Protective Coatings: Check daily application rate and resulting dry film thickness.

B. Gaskets: Randomly test rubber cord for diameter, tensile strength, elongation, compression set, hardness, and specific gravity after oven aging on one out of 100 gaskets.

C. Weld Testing:

1. Perform macroetching tests for complete -penetration production welds on normal production weld tests. Complete joint penetration welds are defined in ANSI/AWS A3.0. Verify complete joint penetration by means of macroetch of joint weld cross section. Macroetch technique in accordance with ASTM E 340.

2. Perform x-ray, ultrasonic, magnetic particle, or dye penetrant testing per AWWA C200 of manual welds on special pipe and fittings.

3. Perform minimum of one set of weld test specimens in accordance with ANSI/AWS A3.0 on each size, grade and wall thickness at minimum of every 3,000 feet of pipe manufactured. Perform no less than one test per project by each welding machine and each operator.

D. Cast four standard test cylinders each day for each 50 cubic yards of core concrete or mortar coating or portion thereof for each mix placed in day. Perform compressive strength test at 28 days. No cylinder test result shall be less than 80 percent of specified strength.

E. Make available copy of Physical and Chemical testing reports for steel cylinders and provide reports at request of Project Manager.

F. Check physical dimensions of pipe and fittings: Physical dimensions to include pipe lengths, pipe LD., pipe O.D. and bend angles.

PART 2 PRODUCTS

2.01 PRESTRESSED CONCRETE CYLINDER PIPE

A. Furnish all concrete pressure pipe by same manufacturer.

B. Provide prestressed concrete cylinder pipe in conformance with AWWA C 301, AWWA C 304 and AWWA M 9 except as modified in this Section. Use of pipe from inventory is permitted only if specifications and certifications are met. Provide testing records for pipe.

C. Do not use prestressed concrete cylinder pipe in aerial crossings, exposed or other unburied areas.

D. Pipe Manufacturer:

1. Must have minimum of 5 years of manufacturer's pipe installations that have been in successful and continuous service.

2. Must maintain on site or in plant minimum of four 22.5-degree bends per 10,000 linear feet of water line. Additionally, for 102” pipe and larger, four bevel adaptors must be maintained on site or in the plant. Any combination of bends may be substituted at manufacturer's option (i.e. two 11.25-degree bends are equivalent to one 22.5-degree bend and will be counted as one fitting). Must be capable of delivering bends or bevel adaptors to job site within 12 hours of notification. These fittings are in addition to fittings called out on Drawing and must be available at all times.

E. Pipe Design Conditions:

1. Working pressure: 150 psi.

2. Hydrostatic field test pressure: 150 psi.

3. Maximum pressure due to surge: 225 psi.

4. Minimum pressure due to surge: -5 psi.

5. Unit weight of soil: 120 pcf minimum, unless otherwise specified.

6. Minimum trench width: O.D. of pipe + four (4) feet.

7. Pipe and Fittings: Designed to withstand most critical simultaneous application of external loads including construction loads and internal pressures.

8. Design: Based on minimum of AASHTO HL-93 loading, AREMA Cooper E-80 loads when under railroads, and depths of bury as indicated. Design pipe with Marston's earth loads for transition width trench for all heights of cover.

   a. Calculate moments and thrusts in wall based on height of earth load, live load, water weight, and pipe weight.

b. For earth load heights up to 16 feet, use bedding sand as bedding material and use 90-degree Olander coefficients for earth load, live load, and water weight contained in pipe along with 15-degree Olander coefficients for pipe weight.

c. For earth load heights 16 feet and greater, use cement stabilized sand as bedding material below springline of pipe, and use 150-degree Olander coefficients for earth load, live load, and water weight contained in pipe along with a 15-degree Olander coefficient for pipe weight.

9. Groundwater Level: Assume below pipe for pipe design. Assume equal to natural ground surface for other conditions.

10. Design pipe for transmitting potable water, unless otherwise shown on Drawings.

11. Manufacture pipe for adverse environmental conditions in accordance with Section 7.5.5 of AWWA C304.

12. Design pipe for buried conditions and kept empty for up to 365 days.

13. Tunnel and Augered Sections: Provide constant outside diameter from bell to spigot end for pipe. Exclude structural benefits associated with primary liner. Design pipe and pipe joints to carry loads including but not limited to: overburden and lateral earth pressures, subsurface soil, grouting, other conditions of service, thrust of jacks, and stress anticipated during handling and installation.

F. Coatings and Linings:

1. Provide Portland cement; ASTM C 150, Type I or II. Provide one type of cement for entire project.

2. Water Absorption Test: ASTM C 497, Method A; perform on samples of cured mortar coating taken from each working shift. Cure mortar coating samples in same manner as pipe.

a. Test Value: Average minimum of 3 samples taken from same working shift, no greater than 9 percent for average value, 10 percent for individual value.

b. Test Frequency: Perform tests each working shift until conformance to absorption requirements has been established by 10 consecutive passing test results, at which time testing may be performed weekly. Resume testing for each working shift when absorption test results fail until conformance to absorption requirements is reestablished by 10 consecutive passing test results.

3. Apply one coat of primer to exposed steel parts of steel bell and spigot rings. Prior to coating, blast clean in accordance with SSPC-SP7 (Brush Off Blast Cleaning). Apply primer in accordance with manufacturer's recommendations.

4. Coat and line access inlets, service outlets, test inlets and air release/vacuum relief riser pipe with same coating and lining of water line in accordance with AWWA C 301, Section 4, unless otherwise indicated on Drawings.

5. Do not exceed two hours between application of first and last course when cement mortar is applied in more than one course; otherwise, do not defer placing of coating of any portion of pipe length. Verify cement mortar coating thickness on each size of pipe by nondestructive method before removing pipe from coating machine.

6. Remove and replace disbonded lining or coating. Reject pipe requiring patches larger than 100 square inches or 12 inches in greatest dimension. Allow no more than one patch on either lining or coating of pipe. Provide WELD-CRETE Probond Epoxy Bonding Agent ET-150, parts A and B; Sikadur 32 Hi-Mod, or approved equal bonding agent for pipe patching.

G. Fittings and Specials:

1. Design fittings to same internal and external loads as straight pipe.

2. Manufacture in accordance with Section 02518 - Steel Pipe and Fittings for Large Diameter Water Lines.

3. Provide fabricated bends or fittings with minimum radius of 2-1/2 times pipe diameter.

4. Design test plugs to withstand forces generated by hydrostatic test and test pressure from either side. Do not exceed 50 percent of minimum yield for design stresses due to hydrostatic pressure. Assume opposite side of plug does not contain water.

5. Provide no specials less than 4 feet in length unless indicated on Drawings or approved by Project Manager.

6. Butt Straps for Closure Piece: Provide at locations indicated on Drawings or authorized by Project Manager. Minimum 12-inch-wide split butt strap; minimum plate thickness equal to thinnest member being joined; fabricated from material equal in chemical and physical properties to thinnest member being joined. Permit no angular deflection or joint offset at butt-strap joints.

7. Provide minimum 6-inch welded outlet for inspecting each closure section, unless access manway is within 40 feet of closure section.

8. Provide Denso petroleum based tape or approved equal for exposed portions of nuts and bolts.

H. Joints:

1. AWWA C 301 rubber-gasketed or welded bell-and-spigot type except where flanged joints are required for valves and fittings as shown on Drawings. Refer to Section 02511 - Water Lines for details on joints and jointing.

2. Rubber-Gasketed Joints: Single weld bell and spigot ring onto steel cylinder. In thrust areas, double weld bell-and-spigot onto steel cylinder. Bond as shown on Drawings to provide electrical continuity along entire pipeline.

3. Restrained Joints: Restrain joints by welding or harnessing joints.

a. Design Pressure: 1.5 times working pressure.

b. Harnessed Joints: AWWA M 9, clamp or snap ring type, except where prohibited. Limit maximum size of snap ring joints to 30-inch diameter pipe.

c. Groundwater Level: Assumed to be equal to natural ground surface.

d. Provide restrained joint pipe with adequate cylinder thickness to transmit full thrust generated by internal pressure across joints.

(1) Calculate distance of restrained joints based on resistance along each leg of bend with thrust based on bend angle.

(2) Calculate cylinder thickness not to be less than that defined in following table:

Inside Diameter (inches)	Cylinder Thickness
Greater than 120	0.25 inch
102 to 120	4 gauge
90 to 96	6 gauge
72 to 84	8 gauge
48 to 66	10 gauge
Less than 48	12 gauge

(3) Allow cylinder thickness to reduce linearly from maximum calculated thickness or from minimum cylinder thickness (as determined in Paragraph 2.01 H.3.d.1, whichever controls, to minimum thickness required by design over required length (as determined in Paragraph 2.01 H.3.d.1) of restrained joints.

4. Use only fully circumferentially welded joints in areas considered potentially petroleum contaminated, within tunnels and under foreign pipelines. Perform welding in accordance with Section 02511 – Water Lines.

5. Pipe Flanges: AWWA C 207 for standard steel flanges of pressure class corresponding to pipe class.

I. Pipe Lengths: Provide pipe sections in standard lengths with minimum length of 16 feet and maximum length of 25 feet, and as indicated on approved shop Drawings or approved by Project Manager. Gasketed joints are allowed on standard lengths of pipe. Non-standard pipe lengths must be approved by Project Manager and joints must be welded as specified herein to achieve equal to or greater than standard pipe length before gasketed joints can be used. Internally and externally mark pipe section with durable marking to show location and pipe pressure.

J. Hydrostatic Test of Cylinder: AWWA C 301, Section 4.6.4.3, at point of manufacture. Hold test for minimum 2 minutes for thorough inspection of cylinder. Repair or reject cylinders revealing leaks or cracks.

K. Transport fittings 42 inches in diameter and larger with end caps and stulls. Remove end caps just prior to installation. Remove stulls after completion of backfill operation.

L. Provide radius of curve as indicated on Drawings unless approved by Project Manager. Make curves and bends by deflecting joints, by use of beveled joints, or by combination of two methods, unless otherwise indicated on Drawings. Do not exceed deflection or joint offset angle recommended by pipe manufacturer. Provide beveled pipe sections of standard length used in curved alignment, except when shorter sections are required to limit radius of curvature. In such case, provide sections throughout curve of substantially equal length. When manufacturing straight pipe sections, manual welding is allowed for following:

1. Tack welding of coils and plates during continuous pipe making process.

2. Rewelding and repairing structural defects in plate and automatic machine welds.

3. Attaching new coil of steel to previous coil.

M. Prior to arrival on project site, identify pipe sections within limits of thrust restraint with permanent, brightly colored, and highly visible markings on outer pipe coating as approved by Project Manager.

2.02 PRESTRESSING WIRE

A. General:

1. Conform to requirement of ASTM A 648, AWWA C 301 and this specification.

2. Furnish test results from independent manufacturer (i.e., manufacturer with no legal or financial ties to pipe manufacturer). Tests must have been performed within 12 months prior to submittal or when supplier changes.

3. Test foreign manufactured wire by local independent laboratory.

4. Prestressing wire surface temperature: not more than 360 degrees at any point in drawing process. Audit surface temperature of wire throughout length of wire drawing process daily for each working shift producing ASTM A 648 wire.

5. Do not use wire with visible pitting or rust that cannot be wiped off.

6. Do not use wire that fails, for no observable mechanical reason other than tension force, during circumferential wrap. Do not splice, but reject this section of wire.

B. Perform mechanical tests per AWWA C301 - Steel Reinforcement except as modified below:

1. Retest coil for which failed torsion test sample has radial, spiral (that is, longitudinal) split visible to unaided eye or evidenced by abrupt offset in wire surface detectable with fingernail.

2. Test sample, for mechanical requirements, from 1 of each 10 consecutively produced coils or fraction thereof in each lot. Pipe manufacturer to establish procedures so samples are randomly selected from entire length of wire coils.

C. Perform hydrogen embrittlement sensitivity testing on samples of prestressing wire in accordance with ASTM A648 and A1032. Test one set of pre-qualified samples for each anticipated wire manufacturing source anticipated by pipe manufacturer for project. Perform tension, wrapping, and torsion on wire samples. Perform pre-qualification testing prior to pipe manufacturing and for each source of supply for wire. Do not use wire failing to conform to test requirements of specification. Acceptance criteria are according to ASTM A648, S1, and AWWA C301, 4.4.8.1. Utilize only wire that meets both of following:

1. Passed aforementioned test.

2. Manufactured from same source and manufacturing procedures.

2.03 GROUT FOR JOINTS AND SPECIAL APPLICATION

A. Joint Grout:

1. Cement Grout Mixture: One part cement to two parts of fine, sharp clean sand. Mix interior joint mortar with as little water as possible until very stiff but workable. Mix exterior joint mortar with water until it has consistency of thick cream.

2. Water: Potable water with total dissolved solids less than 1000 mg/1; ASTM D 512 chloride ions less than 100 mg/1 for slurry and mortar cure; ASTM D 1293 pH greater than 6.5. Use potable water with 250 ppm limit on chlorides and sulfates.

3. Portland Cement: ASTM C 150, Type I or II. Provide one type of cement for entire project.

4. Sand:

   a. Interior joints: ASTM C 35 fine graded plaster sand.

   b. Exterior joints: ASTM C 33 natural sand with 100 percent passing No. 16 sieve.

5. Mix cement grout to specific gravity of 19 lb/gallon or greater as measured by grout/slurry balance. Use balance manufactured grout/slurry by Baroid or approved equal. Perform test in presence of and at request of Project Manager. Add additional cement grout or water to mixed cement grout to bring mix to proper moisture content or specific gravity. Discard cement grout that has been mixed more than 20 minutes and is not at proper specific gravity or moisture content.

B. Provide approved Non-shrink Grout for Special Applications, Patches and Repairs.

1. Conform to requirements of ASTM C 1107, Non-shrink Grout.

2. Pre-blended factory-packaged material manufactured under rigid quality control.

3. Contain non-metallic natural aggregate, be non-staining and non-corrosive.

4. Meeting NSF 61 Standard suitable for use in contact with potable water supply.

5. Exterior: Highly flowable to fill joint wrapper without leaving voids or trapped air. Interior capable of being placed with plastic consistency.

6. Non-bleeding and non-segregating at fluid consistency.

7. Contain no chlorides or additives which may contribute to corrosion of prestressed concrete cylinder pipe.

8. Free of gas-producing, gas-releasing agents.

9. Resist attack by oil or water.

10. Mix, place, and cure in accordance with manufacturer's recommendations. Upon 72 hours notice, provide services of qualified representative of non-shrink grout manufacturer to aid in use of product under job conditions.

11. Mix non-shrink grout to specific gravity of 17.7 lb/gallon or greater as measured by grout/slurry balance. Use grout/slurry balance manufactured by Baroid or approved equal. Perform test in presence of and at request of Project Manager. Add additional cement grout or water to bring mix to proper moisture content or specific gravity. Discard grout that has been mixed more than 20 minutes and is not at proper specific gravity or moisture content.

12. Compressive strength: ASTM C 1107 2500 psi minimum 7-day unconfined; 5000 psi minimum 28-day unconfined.

C. Finished surface of lining and interior joint to be comparable to surface rubbed with No. 16 carborundum stone. Rub joint mortar sufficiently to bring paste to surface, to remove depressions and projections, and to produce smooth, dense surface. Add cement to form surface paste as necessary. Leave interior with clean, neat and uniform-appearing finish.

D. Joint Wrapper: Minimum width of 9 inches for 33-inch diameter and smaller; minimum width of 12 inches for diameters greater than 33-inch hemmed at edge to allow threading with minimum 5/8-inch-wide steel strap. Provide minimum 6-inch-wide wire Ethafoam strip sized, positioned, and sewn circumferential in center of wrapper.

2.04 CATHODIC PROTECTION

A. Connect each joint of pipe with bonding straps or approved devices to maintain continuity of current. Provide bonding straps free of foreign material.

B. Electrically isolate water line from other connections. Use insulating type joints or nonmetallic pipe unless otherwise indicated on Drawings.

PART 3 EXECUTION

3.01 INSTALLATION

A. Conform to requirements of Section 02511 - Water Lines. Do not install pipe without approved lay schedule.

B. Manufacturer will make available services of representative, throughout project duration when deemed necessary by Project Manager, to advise aspects of installation including but not limited to handling, storing, cleaning and inspecting, coatings and linings repairs, and general construction methods affecting pipe.

C. Bedding and Backfilling:

1. Conform to requirements of Section 02317 - Excavation and Backfill for Utilities.

2. Align pipe at proper grade prior to joint connection and do not shift after jointing operation has been completed.

3. Do not move trench support system (trench safety system) once bedding material is compacted.

4. Excavate outside specified trench section for bell holes, and for spaces sufficient to permit removal of slings. Provide bell holes at proper locations for unrestricted access to joint. Form bell holes large enough to facilitate joint wrapping and to permit visual examination of process. Enlargement of bell holes as required or directed by Project Manager. Subsequent backfilling thereof will not be considered as authorized additional excavation and backfill. Backfill bell holes and spaces to satisfaction of Project Manager.

5. Remove blocking after placing sufficient backfill to hold pipe in position.

6. Use cement-stabilized sand in areas of trench excavation 16 feet and greater, as bedding material up to springline of pipe.

D. Follow non-shrink grout manufacturer's specifications for non-shrink grouting.

E. Install each pipe section in sequence identified on lay schedule. Deviations from lay schedule sequence shall be approved by Project Manager and denoted on final lay schedule.

F. Use adequate surveying methods, procedures and employ competent surveying personnel to ensure pipe sections are laid to line and grade and within stipulated tolerances. Measure and record, in form approved by Project Manager, in-place survey data for pipe laid each day and submit copy of data to Project Manager at end of that day. Survey data to include unique pipe number, deflection or joint offset angle at pipe joint and whether beveled ends were used, invert elevation at pipe joint, deviation of joint from project line, deviation of joint from project grade, inside pipe joint lap measured at top, bottom, and at springline (each side).

G. Static Electricity:

1. Properly ground steel pipeline during construction as necessary to prevent build-up of static electricity.

2. Electrically test where required after installation of pipeline is complete.

3.02 CLOSURES AND APPROVED PIPE MODIFICATIONS

A. No modifications of standard pipe for closures will be permitted in field. No field cutting of pipe or exposure of prestressed wire is permitted without written approval from Project Manager.

B. Pipe manufacturer's representative and Project Manager to entirely witness closures and approved pipe modification efforts.

C. Provide minimum lap of 4 inches between member being joined and edge of butt strap. Weld on both interior and exterior, unless otherwise approved by Project Manager.

D. Provide full circumferential welds on joints required to be welded. Employ independent certified testing laboratory, approved by Project Manager, to perform weld tests on field welds. Include cost of testing in contract unit price for water line. Use magnetic particle test method for lap welds or X-ray methods for butt welds, for 100 percent of joint welds. Maintain records of tests. When defective weld is revealed, repair defective weld, and retest. Use wire and flux from same manufacturer throughout entire project.

E. Fill wrapper in field and allow excess grout water to seep out. Refill wrapper as necessary. When joint mortar level has stabilized and begun to mechanically stiffen, lap Ethafoam wrapper over top of joint, and secure in place.

F. Stretch test each gasket splice to twice its unstretched length and inspect for defects.

3.03 VISIBLE CRACKS

A. No visible cracks longer than 6 inches, measured to be within 15 degrees of line parallel to pipe longitudinal axis, are permitted except:

1. In surface laitance of centrifugally cast concrete,

2. In sections of pipe with steel reinforcing collars or wrappers, or

3. Within 12 inches of pipe ends.

B. Repair interior lining cracks that exceed 1/16-inch (0.0625 inches) wide.

C. Reject pipe with exterior coating cracks that exceed 0.01 inches wide.

D. Immediately remove pipe from site when pipe has cracks exceeding limitations and cracks are not repairable.

3.04 FIELD REPAIR PROCEDURES FOR COATING/LINING

A. Areas less than or equal to 6 inches in diameter: Patch honeycomb and minor defects in concrete surfaces with non-shrink grout conforming to section 2.03 B. Use only manual or small (low pressure) air chisels to chip away mortar coating or lining. Cut out unsatisfactory material and replace with non-shrink grout, securely bonded to existing coating or lining. Finish junctures between patches and existing concrete as inconspicuous as possible. Strike off non-shrink grout flush with surrounding surface after patch has stiffened sufficiently to allow for greatest portion of shrinkage. Finish surface in accordance with lining requirements.

B. Pipe with defective coating areas greater than 6 inches in diameter cannot be used. Immediately remove pipe from project.

C. Reject pipe when steel cylinder is dented while making field repair. Immediately remove pipe from project.

END OF SECTION

SECTION 02508

EXTRA STRENGTH CLAY PIPE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Extra strength vitrified clay pipe for direct burial.

B. Vitrified clay pipe for jacking and microtunneling.

1.02 REALTED SECTIONS

A. Section 01270 – Measurement and Payment

B. Section 01330 – Submittal Procedures

C. Section 02441 – Microtunneling

D. Section 02445 – Jack and Bore/Jack and Mine/Pilot Tube Guided Boring Tunnels

E. Section 02531 – Gravity Sanitary Sewers

F. Section 02533 – Acceptance Testing for Sanitary Sewers

1.03 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. No separate payment will be made for extra strength vitrified clay pipe under this section. Include cost in unit price work, as specified in the following sections:

a. Section 02441 - Microtunneling

b. Section 02445 - Jack and Bore/Jack and Mine/Pilot Tube Guided Boring Tunnels.

c. Section 02531 - Gravity Sanitary Sewers.

2. Refer to Section 01270 - Measurement and Payment for unit price procedures.

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

1.04 REFERENCES

A. ASTM C 12 ~~–~~ Standard Practice for Installing Vitrified Clay Pipe Lines.

B. ASTM C 301 ~~-~~– Standard Test Methods for Vitrified Clay Pipe.

C. ASTM C 425 ~~-~~– Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings.

D. ASTM C 700 ~~-~~– Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated.

E. ASTM C 828 ~~-~~– Standard Test Method for Low-Pressure Air Test of Vitrified Clay Pipe Lines.

F. ASTM C 1091 - Standard Test Method for Hydrostatic Infiltration Testing of Vitrified Clay Pipe Lines.

G. ASTM C 1208 - Standard Specification for Vitrified Clay Pipe and Joints for Use in Microtunneling, Sliplining, Pipe Bursting, and Tunnels.

H. ASTM D 1784 - Standard Classification System and Basis for Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.

I. National Clay Pipe Institute (NCPI) – Vitrified Clay Pipe Engineering Manual.

1.05 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

B. Submit complete product data for pipe, fittings, gaskets and couplings for approval. Indicate conformance to appropriate reference standards.

C. Submit certificates by a testing laboratory, hired and paid by the manufacturer, that clay pipes meet applicable standards when tested in accordance with ASTM C 301.

D. Submit manufacturer technical catalog.

PART 2 PRODUCTS

2.01 VITRIFIED CLAY PIPE

A. Vitrified clay pipe for direct burial shall conform to ASTM C 700 requirements for extra strength clay pipe.

B. Approved manufacturers of extra strength clay pipe are:

1. Mission Clay Products Corporation

2. Dickey Company.

2.02 JOINTS

A. Joints for extra strength vitrified clay shall conform to ASTM C 425.

1. For clay pipe 21 inches in diameter and larger, conform to requirements for compression joints for bell-and-spigot pipe.

2. For clay pipe 18 inches in diameter and smaller, conform to requirements for compression couplings for plain-end pipe.

B. Joints for jacking, sliplining, and microtunneling pipe shall conform to ASTM C 1208.

2.03 GASKETS

A. When no contaminant is identified, furnish rubber or polyurethane elastomer gasket material conforming to standards listed above.

B. Pipe 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, Engineer of the Record and approved by City Engineer prior to installation

2.04 COMPRESSION COUPLINGS

A. The PVC collar material for compression couplings of plain-end pipe shall conform to requirements of ASTM D 1784, Class 12454-B.

B. Couplings for microtunneling and other pipe jacking methods shall be made with Type 316 stainless steel sleeve couplings that utilize elastomeric sealing gaskets as the sole means to maintain joint watertightness. The joints shall have the same outside diameter as the pipe so when the pipes are assembled, the joints are flush with the pipe outside surface.

PART 3 EXECUTION

3.01 INSTALLATION

A. Conform to installation requirements of:

1. Section 02531 - Gravity Sanitary Sewers; and

2. Section 02441 - Microtunneling or Section 02445 - Jack and Bore/Jack and Mine/Pilot Tube Guided Boring Tunnels

B. Install pipe in accordance with ASTM C 12, the NCPI Vitrified Clay Pipe Engineering Manual, and manufacturer's recommendations.

3.02 ACCEPTANCE TESTING

A. Perform acceptance testing in accordance with Section 02533 - Acceptance Testing for Sanitary Sewer, and ASTM C 1091. Do not use procedures from ASTM C 828 unless authorized by Project Manager.

3.03 FIELD QUALITY ~~ASSURANCE~~CONTROL

A. The City may run tests on field samples following applicable ASTM standards at an independent laboratory to verify the required physical properties and characteristics of supplied materials. Provide product samples as requested by Project Manager.

END OF SECTION

SECTION 02509

FIBERGLASS REINFORCED PIPE FOR PRESSURE MAINS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Fiber Reinforced Pipe for buried water lines up to 30 inches in diameter, unless otherwise approved by Project Manager.

B. Fiber Reinforced Pipe for buried sanitary sewer force mains up to 16 inches in diameter, unless otherwise approved by Project Manager.

1.02 RELATED SECTIONS

A. Section 01270 - Measurement and Payment

B. Section 01330 - Submittal Procedures

C. Section 02317 - Excavation and Backfill for Utilities

D. Section 02441 – Microtunneling

E. Section 02445 - Jack and Bore/Jack and Mine/Pilot Tube Guided Boring Tunnels

F. Section 02465 - Drilled Shaft Foundations

G. Section 02501 - Ductile Iron Pipe and Fittings

H. Section 02502 - Steel Pipe and Fittings

I. Section 02511 - Water Lines

J. Section 02514 - Disinfection of Water Lines

K. Section 02515 - Hydrostatic Testing of Pipelines

L. Section 02518 - Steel Pipe and Fittings for Large Diameter Water Lines

M. Section 02532 - Sanitary Sewer Force Mains

1.03 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. No separate payment will be made for fiberglass pipe under this Section. Include cost in unit price for Work, as specified in Section 02511 - Water Lines and Section 02532 - Sanitary Sewer Force Mains.

2. Refer to Section 01270 - Measurement and Payment for unit price procedures.

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

1.04 REFERENCES

A. AASHTO - Standard Specifications for Highway Bridges.

B. AREMA - Manual of Railway Engineering, Volume B, Chapter 15.

C. ASTM D696 - Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between −30°C and 30°C with a Vitreous Silica Dilatometer.

D. ASTM D 2412 - Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.

E. ASTM D 2992 ~~-~~– Standard Practice of Obtaining Hydrostatic or Pressure Design Basis for "Fiberglass" (Glass- Fiber-Reinforced-Thermosetting~~)~~ -Resin) Pipe and Fittings.

F. ASTM D 2996 - Standard Specification for Filament-Wound “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.

G. ASTM D 3262 - Standard Specification for “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe.

H. ASTM D 3681 - Standard Test Method for Chemical Resistance of “Fiberglass” (Glass-Fiber- Reinforced Thermosetting-Resin) Pipe in a Deflected Condition.

I. ASTM D 3754 - Standard Specification for “Fiberglass” (Glass-Fiber Reinforced Thermosetting-Resin) Sewer and Industrial Pressure Pipe.

J. ASTM D 4161 - Standard Specification for “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Joints Using Flexible Elastomeric Seals.

K. ASTM F 477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

L. AWWA C 950 – Fiberglass Pressure Pipe.

M. AWWA M 45 – Fiberglass Pipe Design.

N. ISO 14692 – Petroleum and Natural Gas Industries – Glass-Reinforced Plastics (GRP) Piping.

O. NSF/ANSI ~~Standard~~ 61 - Drinking Water System Components - Health Effects.

1.05 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

B. Provide sufficient data for the Project Manager to properly evaluate the pipe.

C. Product data submittals shall include the following, as a minimum:

1. Details of the proposed pipe.

2. Properties and strengths of the pipe.

3. Details of pipe joint.

4. Pipe design analysis and thrust restraint calculations in accordance with AWWA M45 – Fiberglass Pipe Design, latest edition.

5. Instruction on storage, handling, transporting, and installation.

6. Standard catalog sheets.

D. Test Reports: Provide test reports upon request, certifying that the pipe has been tested in accordance with and exceeds minimum requirements of ASTM D 2412, ASTM D 2992 (if applicable), D 3262 and ASTM D 3681.

E. Certification from manufacturer that fiberglass pipe was hydrostatically tested at factory in accordance with AWWA C 950 and requirements of this section.

1. Hydrostatic Test Pressure: 150 psi

2. Test Duration: Two (2) minutes

F. An affidavit of compliance stating that all delivered materials comply with the requirements of these specifications as well as compliance with AWWA C950.

G. For pressure mains 24~~-~~inches in diameter and larger, shop drawings signed and sealed by Professional Engineer registered in State of Texas showing:

1. Manufacturer's pipe design calculations including thrust restraint design.

2. Details of pictorial nature of critical features and specials indicating alignment and grade, laying dimensions, fabrication, fitting, flange, and fully dimensioned details, with plan view detailing pipe invert elevations, bends, and other critical features. Indicate station numbers for fittings corresponding to Drawings. Do not start production of pipe and fittings prior to review and approval by Project Manager. Provide final approved lay schedule on CD-ROM in Adobe Portable Document Format (*.PDF).

3. Certification from manufacturer that design was performed for project in accordance with requirements of this section. Certification to be signed and sealed by Professional Engineer registered in State of Texas.

H. Submit manufacturer technical catalog.

1.06 QUALITY CONTROL

A. Manufacturer to provide permanent quality control department and laboratory facility capable of performing inspections and testing as required by Specifications. Material testing, inspection procedures, and manufacturing process are subject to inspection by Project Manager. Perform manufacturer's tests and inspections required by referenced standards and these Specifications.

B. Calibrate within last 12 months equipment such as scales, measuring devices, and other calibration tools used in manufacture of pipe. Affix tag recording date of last calibration on each device used in manufacture of pipe.

1.07 TESTING

A. Joints: Coupling joints shall be qualified per the tests of Section 7 of ASTM D 4161.

B. Provide pipes tested in accordance with AWWA C950 and ASTM D 3754 as applicable.

C. Hydrostatic Testing: AWWA C950, Section 5.1.2.1.1, at point of manufacture. Hold test for minimum 2 minutes for thorough inspection of pipe. Reject pipe revealing leaks or cracks.

PART 2 PRODUCTS

2.01 FIBERGLASS PIPE

A. Manufacture pipe by filament winding process to result in a dense, nonporous, corrosion- resistant, consistent composite structure to meet the operating conditions as shown on the Drawings.

1. Do not use stiffening ribs or rings.

2. The workmanship of the pipe shall be free of defects such as delaminations, indentations, pinholes, bubbles, cracks, pits, blisters, foreign inclusions, and resin- reduced areas. Reasons for these defects free workmanship is because of the serviceability and strength of the pipe could be compromised.

3. The pipe must be as uniform as commercially practicable in opacity, color, density as well as other physical properties.

4. Centrifugally cast fiberglass pipe may be used in lieu of filament-wound for pressure pipe with approval of Project Manager, however, this substitution will not be approved for water lines.

B. Furnish pipes in the diameters specified and within the tolerances specified below.

1. Tolerances:

   a. Sanitary Sewer Force Mains: Diameter tolerances in accordance with AWWA C950.

   b. Water Mains: Diameter tolerances in accordance with AWWA C950 for diameters up to 30 inches.

C. Lengths: Supply at least 90 percent of total footage of each size and class of pipe, excluding special order pipes in nominal lengths of 20 feet unless approved by Project Manager. No nominal lengths of less than four (4) feet may be used.

D. Wall Thickness: Provide minimum average wall thickness of stated design thickness. Provide minimum single point thickness not be less than 98 percent of stated design thickness for sanitary sewer applications and not less than 100 percent for water mains.

E. End Squareness: Provide pipe ends square to pipe axis with maximum tolerance of 1/8 inch.

F. Refer to list of Approved Products for acceptable manufacturers.

2.02 DESIGN CRITERIA

A. Design fiberglass pressure pipe according to AWWA Manual M 45 – Fiberglass Pipe Design, latest edition.

B. Sanitary Sewer Force Mains:

1. Provide minimum 150 psi Pressure Class. 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. Pipe for Jacking: Govern stiffness class of FRP in a pipe jacking operation by either ring deflection 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 1.04~~5~~, Submittals.

   a. Perform pipe stress calculations based on jacking loads to conform to Section 02441 - Microtunneling or Section 02445 - Jack and Bore/Jack and Mine/Pilot Tube Guided Boring Tunnels

3. Calculate pipe deflection to 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. Prepare deflection on calculations using long-term (drained) values for soil parameters contained in the geotechnical investigation report for the Project, or other site-specific data

4. Provide dual-angle, filament-wound fiberglass reinforced epoxy pipe with integral epoxy liner and exterior coating in sizes from 4~~-~~inchs to 16~~-~~inchs diameter. Conform to requirements of ASTM D 2996, depending on size and class of pipe required.

5. Hydrostatic design value shall be not less than 21,000 psi when tested in accordance with ASTM D 2992(B) and not less than 8000 psi when tested according to ASTM D 2992(A).

6. Burial depths for pipes with standard wall thickness shall be between 3 feet and 25 feet.

7. Joints: Heavy duty threaded coupling system with positive O-ring seals. For 4~~-~~ inches through 6~~-~~inches diameters, provide mechanical joints with fast advance, acme-type threads. Male threaded portion of couplings shall lock the mechanical joints for couplings for pipe diameters of 8 inches through 16 inches. Axial movement of couplings shall allow up to 2 degrees of angular deflection without affecting O-ring seal integrity.

8. Pipes, fittings, and other components in this system shall be rated for service to 150 psig at 120 degrees F. Components shall be rated at or above design pressure of system.

C. Water Lines. At minimum, provide 150 psi Pressure Class and 46 psi Stiffness Class. Manufacturer to provide calculations in accordance with AWWA M 45 to determine the appropriate pressure class and stiffness class to withstand actual installation conditions, based on the following Design Criteria:

1. Working Pressure: 150 psi.

2. Hydrostatic Field Test Pressure: 150 psi.

3. Maximum Pressure Due to Surge: 225 psi.

4. Minimum Pressure Due to Surge: -10 psi

5. Unit Weight of Soil: 120 pcf.

6. Bedding constant (K) = 0.1.

7. Deflection lag factor (Dl) = 1.3

8. Minimum Trench Width: O.D. of pipe + four (4) feet.

9. Maximum allowable long term deflection not to exceed 5 percent of original pipe diameter.

10. Design:

a. Design to withstand most critical simultaneous application of external loads including construction loads and internal pressures.

b. Base on minimum of AASHTO HL-25 loading, AREMA Cooper E-80 loads when under railroads, and depths of bury as indicated.

c. Calculate earth loads and thrusts for restrained (tied) joints based on AWWA M45.

d. Groundwater Level: Assume groundwater elevation at ground surface.

e. Design pipe for buried conditions.

D. Tunnel and Augered Sections: Exclude structural benefits associated with primary liner. Design pipe and pipe joints to carry loads including but not limited to: Overburden and lateral earth pressures, subsurface soil, grouting, other conditions of service, thrust of jacks, and stress anticipated during handling and installation. Do not create grout holes with pipe.

2.03 MATERIALS

A. 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.

B. 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.

C. Fillers: Silica sand or other suitable materials may be used.

D. Additives: Resin additives, such as pigments, dyes, curing agents, thixotropic agents, and other coloring agents, if used, shall in no way be detrimental to the performance of the product nor impair visual inspection of the finished products.

E. Internal Liner Resin:

1. Water Lines: Manufacture using materials meeting NSF 61. Any material used within the pipe must comply with requirements of the Safe Drinking Water Act and other federal requirements. If transporting potable water, fiberglass pipe must be evaluated and certified for this specific use. The mark or seal of the laboratory that is responsible for evaluating the pipe must be included on the pipe.

2. Sanitary Sewer Force Mains: Fiberglass pipe shall have resin-rich liner of following thickness:

a. For nominal sizes 4 inches through 6 inches, conform to ASTM D 2996 RTRP 11CX 5430, with minimum liner thickness of 0.020 inch.

b. For nominal sizes 8 inches through 16 inches, conform to ASTM D 2996 RTRP 11FX 3210, with minimum liner thickness of 0.025 inch.

c. The coefficient of linear thermal expansion shall be 8.5 x 10-6 inch/inch/degrees F for 4-inch through 6-inch pipe and 12.0 x 16-6 inch/inch/degrees F for 8-inch through 16-inch pipe in accordance with ASTM D 696.

2.04 JOINTS

A. Gasketed Joints: Unless otherwise specified, field connect pipe with fiberglass sleeve couplings or confined o-ring bell-and-spigot joints that utilize elastomeric sealing gaskets as sole means to maintain joint water tightness. Joints shall meet performance requirements of ASTM D 4161.

1. Supply rubber gaskets from an approved gasket manufacturer in accordance with ASTM F 477, when no contaminant is identified and suitable for the service intended. Affix gaskets to pipe by means of a suitable adhesive, or install in such a manner so as to prevent the gasket from rolling out of the pre-cut groove in the pipe or sleeve coupling.

2. When pipe is to be installed in potentially contaminated areas, provide the following gasket materials for the noted contaminants.

CONTAMINANT	GASKET MATERIAL REQUIRED
Petroleum (diesel, gasoline)	Nitrile Rubber (for sanitary sewers) Viton (FKM) (for water lines)
Other Contaminants	As recommended by the pipe manufacturer

3. If required gasket material is not available for use, pipe other than fiberglass pipe must be used in potentially contaminated areas.

B. Restrained Joints: Utilize locking or butt-and-wrap (laminated) joints capable of withstanding internal pressure and longitudinal tensile loads.

1. Design restrained joint pipe using the allowable stress for combined biaxial loading determined in accordance with the trapezoidal design envelope design procedure of ISO 14692, latest edition. Provide test results or other verification of joint and thrust pipe design for approval by Project Manager with submittal of pipeline layout drawings.

2. Provide butt-and-wrap joints where restrained joints are called out on 66-inch diameter and larger.

3. Butt-and-Wrap Joints: Provide fiberglass reinforced overlay build up of minimum dimensions of 4 inches by 6 inches around circumference joints located at thrust source and sections of pipe located within thrust restraint limits.

4. Biaxial Lock Joint: Joints shall consist of plastic bar(s) inserted into circumferential void(s) around rubber gasket joint. Circumferential void is formed by matching recessed grooves on bell and spigot. Bar(s) shall fill void, forming an interference fit with bell and spigot to prevent joint from separating. Joint water-tightness is provided by joint gasket.

5. If centrifugally cast fiberglass pipe is provided with approval from Project Manager, and approved restrained joints are not available, provide external thrust restraint system in accordance with Paragraph 3.02 – External Thrust Restraints.

2.05 FITTINGS

A. Provide fittings for water mains capable of withstanding specified test pressures.

1. Outlets and Tees. Provide fiberglass pipe, ductile iron, or steel pipe when branch is less than 20 percent of diameter of main pipe and less than or equal to 8 inches diameter. Attach by glass reinforced overlays as approved by Project Manager.

2. Provide ductile iron or steel pipe bends and outlets or tees greater than eight (8) inches in diameter or which are greater than 20 percent of diameter of main pipe.

a. Use same materials (ductile iron or steel) throughout entire project.

b. Conform to Section 02518 - Steel Pipe and Fittings for Large Diameter Water Lines or Section 02501 - Ductile Iron Pipe and Fittings for other fittings and bends.

B. Provide fittings for force mains capable of withstanding specified test pressures.

1. Outlets and Tees. Provide fiberglass pipe or ductile iron pipe when branch is less than 20 percent of diameter of main pipe and less than or equal to 8-inch diameter. Attach by glass reinforced overlays as approved by Project Manager.

2. Provide ductile iron pipe bends and outlets or tees greater than eight (8) inches in diameter or which are greater than 20 percent of diameter of main pipe.

a. Use same materials (ductile iron) throughout entire project.

b. Conform to Section 02501 - Ductile Iron Pipe and Fittings for other fittings and bends.

C. Fiberglass Pipe Fittings. Created by filament-winding or cut and miter process as described in AWWA M 45.

1. Provide tolerance of angle of elbow and angle between main and leg of wye or tee to plus or minus 2 degrees. Provide tolerance on laying length of fitting to plus or minus 2 inches.

2.06 INSPECTION

A. The Project Manager shall be entitled to inspect pipes or witness the pipe manufacturing. Such inspection shall not relieve the manufacturer of the responsibilities to provide products that comply with the applicable standards and these Specifications.

B. Manufacturer's Notification: Should the Project Manager wish to see specific pipes during any phase of the manufacturing process, the manufacturer must provide the Project Manager with adequate advance notice of when and where the production of those pipes will take place.

C. Failure to Inspect: Should the Project Manager elect not to inspect the manufacturing, testing, or finished pipes, it in no way implies approval of products or tests.

2.07 PACKAGING, HANDLING, AND SHIPPING

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

PART 3 EXECUTION

3.01 INSTALLATION

A. Install pipe and fittings in accordance with requirements of Section 02511 – Water Lines or 02532 - Sanitary Sewer Force Mains.

B. The manufacturer must supply a suitable qualified field service representative to be present periodically during the installation of pipe.

C. Pipe Bedding: Conform to requirements of Section 02317 - Excavation and Backfill for Utilities.

D. Pipe Handling: Use textile slings.

E. Jointing:

1. Clean ends of pipe and coupling components.

2. Check pipe ends and couplings for damage. Correct any damage found.

3. Coupling grooves must be completely free of dirt.

4. Apply joint lubricant to pipe ends and rubber seals of coupling. Use only lubricants approved by the pipe manufacturer.

5. Use suitable auxiliary equipment, such as a wire rope puller, to pull joints together.

6. 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.

7. In the process of jointing the pipe, do not allow the deflection angle to exceed the deflection permitted by the manufacturer.

F. 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.

G. Tests:

1. Water Lines: Conform to requirements of Section 02514 – Disinfection of Water Lines and Section 02515 – Hydrostatic Testing of Pipelines.

2. Sanitary Sewer Force Mains: Conform to requirements of Section 02532 – Sanitary Sewer Force Mains.

3.02 EXTERNAL THRUST RESTRAINT

A. In areas of thrust restraint not using an approved restrained joint, such as with centrifugally cast fiberglass pipe, use one of three methods below. Submit system for approval by Project Manager.

1. Encased Design: For areas with restrained joint length of less than 20 feet from thrust source.

a. Provide thrust coupling as specified herein.

b. Use reinforced concrete to encase bend and pipe within area of thrust restraint. Encasement shall be of enough strength to accept 125% of designed pipe thrust.

c. Last four inches on both ends of encasement of fiberglass pipe shall be faced with minimum 1/4 inch thick rubber padding.

d. Locate sleeve coupling outside encased area.

2. H-Pile Design: System design and construction to conform to Section 02465 - Drilled Shaft Foundation and to be signed and sealed by Professional Engineer in State of Texas.

a. Provide thrust coupling as specified herein.

b. Use concrete pipe support to support entire bend. Pipe supports shall have cradle with minimum 120 degree support arc. Support arcs shall be faced with minimum 1/4 inch thick rubber padding.

c. Unless otherwise approved by Project Manager, install driven H-piles, with minimum of twelve (12) piles per individual support [three (3) piles on pipe cross-section axis by four (4) piles on pipe flow axis configuration] under concrete pipe support. Piles shall be of enough strength and depth to accept 125% of designed pipe thrust through shear resistance.

d. Anchor bends to pipe support in manner to prevent over stressing fiberglass reinforced pipe.

3. Use ductile iron or steel for fittings and pipe in thrust area, in accordance with requirements in Section 02501 - Ductile Iron Pipe and Fittings, Section 02502 - Steel Pipe and Fittings, and Section 02511 - Water Lines. Join fiberglass reinforced pipe to steel or ductile iron pipe outside of thrust area using fiberglass pipe manufacturer recommendation.

END OF SECTION

SECTION 02510

POLYPROPYLENE (PP) CORRUGATED WALL PIPE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Polypropylene (PP) pipe for gravity sanitary sewers and drains, including fittings.

B. Polypropylene (PP) pipe for gravity storm sewers and culverts.

1.02 RELATED SECTIONS

A. Section 01270 – Measurement and Payment

B. Section 01330 – Submittal Procedures

C. Section 02317 – Excavation and Backfill for Utilities

D. Section 02531 – Gravity Sanitary Sewers

E. Section 02533 – Acceptance Testing for Sanitary Sewers

F. Section 02550 – Sliplining Sanitary Sewers

G. Section 02631 – Storm Sewers

1.03 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. No separate payment will be made for PP pipe under this Section. Include cost in unit prices for work, as specified in following sections:

    a. Section 02531 - Gravity Sanitary Sewers

    b. Section 02631 – Storm Sewers

2. Refer to Section 01270 - Measurement and Payment for unit price procedures.

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

1.04 DEFINITIONS

A. AASHTO - American Association of State Highway and Transportation Officials.

B. AASHTO's Product Evaluation and Audit Solutions – AASHTO's program to evaluate materials, products, and devices of common interest for use in highway and bridge construction.

C. Soil-tight Joints: Joints meeting the definition in AASHTO Standard Specifications for Highway Bridges, Section 26.4.2.4.

D. Watertight Joints: Joints meeting the requirements of ASTM D 3212.

~~1.04~~1.05 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO), AASHTO LRFD Bridge Design Specifications, current edition.

B. AASHTO, Standard Specifications for Highway Bridges, current edition.

~~A.~~C. AASHTO M330 - ~~-~~Polypropylene Pipe, 300- to 1500-mm (12- to 60-in.) Diameter.

~~B.~~D. ASTM D 2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.

~~C.~~E. ASTM D 3212 - Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.

~~D.~~F. ASTM F 477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

~~E.~~G. ASTM F 2764 - Standard Specification for 6 to 60 in. [150 to 1500 mm] Polypropylene (PP) Corrugated Double and Triple Wall Pipe and Fittings for Non-Pressure Sanitary Sewer Applications.

~~F.~~H. ASTM F 2881- Standard Specification for 12 to 60 in. [300 to 1500 mm] Polypropylene (PP) Dual Wall Pipe and Fittings for Non-Pressure Storm Sewer Applications.

~~1.05~~1.06 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

B. Submit shop drawings showing design of pipe and fittings indicating alignment and grade, pipe length, laying dimensions, fabrication, fittings, flanges, gasket material, and special details.

C. Submit detailed calculations for pipe design per AASHTO LRFD Bridge Design Specifications. Refer to Section 02631 – Storm Sewers submittal requirements for more details.

D. Submit details of Pipe Joints and jointing procedure for PP pipe.

E. Submit manufacturer technical catalog.

F. Submit manufacturer's installation specifications before beginning work. Include maximum fill depth and backfill requirements in manufacturer's installation specifications.

G. Submit a certificate of compliance with each shipment stating that the materials and assemblies fully comply with the requirements of the Contract.

1. Ensure that manufacturer's Certification of Compliance contains the following information:

a. Project Name.

b. Name of the Contractor.

c. Material description.

(1) Manufacturing plant

(2) Date of manufacture

(3) Pipe dimensions

(4) Pipe stiffness

(5) Pipe flattening

(6) Brittleness

(7) ASTM Resin Cell classification

(8) Workmanship

d. Typed or printed name of the person who signed the certification.

~~1.~~2. Provide the date and method of shipment from the product origin within the transmittal.

~~1.06~~1.07 QUALITY ~~CONTROL~~ASSURANCE

A. Provide manufacturer's certificate of conformance to Specifications.

B. 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.

C. Project Manager reserves right to inspect pipes or witness pipe manufacturing. Inspection shall in no way relieve manufacturer of responsibilities to provide products that comply with applicable standards and these Specifications.

1. Manufacturer's Notification: Should Project Manager wish to witness manufacture of specific pipes, manufacturer shall provide Project Manager with minimum three weeks notice of when and where production of those specific pipes will take place.

2. Failure to Inspect. Approval of products or tests is not implied by Project Manager's decision not to inspect manufacturing, testing, or finished pipes.

D. Pipe manufacturer to provide services of experienced, competent, and authorized representative to visit site to advise and consult Contractor during jointing and installation of pipe.

E. Manufacturer Qualifications: Manufacturer shall specialize~~ing~~ in manufacturing the products specified in this section with documented experience of minimum 5 years of pipe installations that have been in successful, continuous service for same type of service as proposed Work.

F. Manufacturers shall be AASHTO- Product Evaluation and Audit Solutions-certified. Qualified manufacturers must also maintain and submit a current AASHTO- Product Evaluation and Audit Solutions certificate of compliance.

1. For a list of AASHTO-Product Evaluation and Audit Solutions certified manufacturers, see the following webpage: https://transportation.org/product-evaluation-and-audit-solutions/.

~~PART 2 QUALIFICATIONS~~

~~PART 3~~PART 2 PRODUCTS

~~3.01~~2.01 GENERAL

A. Provide ~~products manufactured by companies~~ approved products listed on the City of Houston ~~Standard Product List~~ Approved Products List or approved equal.

B. Furnish corrugated-wall gravity sanitary sewer pipe with bell-and-spigot end construction conforming to ASTM D 3212. Joining will be accomplished with dual elastomeric gaskets in accordance with manufacturer's recommendations. Use integral bell-and-spigot gasketed joint designed so that when assembled, elastomeric gasket, contained in machined groove on pipe spigot, is compressed radially in pipe bell to form a positive seal. Design joint to avoid displacement of gasket when installed in accordance with manufacturer's recommendations.

C. Furnish corrugated-wall polypropylene (CPP) pipe for gravity storm sewer and storm sewer culvert pipe. Joints shall be installed such that connection of pipe sections will form continuous line free from irregularities in flow line. ~~Suitable joints are:~~

D. Jointing:

1. Provide joints and fittings meeting the following requirements:

   a. Integral Bell and Spigot with dual elastomeric gaskets. Bell shall overlap minimum of two corrugations of spigot end when fully engaged. Provide the spigot end with an O-ring gasket in accordance with 2.01.D.2.

   b. Exterior Bell and Spigot. Fully weld the bell to the exterior of the pipe and overlap the spigot end so that the flow lines and ends match when fully engaged. Provide the spigot end with an O-ring gasket in accordance with 2.01.D.2.

   c. Split Couplers. Used for gravity storm sewer Soil-Tight Joint connections only. Join pipe with coupling bands covering at least two full corrugations on the ends of each pipe being joined.

~~1.~~2. Gaskets:

   a. Meet requirements of ASTM F 477. Use gasket molded into circular form or extruded to proper section and then spliced into circular form. When no contaminant is identified, use gaskets of properly cured, high-grade elastomeric compound. Basic polymer shall be natural rubber, synthetic elastomer, or blend of both.

   b. PP Pipes are not allowed to be installed in potentially contaminated areas, unless approved by City Engineer.

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

~~2.~~3. Lubricant. Use lubricant for assembly of gasketed joints which has no detrimental effect on gasket or on pipe, in accordance with manufacturer's recommendations.

~~3.~~4. Diameters 12-inch through ~~60~~48-inch shall have a reinforced bell with a polymer composite band installed by the manufacturer.

~~3.02~~2.02 MATERIALS FOR SANITARY SEWER

A. Pipe and Fittings: Polypropylene compound for pipe and fitting production shall be impact modified copolymer meeting the material requirements of ASTM F 2764.

~~3.03~~2.03 MATERIALS FOR GRAVITY STORM SEWERS AND STORM SEWER CULVERTS

A. Pipe and Fittings:

1. Polypropylene compound for pipe and fittings production shall be impact modified copolymer meeting the material requirements of ASTM F 2881 and AASHTO M330.

2. Provide Type S pipes (outer corrugated wall with smooth inner liner).

3. Section Properties shall meet the following requirements:

    a. Provide the minimum wall thickness of the inner walls for Type S pipe as specified in AASHTO M 330, Section 7.2.2. Meet the pipe stiffness at 5% deflection requirement as specified in AASHTO M 330, Section 7.4. The minimum section properties must meet the 75- yr. design life requirements in the AASHTO LRFD Bridge Design Specifications, Section 12.

~~1.~~4. Pipe size shall not exceed 48-inches in diameter.

~~3.04~~2.04 TEST METHODS FOR SANITARY SEWER

A. Conditioning

1. Conditioning of samples prior to and during tests is subject to approval by Project Manager. When referee tests are required, condition specimens in accordance with ASTM F 2764, section 7.1.1.

B. Flattening

1. Flatten three specimens of pipe, prepared in accordance with ASTM F 2764, section 7.5.

C. Joint Tightness

1. Test for joint tightness in accordance with ASTM D 3212.

D. Purpose of Tests

1. Flattening and joint tightness tests are not intended to be routine quality control tests, but rather to qualify pipe to a specified level of performance.

~~3.05~~2.05 TEST METHODS FOR GRAVITY STORM SEWERS AND STORM CULVERTS

A. All testing and material requirements shall be in accordance with ASTM F 2881.

B. Mandrel Testing: Use a mandrel to test flexible pipe for deflection. Refer to Section 02533 – Acceptance Testing for Sanitary Sewers for the mandrel and test requirements.

~~3.06~~2.06 MARKING

A. Mark each standard and random length of pipe in compliance with these Specifications with following information:

1. Pipe size.

2. Pipe class.

3. Production code.

4. Material designation.

~~PART 4~~PART 3 EXECUTION

~~4.01~~3.01 INSTALLATION

A. Conform to requirements of following Sections:

1. Section 02550 – Slip lining Sanitary Sewers.

2. Section 02531 - Gravity Sanitary Sewers.

3. Section 02533 - Acceptance Testing for Sanitary Sewers.

B. Install pipe in accordance with the manufacturers recommended installation procedure and ASTM D 2321.

C. Install the joints so that the connection of the pipe sections forms a continuous line free from irregularities in the flow line. For Storm sewer applications, if no joint type is specified in the Contract documents, provide a Soil-Tight Joint meeting the requirements of this specification.

~~B.~~D. Unless otherwise authorized, start laying pipe on the bedding at the outlet end with the separate sections firmly joined together. Hoist and lower sections of pipe into the trench without damaging the pipe or disturbing the bedding or the sides of the trench. Remove and re-lay any pipe that is not in alignment or that shows excessive settlement after laying, at no expense to the City.

~~C.~~E. PP pipe is not approved in applications requiring augering of pipe.

F. Bedding and backfill:

1. Conform to requirements of Section 02317 - Excavation and Backfill for Utilities.

2. Inspect inside periphery of pipe for local or unequal deformation caused by improper construction methods during backfilling. Stop work and address backfilling technique if measured deflection of pipe exceeds 5% or there are other issues found effecting quality of pipe installation.

~~1.~~3. To validate pipe installation methods, perform an initial quality control inspection after first installation of each size of pipe is completed on the project. Notify the Engineer of Record and Project Manager when this inspection takes place.

~~D.~~G. Use only workmen trained in the installation of PP Pipe.

H. Cutting pipe: Comply with pipe manufacturer's recommendations. After cutting, leave end pipe in accordance with manufacturer's recommendations.

I. Store pipe above ground on adequate blocking. Always keep pipe clean and fully drained during storage. Provide proper equipment for hoisting and lowering the pipe into the trench without damaging the pipe or disturbing the bedding or the walls of the trench. Any protective covering of gaskets should remain until the pipe is ready for installation.

J. Multi-barrel installations are not allowed.

END OF SECTION

SECTION 02533

ACCEPTANCE TESTING FOR SANITARY SEWERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Acceptance testing for~~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.

5. Smoke testing of point repairs.

6. Television and Video Inspection.

B. All tests listed in this Section are not necessarily required on this Project. Required tests are named in other Sections which refer to this Section for testing criteria and procedures.

1.02 RELATED SECTIONS

A. Section 01270 – Measurement and Payment

B. Section 01330 – Submittal Procedures

C. Section 01578 – Control of Ground and Surface Water

1.03 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. No payment will be made for acceptance testing under this Section. Include - payment in unit price for work requiring acceptance testing.

2. Refer to Section 01270 - Measurement and Payment for unit price procedures.

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

1.04 REFERENCES

A. ASTM C 828 - Standard Test Method for Low--Pressure Air Test of Vitrified Clay Pipe Lines.

B. ASTM D 3034 - Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

C. ASTM F 794~~—~~ - Standard Specification for Poly (Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter.

D. ASTM F 1417 - Standard Practice for Installation Acceptance of Plastic Non-Pressure Sewer Lines Using Low-Pressure Air.

E. ASTM C 1244 - Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill.

1.05 PERFORMANCE REQUIREMENTS

A. Gravity flow sanitary sewers are required to have straight alignment and uniform grade between manholes.

B. 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 line segment but prior to final acceptance using standard mandrel to verify that installed pipe is within specified deflection tolerances.

C. Must meet Texas Commission on Environmental Quality (TCEQ) Testing Requirements Chapter-217-57.

1.06 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

B. Test Plan: Before testing begins and in adequate time to obtain approval through submittal process, prepare and submit test plan for approval by Project Manager. Include testing procedures, methods, equipment, and tentative schedule. Obtain advance written approval for deviations from Drawings and Specifications.

C. Test Reports: Submit test reports for each test on each segment of sanitary sewer.

1.07 GRAVITY SANITARY SEWER QUALITY ASSURANCE

A. Repair, correct, and retest manholes or sections of pipe which fail to meet specified requirements when tested.

B. Provide testing reports and video tape of television inspection as directed by Project Manager.

C. Upon completion of tape reviews by Project Manager, Contractor will be notified regarding final acceptance of sewer segment.

1.08 SEQUENCING AND SCHEDULING

A. Perform testing as work progresses. Schedule testing so that no more than 1000 linear feet of installed sewer remains untested at one time.

B. Coordinate testing schedules with Project Manager. Perform testing under observation of Project Manager.

PART 2 PRODUCTS

2.01 DEFLECTION MANDREL

A. Mandrel Sizing. Rigid mandrel shall have outside diameter (O.D.) equal to 95 percent of inside diameter (I.D.) of pipe. Inside diameter of pipe, for purpose of determining outside diameter of mandrel, shall be average outside diameter minus two minimum wall thicknesses for O.D. controlled pipe and 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.

B. Mandrel Design. Rigid mandrel shall be constructed of metal or rigid plastic material that can withstand 200 psi without being deformed. Mandrel shall have nine or more "runners" or "legs" as long as total number of legs is odd number. Barrel section of mandrel shall have length of at least 75 percent of inside diameter of pipe. Rigid mandrel shall not have adjustable or collapsible legs which would allow reduction in mandrel diameter during testing. Provide and use proving ring for modifying each size mandrel.

C. Proving Ring. Furnish "proving ring" with each mandrel. Fabricate ring of 1/2-inch-thick, 3-inch-wide bar steel to diameter 0.02 inches larger than approved mandrel diameter.

D. Mandrel Dimensions (5 percent allowance). Average inside diameter and minimum mandrel diameter are specified in Table 02533-5, Pipe vs. Mandrel Diameter, at end of this Section. Mandrels for higher strength, thicker wall pipe or other pipe not listed in table may be used when approved by Project Manager.

2.02 EXFILTRATION TEST

A. Water Meter: Obtain transient water meter from City for use when water for testing will be taken from City system. Conform to City requirements for water meter use.

B. Test Equipment:

1. Pipe plugs.

2. Pipe risers where manhole cone is less than 2 feet above highest point in pipe or service lead.

2.03 INFILTRATION TEST

A. Test Equipment:

1. Calibrated ~~90 degree~~90-degree V-notch weir.

2. Pipe plugs.

2.04 LOW PRESSURE AIR TEST

A. Minimum Requirement for Equipment:

1. Control panel

2. Low-pressure air supply connected to control panel.

3. Pneumatic plugs: Acceptable size for diameter of pipe to be tested; capable of withstanding internal test pressure without leaking or requiring external bracing.

4. Air hoses from control panel to:

a. Air supply.

b. Pneumatic plugs.

c. Sealed line for pressuring.

d. Sealed line for monitoring internal pressure.

B. Testing Pneumatic Plugs: Place pneumatic plug in each end of length of pipe on ground. Pressurize plugs to 25 psig; then pressurize sealed pipe to 5 psig. Plugs are acceptable when they remain in place against test pressure without external aids.

2.05 GROUND WATER DETERMINATION

A. Equipment: Pipe probe or small diameter casing for ground water elevation determination.

2.06 SMOKE TESTING

A. Equipment:

1. Pneumatic plugs.

2. Smoke generator as supplied by Superior Signal Company, or approved equal.

3. Blowers producing 2500 scfm minimum.

PART 3 EXECUTION

3.01 PREPARATION

A. Provide labor, equipment, tools, test plugs, risers, air compressor, air hose, pressure meters, pipe probe, calibrated weirs, or any other device necessary for proper testing and inspection.

B. Determine selection of test methods and pressures for gravity sanitary sewers based on ground water elevation. Determine ground water elevation using equipment and procedures conforming to Section 01578 - Control of Ground and Surface Water.

3.02 VISUAL INSPECTION OF GRAVITY SANITARY SEWERS

A. Check pipe alignment visually by flashing 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.

3.03 MANDREL TESTING FOR GRAVITY SANITARY SEWERS

A. 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 line segment.

B. Pull approved mandrel by hand through sewer sections. Replace any section of sewer not passing mandrel. Mandrel testing is not required for stubs.

C. Retest repaired or replaced sewer sections.

3.04 LEAKAGE TESTING FOR GRAVITY COLLECTION SYSTEM PIPES

A. For a collection system pipe that will transport wastewater by gravity flow, test gravity sanitary sewer pipes for leakage by either exfiltration or infiltration methods, as appropriate, or with low pressure air testing.

B. Compensating for Ground Water Pressure:

1. Where ground water exists, install pipe nipple at same time sewer line is placed. Use 1/2-inch capped pipe nipple approximately 10 inches long. Make installation through manhole wall on top of sewer line where line enters manhole.

2. Immediately before performing line acceptance test, remove cap, clear pipe nipple with air pressure, and connect clear plastic tube to nipple. Support tube vertically and allow water to rise in tube. After water stops rising, measure height in feet of water over invert of pipe. Divide this height by 2.3 feet/psi to determine ground water pressure to be used in line testing.

C. Exfiltration test:

1. Determine ground water elevation.

2. Plug sewer in downstream manhole.

3. Plug incoming pipes in upstream manhole.

4. Install riser pipe in outgoing pipe of upstream manhole when highest point in service lead (house service) is less than 2 feet below bottom of manhole cone.

5. Fill sewer pipe and manhole or pipe riser, when used, with water to point 2-1/2 feet above highest point in sewer pipe, house lead, or ground water table, whichever is highest.

6. Allow water to stabilize for one to two hours. Take water level reading to determine drop of water surface, in inches, over one-hour period, and calculate water loss (1 inch of water in 4 feet diameter manhole equals 8.22 gallons) or measure quantity of water required to keep water at same level. Loss shall not exceed that calculated from allowable leakage according to Table 02533-1 at end of this Section.

D. Infiltration test: Ground water elevation must be not less than 2.0 feet above highest point of sewer pipe or service lead (house service).

1. Determine ground water elevation.

2. Plug incoming pipes in upstream manhole.

3. Insert calibrated ~~90 degree~~90-degree V-notch weir in pipe on downstream manhole.

4. Allow water to rise and flow over weir until it stabilizes.

E. Low Air Pressure Test: When using this test conform to ASTM C 828, or ASTM F 1417, as applicable, with holding time not less than that listed in Table 02533-2.

1. Low Pressure Air testing for sections of pipe shall be limited to lines less than 36-~~-~~inch average inside diameter. Refer to charts 02533-2 and 02533-3.

2. Lines 36-inch average inside diameter and larger shall be tested at each joint. Minimum time allowable for pressure to drop from 3.5 pounds per square inch gauge to 2.5 pounds per square inch during joint test shall be 10 seconds, regardless of pipe size.

F. Retest: Repair and retest any section of pipe which fails to meet requirements.

3.05 TEST CRITERIA TABLES

A. Exfiltration and Infiltration Water Tests: Refer to Table 02533-1, Water Test Allowable Leakage, at end of this Section.

B. Low Pressure Air Test:

1. Times in Table 02533-2, Time Allowed for Pressure Loss from 3.5 psig to 2.5 psig, at end of this Section, are based on equation from Texas Commission on Environmental Quality (TCEQ) Design Criteria 217.57

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

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 ft3/min./sq. ft. internal surface

2. Since K value of less than 1.0 shall not be used, there are minimum testing times for each pipe diameter as given in Table 02533-3, Minimum Testing Times for Low Pressure Air Test.

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

3.06 LEAKAGE TESTING FOR MANHOLES

A. After completion of manhole construction, wall sealing, or rehabilitation, but prior to backfilling, test manholes for water tightness using hydrostatic or vacuum testing procedures.

B. 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 minimum of 6 inches outside of manhole walls. Brace inverts to prevent lines from being dislodged when lines entering manhole have not been backfilled.

C. Vacuum testing:

1. 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 recommended maximum inflation pressure; do not over-inflate.

2. Evacuate manhole with vacuum pump to 10 inches mercury (Hg), disconnect pump, and monitor vacuum for time period specified in Table 02533-4, Vacuum Test Time Table.

3. A manhole passes the test if after 2.0 minutes and with all valves closed, the vacuum is at least 9.0 inches of mercury (Hg).

D. Perform hydrostatic exfiltration testing as follows:

1. Seal wastewater lines coming into manhole with internal pipe plug. Then fill manhole with water and maintain it full for at least 1~~one~~ hour.

2. The maximum leakage for hydrostatic testing shall be 0.025 gallons per foot diameter per foot of manhole depth per hour.

3. If water loss exceeds amount tabulated above, locate leaks, complete repairs necessary to seal manhole and repeat test procedure until satisfactory results are obtained.

3.07 SMOKE TEST PROCEDURES FOR POINT REPAIRS

A. Application: Perform smoke test to:

1. Locate points of line failure for point repair.

2. Determine when point repairs are properly made.

3. Determine when service connections have been reconnected to rehabilitated sewer.

4. Check integrity of connections to newly replaced service taps to liners and to existing private service connections.

B. Limitations: Do not backfill service taps until completion of this test. Test only those taps in single manhole section at one time. Keep number of open excavations to minimum.

C. Preparation: Prior to smoke testing, give written notices to area residents no fewer than 2 days, nor more than 7 days, prior to proposed testing. Also give notice to City of Houston Police and Fire Departments 24 hours prior to actual smoke testing.

D. Isolate Section: Isolate manhole section to be tested from adjacent manhole sections to keep smoke localized. Temporarily seal annular space at manhole for sliplined sections.

E. Smoke Introduction:

1. Operate equipment according to manufacturer's recommendation and as approved by Project Manager.

2. Conduct test by forcing smoke from smoke generators through sanitary sewer main and service connections. Operate smoke generators for minimum of 5 minutes.

3. Introduce smoke into upstream and downstream manhole as appropriate. Monitor tap/connection for smoke leaks. Note sources of leaks.

F. Repair and Retest: Repair and replace taps or connections noted as leaking and then retest. Taps and connections may be left exposed in only one manhole section at time. When repair or replacement, testing or retesting, and backfilling of excavation is not completed within 1~~one~~ work day, properly barricade and cover each excavation as approved by Project Manager.

G. Service Connections: On houses where smoke does not issue from plumbing vent stacks to confirm reconnection of sewer service to newly installed liner pipe, perform dye test to confirm reconnection. Introduce dye into service line through plumbing fixture inside structure or sewer cleanout immediately outside structure and flush with water. Observe flow at service reconnection or downstream manhole. Detection of dye confirms reconnection.

3.08 TELEVISION AND VIDEO INSPECTION PROCEDURE

A. Refer to Document 02588- Cleaning and Television Inspection

Table 02533-1
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	13	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	0.0158
			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 of inside diameter per mile per 24 hours.	

* Allowable leakage rate must not exceed 10 gallons per inch of inside diameter per mile per 24 hours, when sewer is identified as located within 25-year flood plain.

Table 02533-2
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	13:56	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	53:25	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 02533-3
MINIMUM TESTING TIMES FOR LOW PRESSURE AIR TEST

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

Table 02533-4 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 1244			

Table 02533-5
PIPE VS. MANDREL DIAMETER

Material and Wall Construction	Nominal Size (Inches)	Average I.D. (Inches)	Minimum Mandrel Diameter (Inches)
PVC-Solid (SDR 26) 5.476	6	6	5.764
	8	7.715	7.329
	10	9.646	9.162
PVC-Solid (SDR 35) 11.150	12	12	11.737
	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-Truss	8	7.750	7.363
	10	9.750	9.263
	12	11.790	11.201
	15	14.770	14.032
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
	48	47.500	45.125
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
	60	60.000	57.000
Fiberglass (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	50.079
	60	60.38	57.361
Polypropylene	12	11.82	11.229
	15	14.78	14.041
	18	17.73	16.844
	24	23.64	22.458
	30	29.55	28.073
	36	35.46	33.687
	42	41.37	39.302
	48	47.28	44.916

END OF SECTION

SECTION 02553

POINT REPAIRS AND OBSTRUCTION REMOVALS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Repair of sanitary sewer lines by replacing short lengths of failed pipe with new pipe.

B. Repair of service lines located within the utility easement or street right-of-way, by replacing short lengths of failed pipe with new pipe.

C. Obstruction removal by remote device or excavation.

1.02 RELATED SECTIONS

A. Document 00410 – Bid Form

B. Section 01270 – Measurement and Payment

C. Section 01330 – Submittal Procedures

D. Section 01504 – Temporary Facilities and Controls

E. Section 01506 – Diversion Pumping

F. Section 01578 – Control of Ground and Surface Water

G. Section 01740 – Site Restoration

H. Section 02260 – Trench Safety System

I. Section 02317 – Excavation and Backfill for Utilities

J. Section 02321 – Cement Stabilized Sand

K. Section 02501 – Ductile Iron Pipe and Fittings

L. Section 02504 – Fiberglass Reinforced Pipe

M. Section 02506 – Polyvinyl Chloride Pipe

N. Section 02528 – Polyethylene Encasement/Wrap

O. Section 02533 – Acceptance Testing for Sanitary Sewers

P. Section 02534 – Sanitary Sewer Service Stubs or Reconnections

Q. Section 02558 – Cleaning and Television Inspection

R. Section 02611 – Reinforced Concrete Pipe

S. Section 03315 – Concrete for Utility Construction

1.03 MEASUREMENT AND PAYMENT

A. Unit Prices:

1. Point Repair:

a. Measurement for sewer line point repair is on a unit price basis for each point repair performed. The length of pipe to be replaced under each point repair pay item, as determined by depth of sewer line measured from natural ground to flowline at the location of the point of repair, is as follows:

(1) Six (6) feet minimum length for sewers up to ten (10) feet deep.

(2) Ten (10) feet minimum length for sewers over ten (10) feet deep.

b. Measurement for sewer line pipe replacement beyond point repair is on a linear foot basis in excess of minimum replacement lengths specified above.

c. Payment for service line point repair is on a linear foot basis for all sizes of service lines and for all depths (same unit price per linear foot, regardless of size and depth). No separate payment will be made for point repair done within the limits of a service line reconnection as defined in Section 02534 - Sanitary Sewer Service Stubs or Reconnections. Minimum length of service line point repair is 3 feet.

d. Measurement for hand excavation is on a cubic yard basis when authorized by the Project Manager in locations where excavation by machine is not suitable.

e. Measurement for abandonment of point repair by excavation is on a per each basis for excavation required to expose existing pipe. Separate measurement will be made for machine excavation and hand excavation.

f. Measurement for abandonment of point repair by video inspection is on a linear foot basis for TV Inspection and Cleaning.

g. The cost of the following items of work are included in the unit prices for point repairs unless included as a bid item in Document 00410 – Bid Form:

(1) Excavation, embedment and backfill.

(2) Hauling away and lawful disposal of excess excavated materials and debris.

(3) Pipe, pipe fittings, adapters and concrete collars.

(4) Smoke testing and any required testing.

(5) Restoration of site improvements, including sodding.

(6) Pre- and post-cleaning video inspection.

h. Pipe replacement required as part of a new or replacement manhole installation, due to existing deteriorated or inadequate pipe, shall be paid for under the Pipe Replacement Beyond Point Repair pay item appropriate for the size and depth of the sewer. Pipe replacement required due to damage by or for the convenience of the Contractor shall be paid by the Contractor.

i. Storm sewer replacement required to properly rehabilitate the sanitary sewer shall be paid under the Point Repair pay item appropriate to the storm sewer size and depth being replaced. Additional length shall be paid under the Pipe Replacement Beyond Point Repair pay item appropriate to the storm sewer size and depth being replaced.

j. Point Repairs performed due to sag in the sewer line shall be paid for under the Point Repair pay item appropriate for the size and depth of the line.

2. Obstruction Removal:

a. Obstruction removal by excavation will be paid on a unit price basis according to depth for each removal. Obstruction removal can be submitted for payment when the obstruction has been cleared from the sewer line to be lined. Liner work must proceed at least 6 feet before payment for removal of another obstruction will be considered (i.e., all obstruction within a distance of 6 feet is considered to be part of the same obstruction.)

b. Depth shall be measured from natural ground level to the flow line at the point of obstruction removal.

c. The cost of the following items of work are included in the unit prices for obstruction removal by remote device or excavation:

(1) Cleaning of sanitary sewers due to broken pipe, roots, dirt, loose deposits, etc.

(2) Television inspection.

(3) Excavation, embedment and backfill.

(4) Hauling away and lawful disposal of excess excavated material and debris.

(5) Restoration of site improvements, including sodding.

d. Payment will not be made for obstruction removal if the existing sewer line, service line or tap is damaged, and a point repair is required. Payment will not be made for removal of a protruding tap if the service reconnection is performed by excavation.

e. Removal of hard deposits, concrete, debris, pipes or any other material in a manhole, or that is accessible from the manhole wall, will be cleared under work items for rehabilitation of sanitary sewer pipes and manholes.

3. Refer to Section 01270 - Measurement and Payment for unit price procedures.

B. Stipulated Price (Lump Sum): If the Contract is a Stipulated Price Contract, payment for work in this Section is included in the total Stipulated Price.

1.04 REFERENCES

A. ASTM C-1173 – Standard Specification for Flexible Transition Couplings for Underground Piping System

~~1.04~~1.05 PERFORMANCE REQUIREMENTS

A. Point Repair:

1. Locate and replace small lengths of one or more pipe sections where isolated line failure has occurred due to settlement, corrosion, crushing, or separation of joints.

2. The Project Manager may identify potential locations for point repair, but the Contractor is responsible for verifying locations. Point repairs to sewer lines are listed in Point Repair Rehabilitation Tables. Point repairs to service lines are listed in Lateral Line Rehabilitation Tables.

3. Determine the location of service line repairs by smoke testing the manhole section in which the failed pipe is located. The Project Manager will authorize the Contractor to make point repairs based on results of smoke testing.

4. Conduct all smoke testing in accordance with the City of Houston "Procedures to Conduct Physical Inspections of the Wastewater Collection System". Smoke testing shall not be performed within 24 hours of a rainfall event or if ponded or standing water is present on the ground or in the drainage channels in the area planned for smoke testing.

5. Smoke testing shall be accomplished utilizing two (2) minimum 1,750 CFM blowers designed specifically for smoke testing of sewers. Place blower on the upstream and downstream manhole of the line section to be tested. Place sandbags in the upstream and downstream manholes to isolate the section being tested and prevent the migration of smoke into sections not being tested. Utilize smoke bombs as necessary to ensure a continuous supply of smoke is provided for the entire duration of the test period.

6. Determine the location of point repairs by smoke testing or closed circuit television inspection of the failed pipe location. The Project Manager will authorize the Contractor to make point repairs.

7. The Project Manager will authorize each point repair after failure points are located. Do not make point repairs without prior authorization of the Project Manager. Perform point repairs only on those portions of service lines which are located in an easement or right-of-way; perform no repairs to service lines on private property.

8. Replace carrier pipe for point repairs unless otherwise directed by the Project Manager.

B. Obstruction Removal: Remove obstructions by one of the following methods:

1. Obstruction removal by remote device:

a. Protruding taps: Service lines that protrude more than one inch into the sewer.

b. Other obstructions: Hanging gaskets, fixed debris, stabilized sand, hardened mineral deposits, roots, rust scale, tuberculation, etc.

2. Obstruction removal by excavation: Obstructions encountered during liner insertion that are removed by digging and exposing the pipe.

~~1.05~~1.06 DEFINITIONS

A. Point Repair: Repair of broken or collapsed gravity sanitary sewer lines on public property, including mains, collectors and service lines, by replacing, at the point of failure, the length of failed pipe with new pipe.

B. Obstruction Removal: Clearing sewer mains of obstructions to allow for rehabilitation.

C. Sewer Lines: Gravity flow pipe lines in the easement or right-of-way which collect sanitary sewer discharges from commercial or residential service lines and discharge into another sewer line (main or collector), or into a lift station or treatment plant.

D. Service Lines: Those gravity flow sewer lines from commercial or residential property that discharge into a sewer line.

~~1.06~~1.07 SUBMITTALS

A. Submittals: Comply with Section 01330 - Submittal Procedures.

B. Submit product data for each pipe product, fitting and jointing material.

C. Submit Pre and Post inspection videos in accordance with Section 02558- Cleaning and Television Inspection.

~~1.07~~1.08 SEQUENCING

A. Before rehabilitating a sewer line section between adjacent manholes, complete point repair and obstruction removal on that section.

B. Clean the line and perform a post-installation video inspection for each point repair on a sewer line not scheduled for additional rehabilitation.

C. Post-installation video inspection of the service line point repair is not required.

PART 2 PRODUCTS

2.01 PVC PIPE

A. PVC Sewer Pipe and Joints: 4-inch through 24-inch pipe complying with Section 02506 - Polyvinyl Chloride Pipe. If point repair is located at a service connection, use a full-bodied fitting for the service connection. No field fabrication of fittings allowed.

2.02 DUCTILE IRON PIPE

A. Ductile Iron Pipe: 4-inch thorough 48-inch, complying with Section 02501 – Ductile Iron Pipe and Fittings.

B. Fittings: Push-on end-joint fittings with bell-and-spigot ends, with bells modified for push- on joints, complying with Section 02501 - Ductile Iron Pipe and Fittings.

C. Interior Coating: Comply with Section 02501 - Ductile Iron Pipe and Fittings.

D. Exterior coating: 8-mil polyethylene tubular material conforming to requirements of Section 02528 – Polyethylene Encasement/~~-~~Wrap.

2.03 REINFORCED CONCRETE PIPE

A. Reinforced Concrete Pipe and Joints: Comply with Section 02611 - Reinforced Concrete Pipe. Reinforced concrete pipe may be used for sewers 21 inches in diameter and larger.

2.04 FRP PIPE

A. FRP Pipe: Comply with Section 02504 - Fiberglass Reinforced Pipe.

2.05 JOINTING MATERIALS

A. Use flexible adapters secured with 1/2-inch stainless steel bands, Flexible adapter must comply with ASTM C-1173.

B. Form a concrete collar around each joint using concrete complying with Section 03315 - Concrete for Utility Construction.

PART 3 EXECUTION

3.01 PROTECTION

A. Provide barricades, warning lights and signs for excavations created by point repairs. Comply with Section 01504 - Temporary Facilities and Controls.

B. Do not allow soil, sand, debris or runoff to enter sewer system.

3.02 DIVERSION PUMPING

A. Install and operate diversion pumping equipment as required to maintain sewage flow and to prevent backup or overflow. Comply with Section 01506 - Diversion Pumping.

3.03 EXCAVATION

A. Excavate and backfill trenches in accordance with Section 02317 - Excavation and Backfill for Utilities.

B. Perform work in accordance with OSHA standards. Employ a trench safety system as required in Section 02260 - Trench Safety System.

C. Install and operate necessary dewatering and surface water control measures as required in Section 01578 – Control of Ground and Surface Water.

D. Remove and lawfully dispose of excess excavated material and debris from the work site daily.

3.04 TYPICAL SEQUENCE OF POINT REPAIR

A. Perform pre-installation video inspection to verify the location of sewer line point repairs. Perform service testing between manholes to verify location of service line point repairs.

B. After the location of a point repair, excavate the required length for the point repair.

C. Prior to replacing pipe, determine condition of the existing line on both sides of the point repair by lamping the line at least 10 feet in each direction. Determine whether additional lengths of line (beyond "minimum length" criteria) need replacement. Report need for additional replacement to the Project Manager and obtain authorization before proceeding.

D. Remove the damaged pipe and replace with new pipe, shaping the bottom of the trench and placing the required pipe bedding so that the grade of the replaced pipe matches the grade of the existing line. Establish proper grade for the pipe being replaced using methods acceptable to the Project Manager.

E. Connect the new pipe to existing pipe using flexible adapters. If joints cannot be made watertight using flexible adapters, place waterstop gaskets on each joint and encase in a reinforced concrete collar as indicated on Drawing 02531-04, Sanitary Sewer Pipe Transition for 36" Sewer and Smaller. Place concrete as specified in Section 03315 - Concrete for Utility Construction. Reconnect affected service connections or stacks using full-bodied fittings. No field fabrication of fittings allowed.

F. After completion of point repair, but prior to backfill, perform a smoke test to demonstrate the integrity of the repair, in the presence of the Project Manager. Test as specified in Section 02533 - Acceptance Testing for Sanitary Sewers. Repair and retest sections that fail until repair passes test.

G. Encase exposed pipe in cement stabilized sand complying with Section 02321 – Cement Stabilized Sand.

H. Backfill the excavation as specified in Section 02317 - Excavation and Backfill for Utilities.

I. Complete site restoration as specified in Section 01740 - Site Restoration.

J. Perform a post-installation video inspection as specified in Section 02558 - Cleaning and Television Inspection. Point repairs that show offset joints, non-uniform grade, incorrect alignment, excessive deflection or similar conditions are considered defective work. Replace pipe and bedding as required to correct defective work.

K. Extra length of Pipe Replacement beyond the Point Repair limits may be extended to the entire section either way, even to the next continuous section, as directed by the Project Manager.

3.05 ABANDONMENT OF POINT REPAIR

A. If a pipe is exposed by excavation and found to be in good condition, not requiring a point repair, the point repair shall be abandoned. Notify the Project Manager.

B. If pre-installation video inspection reveals that no point repair is required, the Contractor shall notify the Project Manager and the point repair shall be abandoned.

C. Backfill the excavation, replace pavement or sidewalk, and repair and seed or sod unpaved areas, as specified in Section 01740 - Site Restoration.

3.06 OBSTRUCTION REMOVAL

A. Remote Device: Remove obstructions identified during video inspection of a sanitary sewer line segment which could cause a non-uniform liner pipe installation or obstruction of the liner during installation. Obtain authorization from the Project Manager for obstruction removal with a remote device before proceeding.

1. Use a power-driven cutting device (robotic cutter) to remove protruding taps. Cut protruding taps so that protrusions are no greater than 3/4 inch. If a protruding tap cannot be removed by the cutting device, then a point repair may be performed. Obtain authorization from the Project Manager before proceeding.

2. To remove other obstructions, use a remote device. Pull or drive the device from manhole to manhole up to a continuous length of 500 feet using a solid steel mandrel, porcupine, root saw, bucket, robotic cutter or similar device to remove the obstruction. Select a device that is adequately sized to remove the obstruction.

B. Excavation: Use excavation as the method of obstruction removal when installation of the liner in the sanitary sewer is in progress. If during the liner insertion operation, a collapsed sewer, off-set joint or other obstruction is encountered which prevents or blocks the passage or insertion of the liner, notify the Project Manager for authorization to excavate. Uncover and remove the obstruction as follows:

1. Excavate at the point where there is an obstruction. Use a trench safety system as required.

2. Break out the existing sanitary sewer pipe (carrier pipe) as directed by the Project Manager. Remove only that amount of material which is causing the obstruction. Remove the minimum amount of carrier pipe.

3. Under such conditions, replacement of the carrier pipe is not required. Do not disturb the existing sewer bedding during excavation. However, if embedment is disturbed during the obstruction removal procedure, place cement-stabilized sand or crushed stone beneath the liner.

4. When the liner is completely in place, encase it with crushed stone or cement stabilized sand as shown on Drawing No. 02317-01, Sanitary Sewer Embedment and Trench Zone Backfill for Dry or Wet Stable Trench.

END OF SECTION

SECTION 02611

REINFORCED CONCRETE PIPE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Reinforced concrete pipe for sanitary sewers and storm sewers.

1.02 RELATED SECTIONS

A. Section 01270 – Measurement and Payment

B. Section 01330 – Submittal Procedures

~~C. Section 02317 – Excavation and Backfill for Utilities.~~

~~D.~~C. Section 02426 – Sewer Line in Tunnels

~~E.~~D. Section 02427 – Plastic Liner for Large-Diameter Concrete Sewers and Structures

~~F.~~E. Section 02431 – Tunnel Grout

~~G.~~F. Section 02441 – Microtunneling

~~H.~~G. Section 02445 – Jack and Bore/Jack and Mine/Pilot Tube Guided Boring Tunnels

~~I.~~H. Section 02448 – Pipe and Casing Augering for Sewers

~~J.~~I. Section 02531 – Gravity Sanitary Sewers

~~K.~~J. Section 02631 – Storm Sewers

1.03 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. No separate payment will be made for reinforced concrete pipe under this Section. Include cost in unit price Work as specified in following Sections:

a. Section 02426 - Sewer Line in Tunnels.

b. Section 02531 - Gravity Sanitary Sewers.

c. Section 02631 - Storm Sewers.

2. Refer to Section 01270 - Measurement and Payment for unit price procedures.

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

1.04 REFERENCES

A. ASTM C 76 - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.

B. ASTM C 443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.

C. ASTM C 497 - Standard Test Method for Concrete Pipe, Manhole Sections, or Tile.

D. ASTM C 506 - Standard Specification for Reinforced Concrete Arch Culvert, Storm Drain and Sewer Pipe

E. ASTM C 507 – Standard Specification for Reinforced Concrete Elliptical Culverts, Storm Drains and Sewer Pipe

F. ASTM C 655 - Standard Specification for Reinforced Concrete D-load Culvert, Storm Drain and Sewer Pipe.

G. ASTM C 877 - Standard Specification for External Sealing Bands for Concrete Pipe, Manholes, and Precast Box Sections.

H. ASTM C 990 – Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections using Preformed Flexible Joint Sealants.

I. ASTM C 1479 – Standard Practice for Installation of Precast Concrete Sewer, Storm Drain, and Culvert Pipe Using Standard Installations.

1.05 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

B. Submit complete product data for pipe, fittings and gaskets for approval. Indicate conformance to appropriate reference standards.

C. Submit manufacturer’s certificate that concrete pipes meet applicable standards.

D. For jacking pipe, submit drawings and data describing grouting port design and closure procedures when required by Section 02431 - Tunnel Grout, including liner repair, as applicable.

PART 2 PRODUCTS

2.01 REINFORCED CONCRETE PIPE

A. Conform circular reinforced concrete pipe to requirements of ASTM C 76, Class III. Conform to rubber gasket joints for sanitary sewers and storm sewers per ASTM C443 and tongue and groove joints ~~-~~for roadside ditch culverts with ~~-~~joints per ASTM C 990.

B. Conform reinforced concrete arch pipe to requirements of ASTM C 506 for Class A-III. Joints shall conform to ASTM C ~~-~~443 or tongue & groove joints shall conform to ASTM C990 with external sealing bands conforming to ASTM C 877. For roadside ditch culverts only, external sealing bands are not required.

C. Reinforced concrete elliptical pipe, either vertical or horizontal, shall conform to requirements of ASTM C 507 for Class VE-III for vertical or Class HE-III for horizontal. Use rubber gasket joints conforming to ASTM C 877. Rubber gasket joints shall conform to ASTM C443. Tongue & groove joints shall conform to ASTM C 990 with external sealing bands conforming to ASTM C 877. For roadside ditch culverts only, external sealing bands are not required

D. Conform reinforced concrete D-load pipe requirements of ASTM C 655.

E. Third-Party Certification Requirement:

1. Precast concrete manufacturers supplying precast concrete products shall maintain active certification from an accepted third-party quality control program at the time of manufacture.

2. Accepted third-party quality control programs are the National Precast Concrete Association (NPCA) Plant Certification Program and the American Concrete Pipe Association (ACPA) Q-Cast Program.

3. Copies of certificates demonstrating compliance with the above third-party plant certification requirements shall be furnished upon the first delivery to the project. Certifications shall be resubmitted annually thereafter or upon request by the Project Manager.

2.02 GASKETS

A. When no contaminant is identified, furnish joints per Article 2.01

B. Use the following gasket materials for pipes to be installed in potentially contaminated areas, especially where free product is found near elevation of proposed sewer:

CONTAMINANT	GASKET MATERIAL REQUIRED
Petroleum (diesel, gasoline)	Nitrile Rubber
Other Contaminants	As recommended by pipe manufacturer, Engineer of the Record and approved by City Engineer prior to installation

2.03 LINERS FOR SANITARY SEWER PIPE

A. Reinforced concrete pipe for sanitary sewers shall be PVC lined and conform to Section 02427 - Plastic Liner for Large-Diameter Concrete Sewers and Structures.

B. Reinforced concrete pipes to be installed in potentially contaminated areas shall have liners recommended by manufacturer as resistant to contaminants identified in Phase II Environmental Site Assessment Report.

2.04 SOURCE QUALITY CONTROL

A. Representatives of City Engineer will inspect manufacturer's plant and casting operations as deemed necessary.

B. Precast Unit Identification: Mark date of manufacture and name or trademark of manufacturer clearly on inside of pipe.

C. Rejection: Precast units rejected for non-conformity with these specifications and for following reasons:

1. Fractures or cracks passing through shell, except for single end crack that does not exceed depth of joint.

2. Surface defects indicating honeycombed or open texture.

3. Damaged or misshaped ends, where damage would prevent making satisfactory joint.

D. Replacement: Immediately remove rejected units from Work site and replace with acceptable units.

E. Repairs: Occasional imperfections resulting from manufacture or accidental damage may be repaired if, in opinion of Project Manager, repaired units conform to requirements of these specifications

PART 3 EXECUTION

3.01 INSTALLATION

A. Conform to requirements of following Sections, as applicable:

1. Section 02441 - Microtunneling

2. Section 02445 - Jack and Bore/Jack and Mine/Pilot Tube Guided Boring Tunnels

3. Section 02448 - Pipe and Casing Augering for Sewers

4. Section 02531 - Gravity Sanitary Sewers.

5. Section 02631 - Storm Sewers.

B. Install reinforced concrete pipe in accordance with ASTM C 1479 and manufacturer's recommendations.

END OF SECTION

SECTION 02612

PRECAST REINFORCED CONCRETE BOX SEWERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Precast reinforced concrete box for storm sewers.

1.02 RELATED SECTIONS

A. Section 01270 – Measurement and Payment

B. Section 01330 – Submittal Procedures

C. Section 02317 – Excavation and Backfill for Utilities

D. Section 02631 – Storm Sewers

1.03 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. No payment will be made for precast reinforced concrete box sewer under this Section. Include payment in unit price for Sections 02631 - Storm Sewers.

2. Refer to Section 01270 - Measurement and Payment for unit price procedures.

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

1.04 REFERENCES

A. ASTM C 1577 – Standard Specification for Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewers Designed According to AASHTO LRFD.

B. ASTM C 990 – Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Flexible Joint Sealants.

C. ASTM C 1677 – Standard Specification for Joints for Concrete Box, Using Rubber Gaskets.

D. ASTM C 1675 – Standard Practice for Installation of Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains and Sewers.

E. ASTM C 1837 – Standard Specification for Production of Dry Cast Concrete for Manufacturing Pipe, Box and Precast Structures.

1.05 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

B. Submit shop drawings and data on box sections, fittings, gaskets, and appurtenances for approval. Indicate conformance to reference standards.

PART 2 PRODUCTS

2.01 PRECAST REINFORCED CONCRETE BOX SEWERS

A. Conform to ASTM C 1577, as indicated on Drawings.

B. Pipe and boxes shall be machine-made or cast by process which will provide for uniform placement of concrete in forms and compaction by mechanical devices to produce dense, structurally sound concrete.

C. Box culverts may be supplied with a tongue and groove joint per ASTM C 990. Rubber gaskets per ASTM C 1677 may be used if indicated on drawings.

D. Third-Party Certification Requirement:

1. Precast concrete manufacturers supplying precast concrete products shall maintain active certification from an accepted third-party quality control program at the time of manufacture.

2. Accepted third-party quality control programs are the National Precast Concrete Association (NPCA) Plant Certification Program and the American Concrete Pipe Association (ACPA) Q-Cast Program.

3. Copies of certificates demonstrating compliance with the above third-party plant certification requirements shall be furnished upon the first delivery to the project. Certifications shall be resubmitted annually thereafter or upon request by the Project Manager.

2.02 CONCRETE

A. Conform to requirements of ASTM C 1837.

B. Use concrete mixed in central batch plant or other batching facility from which quality and uniformity of concrete can be assured. Transit-mixed concrete is not acceptable.

2.03 SOURCE QUALITY CONTROL

A. Representatives of City Engineer will inspect manufacturer's plant and casting operations as deemed necessary.

B. Precast Unit Identification: Mark date of manufacture and name or trademark of manufacturer clearly on inside of box sewer.

C. Rejection: Precast units rejected for non-conformity with these specifications and for following reasons:

1. Fractures or cracks passing through shell, except for single end crack that does not exceed depth of joint.

2. Surface defects indicating honeycombed or open texture.

3. Damaged or misshaped ends, where damage would prevent making satisfactory joint.

D. Replacement: Immediately remove rejected units from Work site and replace with acceptable units.

~~A.~~E. Repairs: Occasional imperfections resulting from manufacture or accidental damage may be repaired if, in opinion of Project Manager, repaired units conform to requirements of these specifications

PART 3 EXECUTION

3.01 INSTALLATION

A. Install concrete box sewer in accordance with ASTM C 1675.

~~3.01~~3.02 BEDDING

A. Bed box sections on foundation of firm and stable material accurately shaped to conform to their bases. Install bedding as specified in Section 02317 - Excavation and Backfill for Utilities. When required by Drawings, use special bedding material. When single-cell box sections are placed in parallel for multi-cell installation, place in conformance with details shown on Drawings.

~~3.02~~3.03 PLACEMENT

A. Carefully lower box sections to bottom of trench and lay accurately in line and grade, with spigot or tongue end downstream entering bell or groove end to full depth and in such manner as not to drag foreign material into annular space.

~~3.03~~3.04 JOINTING

A. Join box sections together and match so that they will form continuous smooth and uniform.

~~3.04~~3.05 BACKFILLING

A. After box has been properly jointed and bedded, commence backfilling.

B. Backfill in accordance with Section 02317 - Excavation and Backfill for Utilities.

END OF SECTION

SECTION 02621

GEOTEXTILE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Geotextile, also called filter fabric, in applications including pipe embedment wrap, around exterior of tunnel liner, around foundations of pipeline structures, and slope stabilization.

1.02 RELATED SECTIONS

A. Section 01270 – Measurement and Payment

B. Section 01330 – Submittal Procedures

C. Section 02317 – Excavation and Backfill for Utilities

D. Section 02426 – Sewer Line in Tunnels

E. Section 02517 – Water Line in Tunnels

1.03 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. No separate payment will be made for Work performed under this Section. Include cost of Work in unit prices for Work requiring geotextile.

2. Refer to Section 01270 - Measurement and Payment for unit price procedures.

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

1.04 REFERENCES

A. AASHTO M 288 - Standard Specification for ~~Geotextile~~ Geosynthetic Specification for Highway Applications.

B. ASTM D 3786 - Standard Test Method for Bursting Strength of Textile Fabrics—Diaphragm Bursting Strength Tester Method.

C. ASTM D 4491 - Standard Test Methods for Water Permeability of Geotextiles by Permittivity.

D. ASTM D 4533 - Standard Test Method for Trapezoid Tearing Strength of Geotextiles.

E. ASTM D 4632 - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.

F. ASTM D 4751 - Standard Test Method for Determining Apparent Opening Size of a Geotextile~~s~~.

G. ASTM D 4833 - Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products.

1.05 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

B. Submit standard manufacturer's catalog sheets and other pertinent information, for approval, prior to installation.

C. Submit installation methods, as part of Work plan for tunneling or for excavation and backfill for utilities. Obtain approval from Project Manager for filter fabric material and proposed installation method prior to use of filter fabric.

PART 2 PRODUCTS

2.01 GEOTEXTILE

A. Provide geotextile (filter fabric) designed for use in geotechnical applications. Filter fabric shall provide permeable layer or media while retaining soil matrix.

B. Use fabric which meets physical requirements for Class A subsurface drainage installation conditions as defined in AASHTO M 288 and as specified in Paragraph 2.02, Properties.

2.02 PROPERTIES

A. Material: Nonwoven, nonbiodegradable, fabric consisting of continuous chain polymer filaments or yarns, at least 85 percent by weight polyolefins, polyesters or polyamide, formed into dimensionally stable network.

B. Chemical Resistance: Inert to commonly encountered chemicals and hydrocarbons over 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[(1)]	0.25 mm	ASTM D 4751
Permittivity (sec-1)	0.2	ASTM D 4491
(1) Maximum average roll value.		

PART 3 EXECUTION

3.01 LINE WORK

A. Conform use of geotextile to backfill for utilities to Section 02317 - Excavation and Backfill for Utilities.

3.02 TUNNEL WORK

A. Use geotextile outside of tunnel primary liner to prevent migration of soil fines into excavated tunnel resulting in voids or settlement. Select geotextile, subject to minimum requirements of Paragraph 2.02, meeting tunnel liner design requirements and installation conditions.

1. Sewers: Conform to Section 02426 - Sewer Line in Tunnels.

2. Waterlines: Conform to Section 02517 - Waterline in Tunnels.

END OF SECTION

SECTION 02631

STORM SEWERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. New storm sewers and appurtenances, modifications to existing storm sewer system and installation of roadside ditch culverts.

1.02 RELATED SECTIONS

A. Section 01270 – Measurement and Payment

B. Section 01330 – Submittal Procedures

C. Section 01555 – Traffic Control and Regulation

D. Section 01578 – Control of Ground and Surface Water

E. Section 02081 – Cast-In-Place Concrete Manholes

F. Section 02082 – Precast Concrete Manholes

G. Section 02086 – Adjusting Manholes, Inlets, and Valve Boxes to Grade

H. Section 02090 – Frames, Grates, Rings, and Covers

I. Section 02221 – Removing Existing Pavements, Structures, Wood, and Demolition Debris

J. Section 02317 – Excavation and Backfill for Utilities

K. Section 02320 – Utility Backfill Materials

L. Section 02321 – Cement Stabilized Sand

M. Section 02322 – Flowable Fill

N. Section 02441 – Microtunneling

O. Section 02445 – Jack and Bore/Jack and Mine/Pilot Tube Guided Boring Tunnels

P. Section 02448 – Pipe and Casing Augering for Sewers

Q. Section 02505 – High Density Polyethylene (HDPE) Solid and Profile Wall Pipe

R. Section 02506 – Polyvinyl Chloride Pipe

S. Section 02510 – Polypropylene (PP) Corrugated Wall Pipe

T. Section 02531 – Gravity Sanitary Sewers

U. Section 02533 – Acceptance Testing for Sanitary Sewers

V. Section 02555 – Manhole Rehabilitation

W. Section 02611 – Reinforced Concrete Pipe

X. Section 02612 – Precast Reinforced Concrete Box Sewers

Y. Section 02632 – Cast-In-Pace Inlets, Headwalls, and Wingwalls

Z. Section 02633 – Precast Concrete Inlets, Headwalls, and Wingwalls

AA. Section 02642 – Corrugated Metal Pipe

BB. Section 02911 – Topsoil

CC. Section 02921 – Hydro Mulch Seeding

DD. Section 02922 – Sodding

EE. Section 02951 – Pavement Repair and Restoration

1.03 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. Payment for storm sewers, including elliptical or box storm sewer with or without seal slab, installed by open-cut, augered with or without casing, or tunneling is on linear foot basis. Measurement for storm sewers and roadside ditch culverts will be taken along center line of pipe from center line to center line of manholes or from end to end of culverts. Measurement for storm sewer will be taken along center line of storm sewer from inside wall of storm sewer junction box when installed in conjunction with storm sewer junction box. Payment will be made for each linear foot installed complete in place, including connections to existing manholes and inlets.

2. Payment for storm sewer leads, including elliptical leads, is on a linear foot basis.

3. Payment for corrugated metal pipe storm sewer outfall, including timber bents, is on a linear foot basis.

~~3.~~4. Refer to Section 01270 - Measurement and Payment for unit price procedures.

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

1.04 REFERENCES

A. AASHTO LRFD Bridge Design Specifications, current edition.

B. City of Houston Code of Ordinances, Chapter 42 – Subdivisions, Developments and Platting, Article I – In General.

~~1.04~~1.05 DEFINITIONS

A. Long Run Culvert: A culvert which is 40 feet or more in length.

~~A.~~B. Local Street: As defined in the City of Houston Code of Ordinances, Chapter 42 – Subdivisions, Developments and Platting, Section 42-1.

~~1.05~~1.06 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

B. Submit manufacturer's literature for product specifications and installation instructions.

C. Submit proposed methods, equipment, materials, and sequence of operations for sewer construction. Plan operations to minimize disruption of utilities to occupied facilities or adjacent property.

D. For ~~flexible~~ thermoplastic pipe products, submit detailed calculations per AASHTO LRFD Bridge Design Specifications upon request by the Project Manager for cases including but not limited to variations from City minimum cover requirements, pipe design validation, pipe failure investigations, and product substitutions. ~~Designs are required for each pipe location~~When ~~C~~calculations are requested by Project Manager, limit calculations ~~are required~~ ~~to~~at the critical pipe locations that control the pipe designs within the project limits. Critical locations shall be approved by the Project Manager. Calculations shall ~~and are to~~ be signed and sealed by a Professional Engineer licensed ~~engineer~~ in the State of Texas. Engineer shall submit a cover letter for pipe design indicating that it is in full accordance with AASHTO's analysis and design criteria.

~~1.06~~1.07 QUALITY ASSURANCE

A. The Condition for acceptance shall be watertight storm sewer that is watertight both in pipe-to-pipe joints and in pipe-to-manhole connections~~.~~

B. Provide manufacturer's certification to Specifications.

~~1.07~~1.08 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer's recommendations.

B. Handle pipe, fittings, and accessories carefully with approved handling devices. Do not drop or roll pipe off trucks or trailers. Do not use Materials cracked, gouged, chipped, dented, or otherwise damaged shall not be use materials for installation.

C. Store pipe and fittings on heavy timbers or platforms to avoid contact with ground.

D. Unload pipe, fittings, and appurtenances as close as practical to location of installation to avoid unnecessary handling.

E. Keep interiors of pipe and fittings free of dirt and foreign matter.

F. Store ~~Thermoplastic (PVC,~~ HDPE and PP~~)~~ pipes out of direct sunlight ~~.~~unless manufacturer's specifications allow.

G. Store PVC pipes out of direct sunlight.

PART 2 PRODUCTS

2.01 PIPE

A. Provide piping materials for storm sewers shall be of sizes and types specified unless otherwise indicated on Drawings.

B. In diameters where material alternatives are available, provide pipe from single manufacturer for each pipe diameter, unless otherwise approved by Project Manager or otherwise shown on Drawings.

C. Existing pipe that has been removed during construction cannot be reused.

2.02 PIPE MATERIAL SCHEDULE

A. Storm Sewer Pipe: Use pipe materials that conform to requirements specified in one or more of the following Sections as shown on the Drawings.

1. Section 02506 - Polyvinyl Chloride Pipe. Not allowed in the following applications:

    a. Potentially Petroleum Contaminated Areas (PPCA).

    b. Augering/ jacking.

    c. Installations in the City right-of-way and easements, except to convey storm water runoff from a private residential lot through a street curb or to a roadside ditch which fronts the residential lot.

    ~~b.~~d. Installations on projects handled by Capital Projects Service line unless allowed according to 2.02.A.1.c.

2. Section 02510 - Polypropylene (PP) Corrugated Wall Pipe.

~~2.~~3. Section 02505 - High Density Polyethylene (HDPE) Solid and Profile Wall Pipe. ~~and Section 02510 – Polypropylene (PP) Corrugated Wall Pipe.~~ For use only where Storm Sewers are associated with Local Streets, where Local Street is defined by City of Houston Code of Ordinances 42-1~~22~~.

~~3.~~4. Section 02611 - Reinforced Concrete Pipe.

~~4.~~5. Section 02612 - Precast Reinforced Concrete Box Sewers.

~~5.~~6. Section 02642 - Corrugated Metal Pipe use only where Corrugated Metal Pipe is shown on Drawings.

B. Driveway Culvert Pipe for Streets with Open Ditches: Use pipe materials conforming to requirements specified in one or more of the following Sections as shown on the Drawings.

1. Section 02505 - High Density Polyethylene (HDPE) Solid and Profile Wall Pipe ~~and Section 02510 – Polypropylene (PP) Corrugated Wall Pipe.~~ Use for Residential Culverts only. ~~Use Concrete Pipe for long run culverts.~~

~~1.~~2. Section 02510 - Polypropylene (PP) Corrugated Wall Pipe.

~~2.~~3. Section 02611 - Reinforced Concrete Pipe.

~~3.~~4. Section 02612 - Precast Reinforced Concrete Box Sewers.

C. Provide pipe meeting minimum class, dimension ratio, or other criteria indicated.

D. Pipe materials other than those listed above shall not be used for storm sewers.

2.03 BEDDING, BACKFILL, AND TOPSOIL MATERIAL

A. Bedding and Backfill Material: Conform to requirements of Sections 02317 - Excavation and Backfill for Utilities, Section 02320 - Utility Backfill Materials, and Section 2321 - Cement Stabilized Sand, and Section 02322 - Flowable Fill.

B. Topsoil: Conform to requirements of Section 02911 - Topsoil.

PART 3 EXECUTION

3.01 PREPARATION

A. Prepare traffic control plans and set up street detours and barricades in preparation for excavation when construction will affect traffic. Conform to requirements of Section 01555 - Traffic Control and Regulation.

B. Provide barricades, flashing warning lights, and signs for excavations. Conform to requirements of Section 01555 - Traffic Control and Regulation. Maintain barricades and warning lights for streets and intersections while Work is in progress or where traffic is affected by Work.

C. Immediately notify agency or company owning utility lines which are damaged, broken, or disturbed. Obtain approval from Project Manager and agency for repairs or relocations, either temporary or permanent.

D. Remove old pavements and structures, including sidewalks and driveways in accordance with requirements of Section 02221 - Removing Existing Pavements, Structures, Wood, and Demolition Debris.

E. Install and operate dewatering and surface water control measures in accordance with Section 01578 - Control of Ground and Surface Water.

3.02 EXCAVATION

A. Earthwork. Conform to requirements of Section 02317 - Excavation and Backfill for Utilities. Use bedding as indicated on Drawings.

B. Line and Grade. Establish required uniform line and grade trench from benchmarks identified by Project Manager. Maintain this control for minimum of 100 feet behind and ahead of pipe-laying operation. Use laser beam equipment to establish and maintain proper line and grade of Work. Or use appropriately sized grade boards which are substantially supported.

C. Trench Excavation. Excavate pipe trenches to level as indicated on Standard Details. Backfill excavation with specified bedding material to level of lower one-third of pipe barrel. Tamp and compact backfill to provide bedding at indicated grade. Form bedding foundation to minimum depth of one-eighth of pipe diameter, but not less than 12-inches

3.03 PIPE INSTALLATION.

A. Install in accordance with pipe manufacturer's recommendations and as specified in this section.

B. Install pipe only after excavation is completed, bottom of trench is shaped, bedding material is installed, and trench has been approved by Project Manager.

C. Install pipe to line and grade indicated on Drawings. Place pipe so that it has continuous bearing of barrel on bedding material with no voids, and is laid in trench so interior surfaces of pipe follows grades and alignments indicated.

D. Install pipe with bells of pipe facing upstream of anticipated flow.

E. Form concentric joint with each section of adjoining pipe to prevent offsets.

F. Place and drive home newly laid sections with a sling or come-a-long winches to eliminate damage to sections. Unless otherwise approved by Project Manager, provide end protection to prevent damage while using back hoes or similar powered equipment to drive home newly laid sections.

G. Keep interior of pipe clean as installation progresses.

H. Keep excavations free of water during construction and until final inspection.

I. When work is not in progress, cover exposed ends of pipes with pipe plug specifically designed to prevent foreign material from entering pipe.

J. For Flexible Pipe Products:

1. Provide a minimum cover as per City Standard detail from top of pavement to top of pipe, but no less than 2 feet.

~~1.~~2. For thermoplastic pipes, provide minimum cover as shown on Drawings.

~~2.~~3. Accomplish transitions to different material of pipe in a manhole or inlet box. No adapter, coupling for dissimilar pipe, or saddle connections allowed.

~~3.~~4. Provide pipe sections in standard lengths with minimum length of 13 feet. Pipe may be field modified to shorten length no less than 4 feet, unless otherwise approved by Project Manager. Field modify pipe per manufacturer's recommendations.

~~4.~~5. No beveling at joint allowed. Cut to be perpendicular to longitudinal axis.

6. For thermoplastic pipes, p~~P~~rovide gasketed bell and spigot joints installed per manufacturer's recommendations. Gasketed pipe joints; clean and free of debris, show no leakage after installation.

~~5.~~7. Refer to Specification 02642 – Corrugated Metal Pipe for CMP joint requirements.

3.04 PIPE INSTALLATION OTHER THAN OPEN CUT OR TUNNELING

A. Conform to requirements of Section 02448 - Pipe and Casing Augering for Sewers where required.

B. Conform to requirements of Section 02441 - Microtunneling where required.

C. Conform to requirements of Section 02445 – Jack and Bore/Jack and Mine/Pilot Tube Guided Boring Tunnels where required.

D. Not allowed for plastic sewer pipe.

3.05 INSTALLATION OF APPURTENANCES

A. Construct manholes to conform to requirements of Sections 02081 - Cast-in-place Concrete Manholes and Section 02082 - Precast Concrete Manholes. Install frames, grate rings, and covers to conform to requirements of Section 02090 - Frames, Grates, Rings, and Covers.

~~B. Install PVC pipe culverts with approved end treatments. Approved end treatments include concrete headwalls, wingwalls and collars.~~

~~C.~~B. Install ~~HDPE and PP~~ pipe culverts with ~~approved end treatments~~appropriate measures (e.g., headwalls, safety end treatments, riprap, sloped paving, earthen protection, etc.) as shown on Drawings. ~~Approved end treatments include concrete headwalls, wingwalls and collars.~~

~~D.~~C. ~~Install~~ For inlets, headwalls, and wingwalls, ~~to~~ conform to requirements of Section 02632 - Cast-in-place Inlets, Headwalls, and Wingwalls and Section 02633 - Precast Concrete Inlets, Headwalls, and Wingwalls.

~~E.~~D. Rehabilitate existing manholes to conform to requirements of Section 02555 – Manhole Rehabilitation. Adjust manhole covers and inlets to grade conforming to requirements of Section 02086 - Adjusting Manholes, Inlets, and Valve Boxes to Grade.

~~F.~~E. Dimension for Type C and Type E manholes shall be as shown on Drawings.

3.06 INSPECTION AND TESTING

A. Perform post installation television inspection in accordance with Section 02531 – Gravity Sanitary Sewers. Hand held cameras may be used in storm sewers in lieu of requirements of Paragraph 3.09 of Section 02531 – Gravity Sanitary Sewers. Clearly stencil distance markings on each joint of pipe to indicate distance from starting manhole when using hand held cameras.

B. Mandrel Testing: Use a mandrel to test flexible pipe for deflection. Refer to Section 02533 – Acceptance Testing for Sanitary Sewers for the mandrel and test requirements.

3.07 BACKFILL AND SITE CLEANUP

A. Backfill trench after pipe installation is inspected and approved by Project Manager.

B. Backfill and compact soil in accordance with Section 02317 - Excavation and Backfill for Utilities.

C. Repair and replace removed or damaged pavement and sidewalks as specified in Section 02951 - Pavement Repair and Restoration.

D. In unpaved areas, grade surface as uniform slope to natural grade as indicated on Drawings. Provide minimum of 4 inches of topsoil and seed according to requirements of Section 02921 Hydro Mulch Seeding, or Section 02922 - Sodding, as required.

END OF SECTION

SECTION 02632

CAST-IN-PLACE INLETS, HEADWALLS AND WINGWALLS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Cast-in-place inlets for storm or sanitary sewers, including cast iron frame and plate or grate.

B. Cast-in-place headwalls including wingwalls for storm sewers.

C. Cast-in-place junction box with lid or grate top.

1.02 RELATED SECTIONS

A. Section 01270 – Measurement and Payment

B. Section 01330 – Submittal Procedures

C. Section 02090 – Frames, Grates, Rings, and Covers

D. Section 02317 – Excavation and Backfill for Utilities

E. Section 03315 – Concrete for Utility Construction

F. Section 04061 – Mortar

1.03 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. Payment for cast-in-place inlets is on unit price basis for each inlet installed.

2. Payment for cast-in-place headwalls including wingwalls is on unit price basis for each headwall including wingwall installed.

3. Payment for cast-in-place junction box with lid or grate top is on unit price basis for each junction box installed.

4. Payment for inlets and for culvert headwalls including wingwalls and junction boxes includes connection of lines and furnishing and installing frames, grates, rings, and covers.

5. Refer to Section 01270 - Measurement and Payment for unit price procedures.

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

1.04 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

B. Submit shop drawings for approval of design and construction details for cast-in-place units which differ from units shown on Drawings.

C. Submit manufacturers' data and details for frames, grates, rings, and covers.

PART 2 PRODUCTS

2.01 MATERIALS

A. Concrete: Class A concrete with minimum compressive strength of 4000 psi conforming to requirements of Section 03315 - Concrete for Utility Construction, unless otherwise indicated on Drawings.

B. Reinforcing Steel: Conform to requirements of Section 03315 - Concrete for Utility Construction.

C. Mortar and Hydraulic Cement - Conform to requirements of Section 04061 - Mortar.

D. Miscellaneous metals: Cast-iron frames, grates, rings, and covers conforming to requirements of Section 02090 - Frames, Grates, Rings, and Covers.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify lines and grades are correct.

B. Verify compacted subgrade will support loads imposed by inlets.

3.02 INSTALLATION

A. Construct units complete in place to dimensions, lines and grades as shown on Drawings.

B. Excavate in accordance with requirements of Section 02317 - Excavation and Backfill for Utilities.

C. Construct box section of inlet of Class A concrete.

D. Forms required for both outside and inside faces of concrete inlet walls, however, when nature of material excavated for inlet can be hand trimmed to smooth vertical face, outside forms may be omitted with approval of Project Manager.

E. Place reinforcing steel to conform to details shown on Drawings. Provide positive means for holding steel cages in place during concrete placement. Welding of reinforcing steel is not permitted unless noted on Drawings. Maximum variation in reinforcement position is plus or minus 10 percent of wall thickness or plus or minus 1/2 inch, whichever is less. Regardless of variation, maintain minimum cover of concrete over reinforcement as shown on Drawings.

F. Chamfer exposed edges unless otherwise indicated on Drawings.

3.03 FINISHES

A. Cut off inlet leads neatly at inside face of inlet wall. Point up with mortar.

B. When box section of inlet complete, shape floor of inlet with mortar to conform to detailed Drawings.

C. Finish concrete surfaces in accordance with requirements of Section 03315 - Concrete for Utility Construction.

3.04 FIELD QUALITY CONTROL

A. Verify that inlets are free of leaks. Repair leaks in approved manner.

3.05 CONNECTIONS

A. Connect inlet leads to inlets.

B. Seal leads inside and outside with hydraulic cement.

3.06 BACKFILL

A. Backfill area of excavation surrounding each completed inlet according to requirements of Section 02317 - Excavation and Backfill for Utilities.

END OF SECTION

SECTION 02633

PRECAST CONCRETE INLETS, HEADWALLS, AND WINGWALLS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Precast concrete inlets for storm or sanitary sewers, including cast iron frame and plate or grate.

B. Precast concrete headwalls and wingwalls for storm sewers.

C. Precast junction box with lid or grate top.

1.02 RELATED SECTIONS

A. Section 01270 – Measurement and Payment

B. Section 01330 – Submittal Procedures

C. Section 02090 – Frames, Grates, Rings, and Covers

D. Section 02317 – Excavation and Backfill for Utilities

E. Section 04061 – Mortar

1.03 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. Payment for inlets is on unit price basis for each inlet installed.

2. Payment for headwalls and wingwalls is on unit price basis for each headwall and wingwall installed.

3. Payment for junction box with lid or grate top is on unit price basis for each junction box installed.

4. Payment for inlets, headwalls, wingwalls, and junction boxes includes connection of lines and furnishing and installing frames, grates, rings, and covers.

5. Refer to Section 01270 - Measurement and Payment for unit price procedures.

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

1.04 REFERENCES

~~A. ASTM C 857 - Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.~~

A. ASTM C 858 - Standard Specification for Underground Precast Concrete Utility Structures.

B. ASTM C 890 - Standard Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures.

C. ~~ASTM C 891 - Standard Practice for Installation of Underground Precast Concrete Utility Structures.~~ASTM C 1889 – Standard Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Utility, Water, and Wastewater Structures Using AASHTO LRFD Design.

~~C.~~D. AASHTO HL-93 design live loading loads as referred to in AASHTO LRFD Bridge Design.

1.05 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

B. Submit shop drawings for approval of design and construction details for precast concrete inlets, junction box headwalls, and wingwalls. Precast units differing from standard designs shown on Drawings will be rejected unless shop drawing submittals are approved. Clearly show proposed substitution is equal or superior in every aspect to standard designs.

C. Submit manufacturers' data and details for frames, grates, rings, and covers.

1.06 STORAGE AND SHIPMENT

A. Store precast units on level blocking. Do not place loads until design strength is reached. Shipment of acceptable units may be made when 28-day strength requirements have been met.

PART 2 PRODUCTS

2.01 MATERIALS

A. Concrete: Provide concrete for precast machine-made units meeting requirements of ASTM C 858 regarding reinforced concrete, cement, aggregate, mixture, and concrete test. Minimum 28-day compressive strength shall be 4,000 psi

B. Design Loading Criteria: Inlets walls, transition slabs, top sections, and inlet base slabs shall be designed, by manufacturer, to requirements of ASTM C 890, and/or ASTM C 1889 for depth as shown on Drawings and to resist following loads

1. AASHTO HL-93 design live loading loads as referred to in AASHTO LRFD Bridge Design Specifications applied to inlet cover and transmitted down to transition and base slabs.

2. Unit soil weight of 120 pcf located above portions of the inlet, including base slab projections.

3. Lateral soil pressure based on saturated soil conditions producing an at-rest equivalent fluid pressure of 100 pcf.

4. Internal liquid pressure based on unit weight of 63 pcf.

~~1.~~5. Dead load of inlet sections fully supported by transition and base slabs.

~~B.~~C. Reinforcing Steel: Place reinforcing steel to conform to details shown on Drawings and as follows:

1. Provide positive means for holding steel cages in place throughout production of concrete units. Maximum variation in reinforcement position is plus or minus 10 percent of wall thickness or plus or minus 1/2-inch, whichever is less. Regardless of variation, maintain minimum cover of concrete over reinforcement as shown on Drawings.

2. Welding of reinforcing steel is not permitted unless noted on Drawings.

~~C.~~D. Mortar and Hydraulic Cement: Conform to requirements of Section 04061 - Mortar.

E. Miscellaneous Metal: Cast-iron frames and plates conforming to requirements of Section 02090 - Frames, Grates, Rings, and Covers.

F. Third-Party Certification Requirement:

1. Precast concrete manufacturers supplying precast concrete products shall maintain active certification from an accepted third-party quality control program at the time of manufacture.

2. Accepted third-party quality control programs are the National Precast Concrete Association (NPCA) Plant Certification Program and the American Concrete Pipe Association (ACPA) Q-Cast Program.

~~1.~~3. Copies of certificates demonstrating compliance with the above third-party plant certification requirements shall be furnished upon the first delivery to the project. Certifications shall be resubmitted annually thereafter or upon request by the Project Manager.

2.02 SOURCE QUALITY CONTROL

A. Tolerances: Allowable casting tolerances for concrete units are plus or minus 1/4 inch from dimensions shown on Drawings. Concrete thickness in excess of that required will not constitute cause for rejection provided that excess thickness does not interfere with proper jointing operations.

B. Precast Unit Identification: Mark date of manufacture and name or trademark of manufacturer clearly on inside of inlet, headwall, or wingwall.

C. Rejection: Precast units rejected for non-conformity with these specifications and for following reasons:

1. Fractures or cracks passing through shell, except for single end crack that does not exceed depth of joint.

2. Surface defects indicating honeycombed or open texture.

3. Damaged or misshaped ends, where damage would prevent making satisfactory joint.

D. Replacement: Immediately remove rejected units from Work site and replace with acceptable units.

E. Repairs: Occasional imperfections resulting from manufacture or accidental damage may be repaired if, in opinion of Project Manager, repaired units conform to requirements of these specifications.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify lines and grades are correct.

B. Verify compacted subgrade will support loads imposed by inlets.

3.02 INSTALLATION

A. Install units complete in place to dimensions, lines, and grades as shown on Drawings.

B. Excavate in accordance with requirements of Section 02317 - Excavation and Backfill for Utilities.

C. Bed precast concrete units on foundations of firm, stable material shaped to conform to shape of unit bases.

D. Provide adequate means to lift and place concrete units.

3.03 FINISHES

A. Use hydraulic cement to seal joints, fill lifting holes and as otherwise required.

B. When box section of inlet has been completed, shape floor of inlet with mortar to conform to Drawing details.

C. Adjust cast iron inlet plate frames to line, grade, and slope shown on Drawings. Grout frame in place with mortar.

D. Install precast adjustment rings above tops of cones or flat-top sections as required to adjust finished elevation and to support inlet plate frame.

~~C.~~E. Place at least two precast concrete grade rings with thickness of 12 inches or less, under casting. Refer to standard details for additional requirements of precast concrete grade rings.

3.04 FIELD QUALITY CONTROL

A. Verify that inlets are free of leaks. Repair leaks in approved manner.

3.05 CONNECTIONS

A. Connect storm sewer leads to inlets as shown on Drawings. Seal connections inside and outside with hydraulic cement. Make connections watertight.

3.06 BACKFILL

A. Backfill area of excavation surrounding each completed inlet, headwall, or wingwall according to requirements of Section 02317 - Excavation and Backfill for Utilities.

END OF SECTION

SECTION 02642

CORRUGATED METAL PIPE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Corrugated metal pipe (CMP).

B. Corrugated metal pipe with smooth interior (CMPSI).

1.02 RELATED SECTIONS

A. Section 01270 – Measurement and Payment

B. Section 01330 – Submittal Procedures

C. Section 02317 – Excavation and Backfill for Utilities

D. Section 02631 – Storm Sewers

1.03 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. No payment will be made for corrugated metal pipe in open cut under this Section. Include payment in unit price for Section 02631 - Storm Sewers.

2. No payment will be made for corrugated metal pipe in non-open cut under this Section. Include payment in unit price for applicable tunneling section.

3. Refer to Section 01270 - Measurement and Payment for unit price procedures.

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

1.04 REFERENCES

~~C.~~A. AASHTO LRFD Bridge Design Specifications.

~~D.~~B. AASHTO M 36 ~~-~~ Standard Specification for Corrugated Steel Pipe, Metallic-Coated, for Sewers and Drains~~.~~

~~E.~~C. AASHTO M 190 - Standard Specification for Bituminous Coated Corrugated Metal Culvert Pipe and Pipe Arches.

~~F.~~D. AASHTO M 196 - Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains.

~~G.~~E. AASHTO M 197 - Standard Specification for Aluminum Alloy Sheet for Corrugated Aluminum Pipe.

~~H.~~F. AASHTO M 218 - Standard Specification for Steel Sheet, Zinc Coated (Galvanized) for Corrugated Steel Pipe.

~~I.~~G. AASHTO M 232 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

~~J.~~H. AASHTO M 245 - Corrugated Steel Pipe, Polymer Precoated, for Sewers and Drains.

~~K.~~I. AASHTO M 246 - Standard Specification for Steel Sheet, Metallic-Coated and Polymer Precoated for Corrugated Steel Pipe.

~~L.~~J. AASHTO M 274 - Standard Specification for Steel Sheet, Aluminum-Coated (Type 2) for Corrugated Steel Pipe.

~~M.~~K. ASTM B 633 - Standard Specification for Electro deposited Coatings of Zinc on Iron and Steel.

~~N.~~L. ASTM A 760 - Standard Specifications for Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains.

M. ASTM A 798 – Standard Practice for Installing Factory-Made Corrugated Steel Pipe for Sewers and Other Applications

N. MIL-DTL-24441 – Military Specification.

~~1.04~~1.05 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

B. Submit shop drawings and calculations with the following information:

1. Design dimensions and details for pipe and fittings indicating alignment, grade, and laying dimensions.

2. Fabrication details, details of fittings and flanges, details of specials, and proposed welding procedures.

3. Show station numbers for pipe and fittings corresponding to Drawings.

4. Submit detailed calculations per AASHTO LRFD Bridge Design Specifications. Designs are required for each pipe location and are to be signed and sealed by a licensed engineer.

~~1.05~~1.06 QUALITY ASSURANCE

A. Provide manufacturer's affidavits that pipe was manufactured in compliance with standards referenced in this Section, and that coatings and linings were not applied or allowed to cure in freezing temperatures

PART 2 PRODUCTS

2.01 PIPE AND FITTINGS

A. Corrugated metal pipe may be galvanized steel, aluminized steel, aluminum or precoated galvanized steel as indicated on Drawings and conforming to following:

Galvanized Steel	AASHTO M 218
Aluminized Steel	AASHTO M 274
Aluminum	AASHTO M 197
Precoated Galvanized Steel	AASHTO M 246

1. Reference to gauge of metal is to U.S. Standard Gauge for uncoated sheets. Tables in AASHTO M 218 and AASHTO M 274 list thicknesses for coated sheets in inches. Tables in AASHTO M 197 list thicknesses in inches for clad aluminum sheets.

B. Coupling bands and other hardware for galvanized or aluminized steel pipe shall conform to requirements of AASHTO M 36 for steel pipe and AASHTO M 196 for aluminum pipe.

1. Coupling bands shall be not more than 3 nominal sheet thicknesses lighter than thickness of pipe to be connected and in no case lighter than 0.052 inch for steel or 0.048 inch for aluminum.

2. Coupling bands shall be made of same base metal and coating (metallic or otherwise) as pipe.

3. Minimum width of corrugated locking bands shall be as shown below for corrugations which correspond to end circumferential corrugations on pipes being joined:

   a. 10 1/2-inches wide for 2 2/3-inch by 1/2-inch corrugations.

   b. 12-inches wide for 3-inch by 1-inch corrugations.

4. Helical pipe without circumferential end corrugations will be permitted only when it is necessary to join new pipe to existing pipe which was installed with no circumferential end corrugations. In this event pipe furnished with helical corrugations at ends shall be field jointed with either helically corrugated bands or with bands with projections (dimples). Minimum width of helical corrugated bands shall conform to following:

   a. 12-inches wide for 1/2-inch deep helical end corrugations.

b. 14-inches wide for 1-inch deep helical end corrugations.

5. Bands with projections shall have circumferential rows of projections with one projection for each corrugation. Width of bands with projections shall be not less than following:

a. 12-inches wide for pipe diameters up to and including 72-inches. Bands shall have two circumferential rows of projections.

b. 16 1/4-inches wide for pipe diameters of 78-inches and greater. Bands shall have four circumferential rows of projections.

6. Bolts for coupling bands shall be 1/2-inch diameter. Bands 12-inches wide or less will have minimum of 2 bolts per end at each connection, and bands greater than 12-inches wide shall have minimum of 3 bolts at each connection.

7. Galvanized bolts may be hot dip galvanized in accordance with requirements of AASHTO M 232, mechanically galvanized to provide same requirements as AASHTO M 232, or electro galvanized per ASTM B 633, Type RS.

C. Coat bituminous coated pipe or pipe arch inside and out with bituminous coating which shall meet these performance requirements and requirements of AASHTO M 190.

1. Uniformly coat pipe inside and out to minimum thickness of 0.05-inch, measured on crests of corrugations.

2. Adhere bituminous coating to metal so that it will not chip, crack, or peel during handling and placement; and to protect pipe from corrosion and deterioration.

3. Where paved invert is shown on Drawings, pipe or pipe arch, in addition to fully-coated treatment described above, shall receive additional bituminous material, same as specified above, applied to bottom quarter of circumference to form smooth pavement. Maintain minimum thickness of 1/8-inch above crests of corrugations.

D. Furnish fittings and specials required for bends, end sections, branches, access manholes, and connections to other fittings. Design fittings and specials in accordance with Drawings and ASTM A 760. Fittings and specials are subject to same internal and external loads as straight pipe.

2.02 PIPE FABRICATION

A. Steel Pipe:

1. Galvanized or aluminized steel pipe shall be full circle or arch pipe conforming to AASHTO M 36, Type I, Type IA, or Type II, as indicated on Drawings.

2. Fabrication with circumferential corrugations, lap joint construction with riveted or spot- welded seams, helical corrugations with continuous helical lock seam, or ultra-high frequency resistance butt-welded seams is acceptable.

B. Aluminum Pipe:

1. Conform to requirements of AASHTO M 196, Type I, Type IA, circular pipe, or Type II, pipe arch as indicated on Drawings.

2. Fabrication with circumferential corrugations, lap joint construction with riveted or spot- welded seams, or helical corrugations with continuous helical lock seam.

3. Portions of aluminum pipe that will be in contact with concrete or metal other than aluminum shall be insulated from these materials with coating of bituminous material meeting requirements of AASHTO M 190. Extend coating minimum distance of one foot beyond area of contact.

C. Precoated Galvanized Steel Pipe:

1. Pipe shall be full circle or arch pipe conforming to AASHTO M 245, Type I, Type IA or Type II as indicated on Drawings.

2. Fabrication with circumferential corrugations, lap joint construction with riveted seams, or helical lock seams is acceptable.

3. Inside and outside coating shall be minimum of 10 mils.

PART 3 EXECUTION

3.01 PREPARATION

A. Repair damaged spelter coating by thoroughly wire brushing damaged area and removing all loose, cracked, or weld-burned spelter coating. Paint cleaned area with ~~zinc dust-zinc oxide~~ paint conforming to ~~Federal~~ Military Specifications ~~TT-P-641G~~MIL-DTL-24441.

B. Repair damaged aluminized or polymer coating in accordance with manufacturer's recommendations.

3.02 EARTHWORK

A. Excavate in accordance with requirements of Section 02317 - Excavation and Backfill for Utilities, except where tunneling or jacking methods are shown on Drawings. When pipes are laid in trench, trench when completed and shaped to receive pipe, shall be of sufficient width to provide free working space for satisfactory bedding and jointing and thorough tamping of backfill and bedding material under and around pipe.

B. Bed pipe in accordance with Drawings. When requested by Project Manager, furnish simple template for each size and shape of pipe for use in checking shaping of bedding. Template shall consist of thin plate or board cut to match lower half of cross section.

C. Where rock in either ledge or boulder form exists below pipe, remove rock below grade and replace with suitable materials so slightly yielding compacted earth cushion is provided below pipe minimum of 12-inches thick.

D. Remove and replace where soil encountered at established grade is quicksand, muck or similar unstable materials in accordance with requirements of Section 02317 - Excavation and Backfill for Utilities. Do not allow cement stabilized materials for backfill to come into contact with uncoated aluminum or aluminized pipe surface.

E. After metal pipe structure has been completely assembled on proper line and grade and headwalls constructed when required by drawing details, place selected material from excavation or borrow along both sides of completed structures equally, in uniform layers not exceeding 6 inches in depth (loose measurement), wetted when required and thoroughly compacted between adjacent structures and between structure and sides of trench, or for distance each side of structure equal to diameter of pipe. Compact backfill material to same density requirements as specified for adjoining sections of embankment in accordance with specifications. Above three-fourths point of structure, place uniformly on each side of pipe in layers not to exceed 12-inches.

F. Only hand operated tamping equipment will be allowed within vertical planes 2-feet beyond horizontal projection of outside surface of structure for backfilling, until minimum cover of 12-inches is obtained. Remove and replace damaged pipe.

G. Do not permit heavy earth moving equipment to haul over structure until minimum of 4-feet of permanent or temporary compacted fill has been placed.

H. During backfilling, obtain uniform backfill material and uniform compacted density throughout length of structure to avoid unequal pressure. Provide proper foundation and bedding under the structure in accordance with ASTM A 798.

I. Prior to adding each new layer of loose backfill material, inspection will be made of inside periphery of structure for local or unequal deformation caused by improper construction methods. Evidence of deformation will be reason for corrective measures as may be directed by Project Manager.

3.03 PIPING INSTALLATION

A. Place pipes on prepared foundation starting at outlet end. Join sections firmly together, with side laps or circumferential joints pointing upstream and with longitudinal laps on sides.

B. Coat metal in joints not protected by galvanizing or aluminizing with approved asphaltum paint.

C. Provide proper equipment for hoisting and lowering sections of pipe into trench without damaging pipe or disturbing prepared foundation and sides of trench. Take up and re-lay pipe which is not in alignment or which shows undue settlement after laying, or is damaged.

D. Lay multiple installations of corrugated metal pipe and pipe arches with center lines of individual barrels parallel. Unless otherwise indicated on Drawings, maintain following clear distances between outer surfaces of adjacent pipes:

Diameter of Pipe	Clear Distance Between Pipes Full Circle and Pipe Arch	Pipe Arch Design No.
18"	1'-2"	2
24"	1'-5"	3
30"	1'-8"	4
36"	1'-11"	5
42"	2'-2"	6
48"	2'-5"	7
54"	2'-10"	8
60"-84"	3'-2"	9
90"-120"	3'-5"	10 & ~~O~~over

E. Where extensions are attached to existing structures, install proper connection between structure and existing as indicated on Drawings, coat connection with bituminous material when required.

F. When existing headwalls and aprons are indicated for reuse on Drawings, sever portion to be reused from existing culvert, and relocate to prepared position. Restore damaged headwalls, aprons or pipes attached to headwall to their original condition.

3.04 JOINTING

A. Use field joints to maintain pipe alignment during construction and prevent infiltration of side material.

B. Lap coupling bands equally on pipes being connected to form tightly-closed joint.

C. Use corrugated locking bands to field join pipes furnished with circumferential corrugations including pipe with helical corrugations having reformed circumferential corrugations on ends. Fit locking bands into minimum of one full circumferential corrugation of pipe ends being coupled.

END OF SECTION

SECTION 02643

PLATE CULVERT STRUCTURES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Structural plate culverts and special structural plate shapes.

1.02 RELATED SECTIONS

A. Section 01270 – Measurement and Payment

B. Section 02317 – Excavation and Backfill for Utilities

C. Section 02320 – Utility Backfill Materials

D. Section 03315 – Concrete for Utility Construction

1.03 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. Payment for structural plate pipes, pipe arches, arches, underpasses or box culverts is on linear foot basis for each structure, measured along flow lines between ends of structures. Separate payment will be made for each different required size, gage, or minimum thickness of required material.

2. For multiple structures, measured length will be sum of lengths of barrels as prescribed above.

3. Include cost of aluminum alloy inverts, toe walls, footings, closure plates, and stiffeners in unit price for structure.

4. Refer to Section 01270 - Measurement and Payment for unit price procedures.

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

1.04 REFERENCES

A. AASHTO M 167 - Standard Specification for Corrugated Steel Structural Plate, Zinc Coated, for Field Bolted Pipe, Pipe Arches, and Arches~~.~~

B. AASHTO M 190 - Standard Specification for ~~Bituminous~~ Asphalt-Coated Corrugated Metal Culvert Pipe and Pipe Arches.

C. AASHTO M 219 - Standard Specification for Corrugated Aluminum Alloy Structural Plate for Field Bolted Pipe, Pipe Arches, and Arches.

D. AASHTO M 243 - Standard Specification for Field-Applied Coating of Corrugated Metal Structural Plate for Pipe, Pipe-Arches, and Arches.

E. ASTM A 153 - Standard Specification for Zinc Coating (Hot-dip) on Iron and Steel Hardware.

F. ASTM B 221 - Standard Specification for Aluminum and Aluminum - Alloy Extruded Bars, Rods, Wires, Profile, and Tubes.

G. ASTM B 695 - Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel.

H. Tex-728-I-Measurement of Dry Film Coating Thickness on Steel

I. MIL-DTL-24441 – Military Specification.

1.05 ACCEPTANCE

A. Furnish itemized list of number and size of plates in each shipment to be used for visual inspection by Project Manager. Inspection will be made of plates for deficiency in size, radius of curvature and evidence of poor workmanship. Inspection may include sampling for chemical analysis and determination of weight of splutter coating. Plates failing to meet requirements of this Section will be rejected.

B. Project Manager may elect to inspect materials in rolling mill or in fabrication shop. Project Manager will have free access to mill or shop for inspection.

C. Repair damaged areas of splutter coating. Repair may be accomplished by painting with ~~dust-zinc oxide~~ paint conforming to ~~Federal~~ Military Specification ~~TT-P-641G~~MIL-DTL-24441 when approved in advance by Project Manager.

D. The following defects are causes for rejection:

1. Uneven laps.

2. Elliptical shaping (unless specified).

3. Variation from straight center line.

4. Ragged edges.

5. Loose, unevenly lined or spaced bolts.

6. Illegible brand.

7. Bruised, scaled, or broken splutter coating.

8. Dents or bends in metal.

PART 2 PRODUCTS

2.01 METAL PIPE AND ARCH MATERIALS

A. Conform plates and fasteners used for construction of structural plate pipes, pipe arches, arches, underpasses, box culverts and special shapes to AASHTO M 167 for galvanized corrugated steel structures, and to AASHTO M 219 for aluminum alloy structures.

B. Steel fasteners shall be mechanically galvanized or hot-dip galvanized and shall conform to ASTM A 153, Class C or D, or ASTM B 695, Class 40. Determine weight of galvanized coating according to Test Method Tex-728-I.

C. Steel plates shall consist of structural units of corrugated galvanized metal. Furnish single plates in standard sizes to permit structure length increments of 2 feet. Plates shall have approximately 2 inch lip beyond each end and crest. Length of given structure shall be approximately 4 inches longer than nominal length, except when skewed or beveled.

D. Aluminum plate shall consist of structural units of corrugated aluminum alloy. For aluminum alloy structures, furnish cut plates on structure ends to permit structure length increments of one foot. Conform aluminum alloy inverts, toe walls, footings and closure plates to material requirements for aluminum structural plate. Extruded aluminum transverse stiffeners shall conform to ASTM B 221, Alloy 6061-T6.

E. Comply headwalls with material requirements shown on Drawings.

2.02 STRUCTURE AND MATERIAL DESIGNATION

A. The types of structures are described on Drawings as follows:

1. Structural Plate Pipe (Galvanized Steel)

2. Structural Plate Pipe (Aluminum)

3. Structural Plate Pipe Arch (Galvanized Steel)

4. Structural Plate Pipe Arch (Aluminum)

5. Structural Plate Arch (Galvanized Steel)

6. Structural Plate Arch (Aluminum)

7. Structural Plate Underpass (Galvanized Steel)

8. Structural Plate Underpass (Aluminum)

9. Structural Plate Box Culvert (Galvanized Steel)

10. Structural Plate Box Culvert (Aluminum)

B. Either galvanized steel or aluminum may be used when no material is designated on Drawings.

2.03 PLATE JOINTS

A. Form plates to provide bolted lap joints. Punch bolt holes so plates having like dimensions, curvature, and same number of bolts per foot of seam are interchangeable.

B. Curve each plate to proper radius so cross-sectional dimensions of finished structure will be as indicated on Drawings.

C. Stagger joints so not more than three plates are jointed at any one point. Unless otherwise specified, place bolt holes along edges of plates forming longitudinal seams in finished structure as follows:

1. Stagger in rows 2-inches apart, with one row in valley and one in crest of corrugations with not less than 4 bolts per foot for galvanized steel structures.

2. Stagger in rows 1 ¾-inches apart, with 2 bolts in each valley and on each crest and not less than 16 bolts per 3 feet for aluminum alloy structures.

D. Provide for bolt spacing of not more than 12 inches for bolt holes along edges of plates that will form circumferential seams in finished structure.

E. Keep minimum distance from center of hole to edge of plate to not less than 1 3/4 times diameter of bolt.

F. Diameter of bolt holes in longitudinal seams not to exceed diameter of bolt by more than 1/8 inch.

G. Cut plates for forming skewed or sloped ends to give angle of skew or slope specified.

H. Repair burned edges to eliminate oxide and burrs. Maintain legible identification numerals on each plate to designate proper position in finished structure.

2.04 CONCRETE

A. Conform to Section 03315 - Concrete for Utility Construction. Unless otherwise shown on Drawings, use Class A concrete for footings and headwalls. Use Class B concrete for slope protection and for invert paving. Place reinforcement as shown on Drawings.

2.05 REINFORCING STEEL

A. Conform to requirements of Section 03315 - Concrete for Utility Construction.

PART 3 EXECUTION

3.01 PROTECTIVE COATINGS, LININGS AND PAVINGS

A. When required, protect structural plate structures with bituminous coating, bituminous lining or have invert paved with bituminous material. Remove moisture, dirt, oil, unbonded or incompatible paint, grease, alkalies, or other foreign matter from surface to be coated before applying coating material.

B. Apply bituminous coatings to inside and outside of structures to minimum thickness of 0.05-inch as provided in AASHTO M 190, Type A.

C. Apply protective coating to coupling bands for coated structures. Use coatings in accordance with AASHTO M 190. Coupling bands may be single-dipped with coating thickness requirement waived.

D. Apply bituminous linings, when required, over bituminous coatings, to inside bottom portion of structure as provided in AASHTO M 190, Type C.

E. When lining~~s~~ and paving~~s~~ are not required, asphalt mastic coating may be substituted for bituminous coating on corrugated steel or aluminum structures on outside surface of structure. Inside surface need not be coated.

F. Use asphalt mastic coating conforming to requirements of AASHTO M 243, except asbestos fibers will not be used. Perform this process at fabrication plant. Apply asphalt mastic material uniformly to outside surface with minimum thickness of 0.05-inch. Pinholes, blisters, cracks or lack of bond are cause for rejection.

G. When protective coatings are applied to structures, clearly identify thickness of metal on inner surface of each section with paint or other approved means. Repair damaged protective coatings, linings, and invert paving. Use bituminous material conforming to AASHTO M 190 or other approved materials to repair damaged asphalt mastic coatings.

H. Coat portion of nuts and bolts projecting outside pipe after installation. Portion of nuts and bolts projecting inside structure need not be coated.

I. When asphalt mastic is used for protective coating, surface at joints of structure need not be coated prior to assembly. Thoroughly seal joints after assembly with asphalt mastic on outside of structure.

3.02 CONSTRUCTION METHODS

A. Excavate in accordance with Section 02317 - Excavation and Backfill for Utilities. Make trenches for pipes, pipe arches, underpasses or box culverts of sufficient width to provide free working space for erection and thorough tamping of backfill and bedding material under and around structure. When quality of native soil is less than proposed backfill material, extend excavation to each side of barrel, minimum horizontal distance of half span or two-thirds of total rise, whichever is greater.

B. Bed foundations for structural plate structures with metal inverts in foundation of sandy earth material as specified in Section 02320 - Utility Backfill Materials, accurately shaped to fit lower part of pipe for at least ten percent of its overall height. Length of bedding arch need not exceed width of bottom plate. Uniformly seat corrugations on minimum 3-inch thick bed of sandy material. For culverts, place bedding to full width of invert.

1. Where rock, in ledge or boulder formation, exists below pipe, remove rock below grade and replace with compacted earth cushion having minimum thickness of 12 inches.

2. Where soil encountered at established grade is quicksand, muck, or similar unstable material, remove and replace material in accordance with Section 02317 - Excavation and Backfill for Utilities. When required, use special bedding as shown on Drawings.

C. Form foundations for structural plate structures with reinforced concrete footings to lines and grades shown on Drawings or as established by Project Manager.

1. Set anchors or slots for box culverts to line and grade when placing concrete for each substructure unit. Conform to Section 03315 - Concrete for Utility Construction for placing substructure units.

2. Place footings entirely in rock, shale or similarly hard material, or on firm soil or compacted soil cushion. When part of founding area is rock, undercut it and replace with minimum 12-inch thick compacted soil cushion. When thin layer of soil is partially covering rock within bearing area and when practical to do so, soil may be removed and footings placed directly on rock in accordance with details shown on Drawings.

D. Erection: Install structural plate structures in accordance with Drawings.

1. Coat steel in joints not protected by galvanizing with suitable bituminous coating.

2. Handle pipes and plates carefully to avoid damage to protective coating. Repair damaged coatings.

3. Use anchor bolts with 3/4-inch diameter by 6-inch minimum length on not more than 19-inch centers for anchoring plates to headwalls or other concrete end treatment.

4. Do not place plates for arch structures until substructure has cured for minimum of 3 days.

5. When plates are in position, tighten nuts and bolts progressively and uniformly, beginning at one end of structure. Tighten nuts second time to torque of not less than 150 ft-lbs nor more than 300 ft-lbs for steel bolts and not less than 100 ft-lbs nor more than 150 ft-lbs for aluminum bolts. When impact wrench is used, check with long-handled, structural, socket, or torque wrench to ensure that they are properly tightened. Replace service bolts used in drawing plates together with standard high strength bolts.

E. Use acceptable shape control devices for monitoring horizontal and vertical shape of structures. Maintain shape within two percent of design span or rise during erection and backfilling.

F. Backfilling: Perform backfilling and embankment construction around pipe in accordance with Section 02317 - Excavation and Backfill for Utilities. Conduct backfill operations to ~~i~~ensure inside dimensions remain within tolerances specified in shape control.

END OF SECTION

SECTION 03315

CONCRETE FOR UTILITY CONSTRUCTION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Cast-in-place concrete work for utility construction or rehabilitation, such as slabs on grade, small vaults, site-cast bases for precast units, and in-place liners for manhole rehabilitation.

1.02 RELATED SECTIONS

A. Section 01270 – Measurement and Payment

B. Section 01330 – Submittal Procedures

C. Section 01454 – Testing Laboratory Services

1.03 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. No payment will be made for concrete for utility construction under this Section. Include cost in applicable utility structure.

2. Obtain services of and pay for certified testing laboratory to prepare design mixes shall be considered incidental to the bid item for the applicable utility structure.

3. Payment for extra grade 60 reinforcing steel in place is on per pound basis.

~~2.~~4. Payment for extra class A concrete with or without forms is on a cubic yard basis.

~~3.~~5. Refer to Section 01270 - Measurement and Payment for unit price procedures.

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

1.04 REFERENCES

A. ACI 117 - Standard Tolerances for Concrete Construction and Materials.

B. ACI 211.1 - Standard Practice for Selecting Proportions for Normal~~, Heavyweight and Mass Concrete.~~ - Density and High - Density Concrete~~ – Guide~~.

C. ACI 302.1R - Guide for Concrete Floor and Slab Construction.

D. ACI 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete.

E. ACI 308.1-23 - ~~Standard Practice for Curing Concrete.~~ External Curing of Cast-in-Place Concrete-Specification.

F. ACI 309R - Guide for Consolidation of Concrete.

G. ACI 311.6-18 - ~~Guide for Concrete Plant Inspection and Field~~Specification for Testing ~~of~~ Ready-Mixed Concrete.

~~G.~~H. ACI 311.7-18 - Specification for Inspection of Concrete Construction.

~~H.~~I. ACI 315-18 ~~- Details and Detailing of Concrete Reinforcement.~~ Guide to Presenting Reinforcing Steel Design Details.

~~I.~~J. ACI 318 - Building Code Requirements for Reinforced Concrete and Commentary.

~~J.~~K. ~~ACI 544 - Guide for Specifying, Mixing, Placing, and Finishing Steel Fiber Reinforced Concrete~~ACI 544.3-08 - Guide for Specifying, Proportioning, and Production of Fiber-Reinforced Concrete.

~~K.~~L. ASTM A 615 - Standard Specification for Deformed and Plain Carbon -Steel Bars for Concrete Reinforcement.

~~L.~~M. ASTM A 767 - Standard Specifications for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement.

~~M.~~N. ASTM A 775 - Standard Specification for Epoxy-Coated Reinforcing Steel Bars.

~~N.~~O. ASTM A 820 - Standard Specification for Steel Fibers for Fiber-Reinforced Concrete.

~~O.~~P. ASTM A 884 - Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement.

~~P.~~Q. ASTM A 1064 - Standard Specification for ~~Carbon~~ Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.

~~Q.~~R. ASTM C 31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.

~~R.~~S. ASTM C 33 - Standard Specification for Concrete Aggregates.

~~S.~~T. ASTM C 39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.

~~T.~~U. ASTM C 42 - Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.

~~U.~~V. ASTM C 94 - Standard Specification for Ready-Mixed Concrete.

~~V.~~W. ASTM C 138 - Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.

~~W.~~X. ASTM C 143 - Standard Test Method for Slump of Hydraulic~~-~~Cement Concrete.

~~X.~~Y. ASTM C 150 - Standard Specification for Portland Cement.

~~Y.~~Z. ASTM C 172 - Standard Practice for Sampling Freshly Mixed Concrete.

~~Z.~~AA. ASTM C 173 - Standard Test Method for Air Content of Freshly Mixed Concrete by Volumetric Method.

~~AA.~~BB. ASTM C 231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.

~~BB.~~CC. ASTM C 260 - Standard Specification for Air-Entraining Admixtures for Concrete.

~~CC.~~DD. ASTM C 309 - Standard Specifications for Liquid Membrane-Forming Compounds for Curing Concrete.

~~DD.~~EE. ASTM C 494 - Standard Specification for Chemical Admixtures for Concrete.

~~EE.~~FF. ASTM C 595 - Standard Specification for Blended Hydraulic Cements.

~~FF.~~GG. ASTM C 685 - Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing.

~~GG.~~HH. ASTM C 1064 - Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete.

~~HH.~~II. ASTM C 1077 - Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation.

JJ. ~~NRMCA - Concrete Plant Standards~~CPMB 100M-00 - Concrete Plant Standards of the Concrete Plant Manufacturers Bureau.

~~II.~~KK. CRD-C572 - Corps of Engineers Specifications For Polyvinyl Chloride Waterstops.

~~JJ.~~LL. CRSI MSP-1 - Manual of Standard Practice.

~~KK.~~MM. CRSI - Placing Reinforcing Bars.

~~LL.~~NN. Federal Specification SS-S-210A - Sealing Compound, Preformed Plastic, for Expansion Joints and Pipe Joints.

1.05 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

B. Submit proposed mix design and test data for each type and strength of concrete in Work.

C. Submit laboratory reports prepared by independent testing laboratory stating that materials used comply with requirements of this Section.

D. Submit manufacturer's mill certificates for reinforcing steel. Provide specimens for testing when required by Project Manager.

E. Submit certification from concrete supplier that materials and equipment used to produce and deliver concrete comply with this Specification.

F. When required on Drawings, submit shop drawings showing reinforcement type, quantity, size, length, location, spacing, bending, splicing, support, fabrication details, and other pertinent information.

G. For waterstops, submit product information sufficient to indicate compliance with this Section, including manufacturer's descriptive literature and specifications.

1.06 HANDLING AND STORAGE

A. Cement: Store cement off the ground in well-ventilated, weatherproof building.

B. Aggregate: Prevent mixture of foreign materials with aggregate and preserve gradation of aggregate.

C. Reinforcing Steel: Store reinforcing steel to protect it from mechanical injury and formation of rust. Protect epoxy-coated steel from damage to coating.

PART 2 PRODUCTS

2.01 CONCRETE MATERIALS

A. Cementitious Material:

1. Portland Cement: ASTM C 150, Type II, unless use of Type III is authorized by Project Manager; or ASTM C 595, Type IP. For concrete in contact with sewage use Type II cement.

2. When aggregates are potentially reactive with alkalis in cement, use cement not exceeding 0.6 percent alkali content in form of Na2O + 0.658K20.

B. Water: Clean, free from harmful amounts of oils, acids, alkalis, or other deleterious substances, and meeting requirements of ASTM C 94.

C. Aggregate:

1. Coarse Aggregate: ASTM C 33. Unless otherwise indicated, use following ASTM standard sizes: No. 357 or No. 467; No. 57 or No. 67, No. 7. Maximum size: Not larger than 1/5 of narrowest dimension between sides of forms, nor larger than 3/4 of minimum clear spacing between reinforcing bars.

2. Fine Aggregate: ASTM C 33.

3. Determine potential reactivity of fine and coarse aggregate in accordance with Appendix to ASTM C 33.

D. Air Entraining Admixtures: ASTM C 260.

E. Chemical Admixtures:

1. Water Reducers: ASTM C 494, Type A.

2. Water Reducing Retarders: ASTM 494, Type D.

3. High Range Water Reducers (Superplasticizers): ASTM C 494, Types F and G.

F. Prohibited Admixtures: Admixtures containing calcium chloride, thiocyanate, or materials that contribute free chloride ions in excess of 0.1 percent by weight of cement.

G. Reinforcing Steel:

1. Use new billet steel bars conforming to ASTM A 615, ASTM A 767, or ASTM A 775, grade 40 or grade 60, as shown on Drawings. Use deformed bars except where smooth bars are specified. When placed in work, keep steel free of dirt, scale, loose or flaky rust, paint, oil or other harmful materials.

2. Where shown, use welded wire fabric with wire conforming to ASTM A 1064 or ASTM A 884. Supply gauge and spacing shown, with longitudinal and transverse wires electrically welded together at points of intersection with welds strong enough not to be broken during handling or placing.

3. Wire: ASTM A 1064. Use 16 1/2 gauge minimum for tie wire, unless otherwise indicated.

H. Fiber:

1. Fibrillated Polypropylene Fiber:

a. Addition Rate: 1.5 pounds of fiber per cubic yard of concrete.

b. Physical Properties:

(1) Material: Polypropylene

(2) Length: 1/2 inch or graded

(3) Specific Gravity: 0.9l

c. Acceptable Manufacturer: W. R. Grace Company, Fibermesh, or approved equal.

2. Steel Fiber: Comply with applicable provisions of ACI 544.3-08 and ASTM A 820.

a. Ratio: 50 to 200 pounds of fiber per cubic yard of concrete.

b. Physical Properties

(1) Material: Steel

(2) Aspect Ratio (for fiber lengths of 0.5 to 2.5 inch, length divided by diameter or equivalent diameter): 30:1 to 100:1

(3) Specific Gravity: 7.8

(4) Tensile Strength: 40-400 ksi~~.~~

(5) Young's Modulus: 29,000 ksi

(6) Minimum Average Tensile Strength: 50,000 psi

(7) Bending Requirements: Withstand bending around 0.125-inch diameter mandrel to angle of 90 degrees, at temperatures not less than 60 degrees F, without breaking

I. Curing Compounds: Type 2 white-pigmented liquid membrane-forming compounds conforming to ASTM C 309.

2.02 FORM WORK MATERIALS

A. Lumber and Plywood: Seasoned and of good quality, free from loose or unsound knots, knot holes, twists, shakes, decay and other imperfections which would affect strength or impair finished surface of concrete. Use S4S lumber for facing or sheathing. Forms for bottoms of caps: At least 2 inches (nominal) lumber or 3/4 inch form plywood backed adequately to prevent misalignment. For general use, provide lumber of 1~~-~~inch nominal thickness or form plywood of approved thickness.

B. Form work for Exposed Concrete Indicated to Receive Rubbed Finish: Form or form-lining surfaces free of irregularities; plywood of 1/4 inch minimum thickness, preferably oiled at mill.

C. Chamfer Strips and Similar Moldings: Redwood, cypress, or pine that will not split when nailed and which can be maintained to true line. Use mill-cut molding dressed on all faces.

D. Form Ties: Metal or fiberglass of approved type with tie holes not larger than 7/8 inch in diameter. Do not use wire ties or snap ties.

E. Metal Forms: Clean and in good condition, free from dents and rust, grease, or other foreign materials that tend to disfigure or discolor concrete in gauge and condition capable of supporting concrete and construction loads without significant distortion. Countersink bolt and rivet heads on facing sides. Use only metal forms which present smooth surface and which line up properly.

2.03 PRODUCTION METHODS

A. Use either ready-mixed concrete conforming to requirements of ASTM C 94, or concrete produced by volumetric batching and continuous mixing in accordance with ASTM C 685.

2.04 MEASUREMENT OF MATERIALS

A. Measure dry materials by weight, except volumetric proportioning may be used when concrete is batched and mixed in accordance with ASTM C 685.

B. Measure water and liquid admixtures by volume.

2.05 DESIGN MIX

A. Use design mixes prepared by certified testing laboratory in accordance with ASTM C 1077 and conforming to requirements of this section.

B. Proportion concrete materials based on ACI 211.1 to comply with durability and strength requirements of ACI 318, ~~Chapters 4 and 5,~~ and this specification. Prepare mix design of Class A concrete so minimum cementitious content is 564 pounds per cubic yard. Submit concrete mix designs to Project Manager for review.

C. Proportioning on basis of field experience or trial mixtures in accordance with requirements ~~at Section 5.3~~ of ACI 318 may be used, when approved by Project Manager.

D. Classification:

CLASS	TYPE	MINIMUM COMPRESSIVE STRENGTH (LBS/SQ. IN.)		MAXIMUM W/C RATIO	AIR CONTENT (PERCENT)	CONSISTENCY RANGE IN SLUMP (INCHES)
		7-DAY	28-DAY			
A	Structural	3200	4000	0.45	4± 1	2 to 4*
B	Pipe Block Fill, Thrust Block	----	1500	----	4± 1	5 to 7
*When ASTM C 494, Type F or Type G admixture is used to increase workability, this range may be 6 to 9.						

E. Add steel or polypropylene fibers only when called for on Drawings or in another section of these Specifications.

F. Determine air content in accordance with ASTM C 138, ASTM C 173 or ASTM C 231.

G. Use of Concrete Classes: Use classes of concrete as indicated on Drawings and other Specifications. Use Class B for unreinforced concrete used for plugging pipes, seal slabs, thrust blocks, trench dams, tunnel inverts and concrete fill unless indicated otherwise. Use Class A for all other applications.

2.06 PVC WATERSTOPS

A. Extrude from virgin polyvinyl chloride elastomer. Use no reclaimed or scrap material. Submit waterstop manufacturer's current test reports and manufacturer's written certification that material furnished meets or exceeds Corps of Engineers Specification CRD-C572 and other specified requirements.

B. Flat Strip and Center-Bulb Waterstops:

1. Thickness: not less than 3/8 inch.

2. Acceptable Manufacturers:

a. Kirkhill Rubber Co., Brea, California

b. Water Seals, Inc., Chicago, Illinois

c. Progress Unlimited, Inc., New York, New York

d. Greenstreak Plastic Products Co., St. Louis, Missouri

e. Approved equal~~.~~

2.07 RESILIENT WATERSTOP

A. Resilient Waterstop: Where shown on Drawings; either bentonite- or adhesive-type material.

B. Bentonite Waterstop:

1. Material: 75 percent bentonite, mixed with butyl rubber-hydrocarbon containing less than 1.0 percent volatile matter, and free of asbestos fibers or asphaltics.

2. Manufacturer's rated temperature ranges: For application, 5 to 125 degrees F; in service, -40 to 212 degrees F.

3. Cross-sectional dimensions, unexpanded waterstop: 1 inch by 3/4 inch.

4. Provide with adhesive backing capable of producing excellent adhesion to concrete surfaces.

C. Adhesive Waterstop:

1. Preformed plastic adhesive waterstop at least 2 inches in diameter.

2. Meets or exceeds requirements of Federal Specification SS-S-210A.

3. Supplied wrapped completely by 2 part protective paper.

4. Submit independent laboratory tests verifying that material seals joints in concrete against leakage when subjected to minimum of 30 psi water pressure for at least 72 hours.

5. Provide primer, to be used on hardened concrete surfaces, from same manufacturer who supplies waterstop material.

6. Acceptable Manufacturer: Synko-Flex Preformed Plastic Adhesive Waterstop, Synko-Flex Products, Inc.; or approved equal.

PART 3 EXECUTION

3.01 FORMS AND SHORING

A. Provide mortar-tight forms sufficient in strength to prevent bulging between supports. Set and maintain forms to lines designated such that finished dimensions of structures are within tolerances specified in ACI 117. Construct forms to permit removal without damage to concrete. Forms may be given slight draft to permit ease of removal. Provide adequate clean out openings. Before placing concrete, remove extraneous matter from within forms.

B. Install rigid shoring having no excessive settlement or deformation. Use sound timber in shoring centering. Shim to adjust and tighten shoring with hardwood timber wedges.

C. Design Loads for Horizontal Surfaces of Forms and Shoring: Minimum fluid pressure, 175 pounds per cubic foot; live load, 50 pounds per square foot. Maximum unit stresses: 125 percent of allowable stresses used for form materials and for design of support structures.

D. Back form work with sufficient number of studs and wales to prevent deflection.

E. Re-oil or lacquer liner on job before using. Facing may be constructed of 3/4 inch plywood made with waterproof adhesive backed by adequate studs and wales. In such cases, form lining will not be required.

F. Unless otherwise indicated, form outside corners and edges with triangular 3/4 inch chamfer strips (measured on sides).

G. Remove metal form ties to depth of at least 3/4 inch from surface of concrete. Do not burn off ties. Do not use pipe spreaders. Remove spreaders which are separate from forms as concrete is being placed.

H. Treat facing of forms with approved form coating before concrete is placed. When directed by Project Manager, treat both sides of face forms with coating. Apply coating before reinforcement is placed. Immediately before concrete is placed, wet surface of forms which will come in contact with concrete.

3.02 PLACING REINFORCEMENT

A. Place reinforcing steel accurately in accordance with approved Drawings. Secure steel adequately in position in forms to prevent misalignment. Maintain reinforcing steel in place using approved concrete and hot-dip galvanized metal chairs and spacers. Place reinforcing steel in accordance with CRSI Publication "Placing Reinforcing Bars." Request inspection of reinforcing steel by Project Manager and obtain acceptance before concrete is placed.

B. Minimum spacing center-to-center of parallel bars: 2 1/2 times nominal bar diameter. Minimum cover measured from surface of concrete to face of reinforcing bar unless shown otherwise on Drawings: 3 inches for surfaces cast against soil or subgrade, 2 inches for other surfaces.

C. Detail bars in accordance with ACI 315-18. Fabricate reinforcing steel in accordance with CRSI Publication MSP-1, "Manual of Standard Practice." Bend reinforcing steel to required shape while steel is cold. Excessive irregularities in bending will be cause for rejection.

D. Do not splice bars without written approval of Project Manager. Approved bar bending schedules or placing drawings constitute written approval. Splice and development length of bars shall conform to ACI 318, Chapters 7 and 12, and as shown on Drawings. Stagger splices or locate at points of low tensile stress.

3.03 EMBEDDED ITEMS

A. Install conduit and piping as shown on Drawings. Accurately locate and securely fasten conduit, piping, and other embedded items in forms.

B. Install waterstops as specified in other sections and according to manufacturer's instructions. Securely position waterstops at joints as indicated on Drawings. Protect waterstops from damage or displacement during concrete placing operations.

3.04 BATCHING, MIXING AND DELIVERY OF CONCRETE

A. Measure, batch, mix, and deliver ready-mixed concrete in accordance with ASTM C 94~~, Sections 8 through 11~~. Produce ready-mixed concrete using automatic batching system as described in~~ NRMCA Concrete Plant Standards~~ CPMB 100M-00 - Concrete Plant Standards of the Concrete Plant Manufacturers Bureau, Part 2 - Plant Control Systems.

B. Measure, mix and deliver concrete produced by volumetric batching and continuous mixing in accordance with ASTM C 685~~, Sections 6 though 8~~.

C. Maintain concrete workability without segregation of material and excessive bleeding. Obtain approval of Project Manager before adjustment and change of mix proportions.

D. Ready-mixed concrete delivered to site shall be accompanied by batch tickets providing information required by ASTM C 94~~, Section 16~~. Concrete produced by continuous mixing shall be accompanied by batch tickets providing information required by ASTM C 685~~, Section 14~~.

E. When adverse weather conditions affect quality of concrete, postpone concrete placement. Do not mix concrete when air temperature is at or below 40 degrees F and falling. Concrete may be mixed when temperature is 35 degrees F and rising. Take temperature readings in shade, away from artificial heat. Protect concrete from temperatures below 32 degrees F until concrete has cured for minimum of 3 days at 70 degrees F or 5 days at 50 degrees F.

F. Clean, maintain and operate equipment so that it thoroughly mixes material as required.

G. Hand-mix only when approved by Project Manager.

3.05 PLACING CONCRETE

A. Give sufficient advance notice to Project Manager (at least 24 hours prior to commencement of operations) to permit inspection of forms, reinforcing steel, embedded items and other preparations for placing concrete. Place no concrete prior to Project Manager's approval.

B. Schedule concrete placing to permit completion of finishing operations in daylight hours. However, when necessary to continue after daylight hours, light site as required. When rainfall occurs after placing operations are started, provide covering to protect work.

C. Use troughs, pipes and chutes lined with approved metal or synthetic material in placing concrete so that concrete ingredients are not separated. Keep chutes, troughs and pipes clean and free from coatings of hardened concrete. Allow no aluminum material to be in contact with concrete.

D. Limit free fall of concrete to 4 feet. Do not deposit large quantities of concrete at one location so that running or working concrete along forms is required. Do not jar forms after concrete has taken initial set; do not place strain on projecting reinforcement or anchor bolts.

E. Use tremies for placing concrete in walls and similar narrow or restricted locations. Use tremies made in sections, or provide in several lengths, so that outlet may be adjusted to proper height during placing operations.

F. Place concrete in continuous horizontal layers approximately 12 inches thick. Place each layer while layer below is still plastic.

G. Compact each layer of concrete with concrete spading implements and mechanical vibrators of approved type and adequate number for size of placement. When immersion vibrators cannot be used, use form vibrators. Apply vibrators to concrete immediately after depositing. Move vibrator vertically through layer of concrete just placed and several inches into plastic layer below. Do not penetrate or disturb layers previously placed which have partially set. Do not use vibrators to aid lateral flow concrete. Closely supervise consolidation to ensure uniform insertion and duration of immersion.

H. Handling and Placing Concrete: Conform to ACI 302.1R, ACI 304R and ACI 309R.

3.06 WATERSTOPS

A. Embed waterstops in concrete across joints as shown. Waterstops shall be continuous for extent of joint; make splices necessary to provide continuity in accordance with manufacturer's instructions. Support and protect waterstops during construction operations; repair or replace waterstops damaged during construction.

B. Install waterstops in concrete on one side of joints, leaving other side exposed until next pour. When waterstop will remain exposed for 2 days or more, shade and protect exposed waterstop from direct rays of sun during entire exposure and until exposed portion of waterstop is embedded in concrete.

C. Splicing PVC Waterstops:

1. Splice waterstops by heat-sealing adjacent waterstop sections in accordance with manufacturer’s printed instructions.

2. Butt end-to-end joints of two identical waterstop sections may be made in forms during placement of waterstop material.

3. Prior to placement in form work, prefabricate waterstop joints involving more than two ends to be joined together, angle cut, alignment change, or joining of two dissimilar waterstop sections, allowing not less than 24 inches long strips of waterstop material beyond joint. Upon inspection and approval by Project Manager, install prefabricated waterstop joint assemblies in form work, and butt-weld ends of 24 inches strips to straight- run portions of waterstop in forms.

D. Setting PVC Waterstops:

1. Correctly position waterstops during installation. Support and anchor waterstops during progress of work to ensure proper embedment in concrete and to prevent folding over of waterstop by concrete placement. Locate symmetrical halves of waterstops equally between concrete pours at joints, with center axis coincident with joint openings. Thoroughly work concrete in joint vicinity for maximum density and imperviousness.

2. Where waterstop in a vertical wall joint does not connect with any other waterstop, and is not intended to be connected to waterstop in future concrete placement, terminate waterstop 6 inches below top of wall.

E. Replacement of Defective Field Joints: Replace waterstop field joints showing evidence of misalignment, offset, porosity, cracks, bubbles, inadequate bond or other defects with products and joints complying with Specifications.

F. Resilient Waterstop:

1. Install resilient waterstop in accordance with manufacturer's instructions and recommendations.

2. When requested by Project Manager, provide technical assistance by manufacturer's representative in field at no additional cost to City.

3. Use resilient waterstop only where complete confinement by concrete is provided; do not use in expansion or contraction joints.

4. Where resilient waterstop is used in combination with PVC waterstop, lap resilient waterstop over PVC waterstop minimum of 6 inches and place in contact with PVC waterstop. Where crossing PVC at right angles, melt PVC ribs to form smooth joining surface.

5. At free top of walls without connecting slabs, stop resilient waterstop and grooves (where used) 6 inches from top in vertical wall joints.

6. Bentonite Waterstop:

   a. Locate bentonite waterstop as near as possible to center of joint and extend continuous around entire joint. Minimum distance from edge of waterstop to face of member: 5 inches.

   b. Where thickness of concrete member to be placed on bentonite waterstop is less than 12 inches, place waterstop in grooves at least 3/4 inch deep and 1 1/4 inches wide formed or ground into concrete. Minimum distance from edge of waterstop placed in groove to face of member: 2.5 inches.

   c. Do not place bentonite waterstop when waterstop material temperature is below 40 degrees F. Waterstop material may be warmed so that it remains above 40 degrees F during placement but means used to warm it shall in no way harm material or its properties. Do not install waterstop where air temperature falls outside manufacturer's recommended range.

   d. Place bentonite waterstop only on smooth and uniform surfaces; grind concrete smooth when necessary to produce satisfactory substrate, or bond waterstop to irregular surfaces using epoxy grout which completely fills voids and irregularities beneath waterstop material. Prior to installation, wire brush concrete surface to remove laitance and other substances that may interfere with bonding of epoxy.

   e. In addition to adhesive backing provided with waterstop, secure bentonite waterstop in place with concrete nails and washers at 12 inches maximum spacing.

7. Adhesive Waterstop:

   a. With wire brush thoroughly clean concrete surface on which waterstop is to be placed and then coat with primer.

   b. If surface is too rough to allow waterstop to form complete contact, grind to form adequately smooth surface.

   c. Install waterstop with top protective paper left in place. Overlap joints between strips minimum of 1 inch and cover back over with protective paper.

   d. Do not remove protective paper until just before final form work completion. Place concrete immediately. time that waterstop material is uncovered prior to concrete placement shall be minimized and shall not exceed 24 hours.

3.07 CONSTRUCTION JOINTS

A. Definitions:

1. Construction joint: Contact surface between plastic (fresh) concrete and concrete that has attained initial set.

2. Monolithic: Manner of concrete placement to reduce or eliminate construction joints; joints other than those indicated on Drawings will not be permitted without written approval of Project Manager. Where so approved, make additional construction joints with details equivalent to those indicated for joints in similar locations.

3. Preparation for Construction Joints: Roughen surface of concrete previously placed, leaving some aggregate particles exposed. Remove laitance and loose materials by sandblasting or high-pressure water blasting. Keep surface wet for several hours prior to placing of plastic concrete.

3.08 CURING

A. Comply with ACI 308.1-23. Cure by preventing loss of moisture, rapid temperature change and mechanical injury for period of 7 curing days when Type II or IP cement has been used and for 3 curing days when Type III cement has been used. Start curing as soon as free water has disappeared from concrete surface after placing and finishing. A curing day is any calendar day in which temperature is above 50 degrees F for at least 19 hours. Colder days may be counted when air temperature adjacent to concrete is maintained above 50 degrees F. In continued cold weather, when artificial heat is not provided, removal of forms and shoring may be permitted at end of calendar days equal to twice required number of curing days. However, leave soffit forms and shores in place until concrete has reached specified 28-day strength, unless directed otherwise by Project Manager.

B. Cure formed surfaces not requiring rubbed-finished surface by leaving forms in place for full curing period. Keep wood forms wet during curing period. Add water as needed for other types of forms. Or, at Contractor's option, forms may be removed after 2 days and curing compound applied.

C. Rubbed Finish:

1. At formed surfaces requiring rubbed finish, remove forms as soon as practicable without damaging surface.

2. After rubbed-finish operations are complete, continue curing formed surfaces by using either approved curing/sealing compounds or moist cotton mats until normal curing period is complete.

D. Unformed Surfaces: Cure by membrane curing compound method.

1. After concrete has received final finish and surplus water sheen has disappeared, immediately seal surface with uniform coating of approved curing compound, applied at rate of coverage recommended by manufacturer or as directed by Project Manager. Do not apply less than 1 gallon per 180 square feet of area. Provide satisfactory means to properly control and check rate of application of compound.

2. Thoroughly agitate compound during use and apply by means of approved mechanical power pressure sprayers equipped with atomizing nozzles. For application on small miscellaneous items, hand-powered spray equipment may be used. Prevent loss of compound between nozzle and concrete surface during spraying operations.

3. Do not apply compound to dry surface. When concrete surface has become dry, thoroughly moisten surface immediately prior to application. At locations where coating shows discontinuities, pinholes or other defects, or when rain falls on newly coated surface before film has dried sufficiently to resist damage, apply additional coat of compound at specified rate of coverage.

3.09 REMOVAL OF FORMS AND SHORING

A. Remove forms from surfaces requiring rubbing only as rapidly as rubbing operation progresses. Remove forms from vertical surfaces not requiring rubbed-finish when concrete has aged for required number of curing days. When curing compound is used, do not remove forms before 2 days after concrete placement.

B. Leave soffit forms and shores in place until concrete has reached specified 28-day strength, unless directed otherwise by Project Manager.

3.10 DEFECTIVE WORK

A. Immediately repair defective work discovered after forms have been removed. When concrete surface is bulged, uneven, or shows excess honeycombing or form marks which cannot be repaired satisfactorily through patching, remove and replace entire section.

3.11 FINISHING

A. Patch honeycomb, minor defects and form tie holes in concrete surfaces with cement mortar mixed one part cement to two parts fine aggregate. Repair defects by cutting out unsatisfactory material and replacing with new concrete, securely keyed and bonded to existing concrete. Finish to make junctures between patches and existing concrete as inconspicuous as possible. Use stiff mixture and thoroughly tamp into place. After each patch has stiffened sufficiently to allow for greatest portion of shrinkage, strike off mortar flush with surface.

B. Apply rubbed finish to exposed surfaces of formed concrete structures as noted on Drawings. After pointing has set sufficiently, wet surface with brush and perform first surface rubbing with No. 16 carborundum stone, or approved equal. Rub sufficiently to bring surface to paste, to remove form marks and projections, and to produce smooth, dense surface. Add cement to form surface paste as necessary. Spread or brush material, which has been ground to paste, uniformly over surface and allow to reset. In preparation for final acceptance, clean surfaces and perform final finish rubbing with No. 30 carborundum stone or approved equal. After rubbing, allow paste on surface to reset; then wash surface with clean water. Leave structure with clean, neat and uniform-appearing finish.

C. Apply wood float finish to concrete slabs.

3.12 FIELD QUALITY CONTROL

A. Testing shall be performed under provisions of Section 01454 - Testing Laboratory Services.

B. Unless otherwise directed by Project Manager, following minimum testing of concrete is required. Testing shall be performed by qualified individuals employed by approved independent testing agency, and conform to requirements of ASTM C 1077.

1. Take concrete samples in accordance with ASTM C 172.

2. Make one set of four compression test specimens for each mix design at least once per day and for each 150 cubic yards or fraction thereof. Make, cure and test specimens in accordance with ASTM C 31 and ASTM C 39.

3. When taking compression test specimens, test each sample for slump according to ASTM C 143, for temperature according to ASTM C 1064, for air content according to ASTM C 231, and for unit weight according to ASTM C 138.

4. Inspect, sample and test concrete in accordance with ASTM C 94, Section 13, 14, and 15, and ACI 311.6-18 and ACI 311.7-18~~-5R~~.

C. Test Cores: Conform to ASTM C 42.

D. Testing High Early Strength Concrete: When Type III cement is used in concrete, specified 7-day and 28-day compressive strengths shall be applicable at 3 and 7 days, respectively.

E. If 7-day or 3-day test strengths (as applicable for type of cement being used) fail to meet established strength requirements, extended curing or resumed curing on those portions of structure represented by test specimens may be required. When additional curing fails to produce required strength, strengthening or replacement of portions of structure which fail to develop required strength may be required by Project Manager, at no additional cost to City.

3.13 PROTECTION

A. Protect concrete against damage until final acceptance by City.

B. Protect fresh concrete from damage due to rain, hail, sleet, or snow. Provide protection while concrete is still plastic, and whenever precipitation is imminent or occurring.

C. Do not backfill around concrete structures or subject them to design loadings until components of structure needed to resist loading are complete and have reached specified 28-day compressive strength, except as authorized otherwise by Project Manager.

END OF SECTION

SECTION 04061

MORTAR

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Mortar and grout for masonry.

1.02 RELATED SECTIONS

A. Section 01270 – Measurement and Payment

B. Section 01292 – Schedule of Values

C. Section 01330 – Submittal Procedures

D. Section 01450 – Contractor's Quality Control

E. Section 01454 – Testing Laboratory Services

F. Section 01610 – Basic Product Requirements

1.03 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. No separate payment will be made for mortar under this Section. Include payment in Lump Sum for building or structure with price breakdown included in Schedule of Values.

2. Refer to Section 01270 - Measurement and Payment and Section 01292- Schedule of Values.

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

1.04 REFERENCES

A. ASTM C 143 - Standard Testing Method for Slump of Hydraulic Cement Concrete.

B. ASTM C 144 - Standard Specification for Aggregate for Masonry Mortar.

C. ASTM C 150 - Standard Specification for Portland Cement.

D. ASTM C 207 - Standard Specification for Hydrated Lime for Masonry Purposes.

E. ASTM C 270 - Standard Specification for Mortar for Unit Masonry.

F. ASTM C 404 - Standard Specification for Aggregates for Masonry Grout.

G. ASTM C 476 - Standard Specification for Grout for Masonry.

H. ASTM C 780 - Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry.

I. ASTM C 109 - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars.

1.05 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

B. Include design mix, indicate Property Method used, required environmental conditions, and admixture limitations.

C. Samples: Submit two ribbons of each mortar color, illustrating color and color range.

D. Submit test reports under provisions of Section 01450 - Contractor's Quality Control.

E. Submit test reports on mortar indicating conformance to ASTM C 270.

F. Submit test reports on grout indicating conformance to ASTM C 476.

G. Submit manufacturer's certificate under provisions of Section 01450 - Contractor's Quality Control, that products meet or exceed specified requirements.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site and store and protect products under provisions of Section 01610 - Basic Product Requirements.

B. Maintain packaged materials clean, dry, and protected against dampness, freezing, and foreign matter.

1.07 ENVIRONMENTAL REQUIREMENTS

A. Maintain materials and surrounding air temperatures to minimum 50 degrees F prior to, during, and 48 hours after completion of masonry work.

PART 2 PRODUCTS

2.01 MATERIALS

A. Portland Cement: ASTM C 150, Type I, white color.

B. Masonry Cement: Not permitted.

C. Mortar Aggregate: ASTM C 144, standard masonry type. Grading and color suitable for type of masonry, one source for entire project. (Not less than 5 percent shall pass No. 100 sieve).

D. Hydrated Lime: ASTM C 207, Type S.

E. Grout Aggregate: ASTM C 404.

F. Water: Clean and potable.

2.02 MORTAR COLOR

A. Mortar Color: Mineral oxide pigment; color; to be selected by Project Manager from manufacturer's samples.

2.03 ADMIXTURES

A. Antifreeze: Antifreeze admixtures will not be permitted.

B. Accelerator: Accelerator may be used only with approval of Project Manager.

2.04 MORTAR

A. Mortar for Load Bearing Walls and Partitions: ASTM C 270, Type S utilizing Property Method to achieve 1800 psi strength.

B. Mortar for Non-load Bearing Walls and Partitions: ASTM C 270, Type S utilizing the Property Method to achieve 1800 psi strength.

C. Mortar for Masonry Below Grade or in Contact with Earth: ASTM C 270, Type M utilizing the Property Method to achieve 2500 psi strength.

D. Pointing Mortar: ASTM C 270, Type N, using the Property Method to achieve 750 psi strength.

2.05 MORTAR MIXING

A. Thoroughly mix mortar ingredients in quantities needed for immediate use in accordance with ASTM C 270 to achieve strengths noted in Paragraph 2.04.

B. Add mortar color and admixtures in accordance with manufacturer's instructions. Provide uniformity of mix and coloration.

C. Do not use anti-freeze compounds to lower freezing point of mortar.

D. If water is lost by evaporation, retemper only within 2 hours of mixing.

E. Use mortar within 2 hours after mixing at temperatures of 80 degrees F, or 2 1/2 hours at temperatures under 50 degrees F.

2.06 GROUT

A. Bond Beams, Lintels, and Other Areas to be Grouted Solid: 3000 psi strength at 28 days; 7 to 8 inches slump per ASTM C 143; mixed in accordance with ASTM C 476, Fine Grout.

2.07 GROUT MIXING

A. Thoroughly mix mortar ingredients in quantities needed for immediate use in accordance with ASTM C 476, Fine Grout.

B. Add admixtures in accordance with manufacturer's instructions. Provide uniformity of mix.

C. Do not use anti-freeze compounds to lower freezing point of grout.

2.08 MIX TESTS

A. Test mortar and grout in accordance with Section 01454 - Testing Laboratory Services.

B. Testing of Mortar Mix: Test in accordance with ASTM C 780. Test mortar mix for compressive strength, consistency, mortar aggregate ratio, water content, air content, and splitting tensile strength.

C. Testing of Grout Mix: Test in accordance with ASTM C 109. Test grout mix for compressive strength and slump.

PART 3 EXECUTION

3.01 EXAMINATION

A. Request inspection of spaces to be grouted.

3.02 PREPARATION

A. Apply bonding agent to existing concrete surfaces.

B. Plug clean out holes with masonry units to prevent leakage of grout materials. Brace masonry for wet grout pressure.

3.03 INSTALLATION

A. Install mortar and grout in accordance with manufacturer's instructions.

B. Work grout into masonry cores and cavities to eliminate voids.

C. Do not displace reinforcement while placing grout.

D. Remove grout spaces of excess mortar.

END OF SECTION

SECTION 04210

BRICK MASONRY FOR UTILITY CONSTRUCTION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Brick masonry work in utility construction for permanent or temporary installation of below ground structures.

B. Brick masonry in repair and rehabilitation of utility lines and associated structures.

1.02 RELATED SECTIONS

A. Section 01330 – Submittal Procedures

B. Section 01454 – Testing Laboratory Services

C. Section 02085 – Valve Boxes, Meter Boxes, and Meter Vaults

D. Section 02086 – Adjusting Manholes, Inlets, and Valve Boxes to Grade

E. Section 02087 – Brick Manholes for Storm Sewer

F. Section 02555 – Manhole Rehabilitation

G. Section 02632 – Cast-In-Pace Inlets, Headwalls, and Wingwalls

H. Section 04061 – Mortar

1.03 UNIT PRICES

A. No payment will be made for brick masonry under this Section unless specifically noted in bid documents. Include payment in unit price for applicable utility structure section.

1.04 REFERENCES

A. ASTM C 32 - Standard Specification for Sewer and Manhole Brick (Made from Clay or Shale).

B. ASTM C 55 - Standard Specification for Concrete Building Brick.

C. ASTM C 62 ~~-~~– Standard Specification for Building Brick (Solid Masonry Units Made from Clay or Shale).

D. ASTM C 67 - Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile.

E. ASTM C 91 ~~-~~ – Standard Specification for Masonry Cement.

F. ASTM C 109 - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50 mm] Cube Specimens).

G. ASTM C 140 - Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.

H. ASTM C 270 - Standard Specification for Mortar for Unit Masonry.

1.05 SUBMITTALS

A. Submittals shall conform to requirements of Section 01330 - Submittal Procedures.

B. Submit certification from the manufacturer that brick units meet applicable requirements of reference standards.

C. As an alternate to providing certification, submit test results that show brick units meet applicable requirements of reference standards, when tested by an approved independent testing laboratory. Test result submittals shall be at no cost to the City.

1.06 HANDLING AND STORAGE

A. Handle and store brick to prevent damage.

B. Store brick and mortar mix off the ground and in a dry place. Cover mortar mix to protect from weather.

PART 2 PRODUCTS

2.01 CLAY AND SHALE BRICK MASONRY UNITS

A. Manholes and Structures: Use brick units made from clay or shale conforming to requirements of ASTM C 32, Grade MM, either cored or solid. Units shall have the following physical properties:

1. Compressive Strength: 2200 psi minimum for individual brick; 2500 psi average for five bricks.

2. Size: 2-1/4" by 7-5/8" by 3-5/8".

3. Test Procedure: ASTM C 67.

B. Sewer Brick: Use brick units made from clay or shale conforming to requirements of ASTM C 32, Grade SM, either cored or solid. Units shall have the following physical properties:

1. Compressive Strength: 3750 psi minimum for individual brick; 5000 psi average for 5 bricks.

2. Size: 2-1/4" by 7-5/8" by 3-5/8".

3. Test Procedure: ASTM C 67.

2.02 CONCRETE BRICK MASONRY UNITS

A. Manholes and Structures: Conform to requirements of ASTM C 55, grade S-1.

B. Dimensions: 2-1/4" by 7-5/8" by 3-5/8".

2.03 MORTAR

A. Provided mortar conforming to the requirements of Section 04061 - Mortar.

PART 3 EXECUTION

3.01 EXAMINATION

A. Ensure that foundations and other surfaces to support brickwork are at proper grades and elevations. Correct improperly prepared surfaces. Work surfaces and masonry shall be free of dirt, grease, oil, or other harmful materials before starting brick masonry work.

3.02 WEATHER REQUIREMENTS

A. Lay no masonry when temperature of outside air is below 50 F, unless satisfactory means are provided to heat materials and protect work from cold and frost.

B. Maintain mortar at 50 F or above and ensure that mortar will harden without freezing.

3.03 BRICK PLACEMENT

A. Use sewer brick where exposed to flow. Where not exposed to flow, use manhole brick.

B. Lay sewer brick with the 2-1/4" by 7-5/8" side exposed to flow.

C. Lay manhole bricks so that in every fifth course the long axis of bricks are perpendicular to the long axis of the four preceding courses.

D. Lay curved courses, and courses in different planes, using bonded and keyed construction.

E. Lay brick plumb and true with courses level and uniformly spaced. Adjust the bond of face brick so that no course will terminate with a piece less than one-half length of brick.

F. Dampen brick prior to placement.

G. Where fresh masonry joins partially set or totally set masonry, clean surfaces of set masonry. Remove loose mortar and brick. Wet brick to obtain the best possible bond.

H. Immediately remove mortar droppings and splashing as work progresses to facilitate final cleaning.

3.04 JOINTS

A. Completely fill joints in brick and other materials with mortar as each course is laid.

B. Make joints in exposed brickwork a uniform 3/8-inch wide, unless otherwise shown on Drawings.

C. When mortar is "thumbprint" hard, tool exposed joints with a round or other suitable jointer that is slightly larger than width of the mortar joint. In tooling, make sure that cracks and crevices are closed.

D. Point holes in exposed masonry. Cut out defective joints and repoint.

3.05 FIELD QUALITY CONTROL

A. Testing will be performed under provisions of Section 01454 - Testing Laboratory Services.

B. A minimum of one set of mortar samples shall be molded for each day's placement as directed by Project Manager. Mold three 2-inch cube specimens. One cube will be tested for compressive strength at 7 days and 2 cubes will be tested for compressive strength at 28 days in accordance with ASTM C 109.

C. Each load of bricks delivered to the jobsite shall be tested.

1. Test clay bricks in accordance with ASTM C 67.

2. Test concrete bricks in accordance with ASTM C 140.

END OF SECTION

THE FOLLOWING ITEMS SHOULD BE CHECKED FOR COORDINATION DURING DESIGN:

****
A. Coordinate this specification with other related specifications including the following related Sections.
****

RELATED SECTIONS
Section 02087 - Brick Manholes for Storm Sewers.
Section 02632 - Cast-in-Place Inlets, Headwalls, and Wingwalls.
Section 02085 - Valve Boxes, Meter Boxes, and Meter Vaults.
Section 02086 - Adjusting Manholes, Inlets, and Valve Boxes to Grade.
Section 02555 - Manhole Rehabilitation.