

Special Specification 7213

Sanitary Sewer Systems



1. DESCRIPTION

This Item will govern for furnishing new materials and installing sanitary sewer systems shown on the plans.

2. TABLE OF CONTENTS

ARTICLE	PAGE
3. EXCAVATION, INSTALLATION AND BACKFILL	1
4. SANITARY SEWER FACILITIES	3
5. HORIZONTAL DIRECTIONAL DRILLING	23
6. BORING AND TUNNELING	32

3. EXCAVATION, INSTALLATION, AND BACKFILL

3.1. **Pipe Installation.** Install pipes true to lines and grades as indicated on the plans. Inspect all pipe and fittings before placing in the trench. Clean all joint surfaces and soiled materials before connecting one another. As work progresses, maintain interior of pipes clean.

3.1.1. Standard Cover. Standard cover depends on the sanitary sewer main size and installation conditions and is generally

- 6 through 12 in. diameter Main: Minimum of 4 ft. cover from top of pipe to finished grade
- Crossing under proposed storm sewer: Minimum of 2 ft. cover from top of pipe to bottom of proposed storm sewer.

3.1.2. Potholing. Existing utilities shown on plans are for informational purposes only. Before new pipe installation, pothole all existing utilities and structures to confirm their location, depth, and size. In the event of conflict or discrepancy that affects the project design, notify the Engineer before proceeding with pipe installation to formulate a solution.

3.1.3. Pipe Zone Embedment. Unless otherwise specified or shown on the plans, embed pipelines either Class I, II, or III material defined in this Article 3.1.8 and installed as described. Native or imported material for embedment may be used provided material conforms to this Specification.

Place embedment materials in lifts not exceeding 8 in. loose depth. Unless otherwise specified or directed in writing, provide homogenous material in the embedment zone

Place bedding to provide uniform and adequate longitudinal support under the pipe. Place the first lift of bedding material from the bottom of the trench to slightly above the bottom of the pipe grade. Unless

otherwise shown on the plans, provide a minimum bedding of 4 in. in depth for pipe sizes 30 in. and smaller, and 6 in. for pipe sizes greater than 30 in.

Install material true to line and grade with bell holes of ample dimension to permit pipe to rest on the full length of the barrel and to permit joint make-up and coating application at joints. Consolidate and compact the bedding material as described in Article 6, and lay pipe to indicated grade.

Place a second lift, and if required, subsequent lifts, of embedment material to the springline of pipe. This process is defined as haunching. Slice material under the haunches of the pipe, carefully filling all voids, and using care to prevent movement of the pipe.

Place Initial Backfill using a third lift from the springline of the pipe to the pipe crown, and a fourth lift from the pipe crown to a point 12 in. above the pipe.

- 3.1.4. Groundwater Installation. In areas where the pipe is installed below existing or future ground water levels, use Class I material throughout the pipe zone and enclose with a layer of approved geotechnical filter fabric. Place fabric carefully along the bottom of the trench and up the side of the trench an enough distance to lap over the top of the completed pipe installation. Lap fabric a minimum of 3 feet in the longitudinal at the end of one roll and beginning of the next, and lap 2 feet in the transverse at the top of pipe, except that for trench widths greater than 3 feet measured at the top of pipe, the top overlap will be 3-feet. Follow manufacturer's recommendations for installation. Provide fabric that is either Mirafi 140N, Dupont Typar 3401, or approved equal.
- 3.1.5. Embedment Class Schedule. Unless otherwise shown on the plans, use the Utility Standard Embedment Class designations for the pipe material types listed in this Article to define each particular pipe's Embedment Condition allowed. Examine the detail drawings for additional information or other special bedding requirements.
- 3.1.6. Consolidation Methods in Embedment Zone. Compact embedment backfill by equipment that is suitable for the type of soil encountered, and is capable of producing the degree of compaction specified. Where applicable, provide backfill materials that is moisture conditioned to produce the required degree of compaction.
- Do not use flooding or jetting methods for compaction of embedment material.
- Use hand or mechanical tamping to compact Class II or III material used in bedding, haunching, and initial backfill, except that the use of mechanical tampers or vibratory compactors directly over the pipe in the embedment area is prohibited. Exercise caution in the use of mechanical compactors in the haunch and initial backfill to 12 in. above the pipe to avoid damaging or misaligning the pipe.
- 3.1.7. Pipe Zone and Backfill. Classify materials according to the Unified Soil Classification System as defined in ASTM D-2487.
- 3.1.8. Class I Material. Provide manufactured angular, well-graded, crushed stone per ASTM D-2321, 1/4 in. to 3/4 in. size material. Acceptable materials under this class designation are: ASTM D-448 - Stone Sizes 4, 67, 5, 56, 57, and 6. Pea Gravel and other uniformly graded material are not acceptable under this class.

Class II Material. Provide coarse sands and gravels per ASTM D-2487 with maximum particle size of 3/4 in., including variously graded sands and gravels, containing less than 5 percent fines (material passing the #200

sieve) generally granular and non-cohesive, either wet or dry. Soil Types GW, GP, SW and SP are included in this class.

Class III Material. Provide fine sand and clayey (clay filled) gravels, per ASTM D 2487, including fine sands, sand-clay mixtures, and gravel-clay mixtures. Class III includes soil Types GM, GC, SM and SC.

Do not use Class IV or V material, as defined in ASTM D-2487, for embedment of flexible pipe.

- 3.1.9. **Compaction and Testing of Pipe Embedment Zone.** Class I material used in the embedment zone may be placed by loose dumping with a minimum of compactive effort, exercising care to assure proper placement of material under the pipe haunches.

Class I material does not specifically require testing unless directed, in which case, such test will be measured by ASTM D-4254 by percent of relative density.

Compact Class II material used in the embedment zone to a density of not less than 90% of Standard Proctor Density defined by ASTM D-698.

Compact Class III material used in the embedment zone to a density of not less than 90% of Standard Proctor Density defined by ASTM D-698.

Do not exceed a moisture content of 3% over the optimum in Class II or III material to assure proper compaction.

Unless otherwise directed, one compaction test in the embedment zone for Class II or III material will be taken at 200 feet intervals along the trench on either side of the pipe, or at any other intervals as may be judged warranted by questionable installation conditions. For pipe sizes 8 in. to 12 in. diameter, perform the first test on the side level with the top of pipe. For sizes 15 in. and larger, perform the first test at the springline of the pipe. For all sizes, perform the second test at the top of the embedment zone.

- 3.1.10. **Density Control and Laboratory Testing.** Unless otherwise specified, reference to "maximum dry density" means maximum density defined by ASTM D-1557 or D-698. Determination of density of backfill in-place, will be in accordance with the requirements of ASTM D-2922.

Unless otherwise specified, the Engineer selects a soils testing laboratory to perform initial density testing of in-place backfill and Contractor is responsible for all density testing of backfills, including tests found not to be within the minimum requirements of the specifications.

Provide laboratory materials testing, including but not limited to determination of Atterberg Limits, Proctor Curves, Grain Size Analysis, as well as laboratory certification of manufactured materials and as required by this Article

Notify the soils testing laboratory and the Engineer 24 hr. in advance to obtain soil density tests to fulfill the compaction requirements.

3.2. **Measurement**

- 3.2.1. **Excavation and Backfill.** This Item will not be measured individually and is subsidiary to the installation of the various water mains, sanitary sewer mains, and related appurtenances.

- 3.2.2. **Cement Stabilized Backfill** . Unless shown on the plans as a pay item, quantities shown are for informational purposes. When specified as a pay item, this Item will be measured by the cubic yard as shown under Item 400, "Cement Sand".
- 3.3. **Payment**. The work performed and the materials furnished in accordance with this Article will not be measured or paid for individually as it is considered subsidiary to the various bid items for water main, including related appurtenances, such as all excavation, bedding, backfill for pipe zone (embedment), final backfill, compaction and compaction testing. Associated dewatering is subsidiary to the different materials and sizes of water mains, steel casings, valves, fittings and appurtenances, and service installation, including but not limited to excavation, embedment and final backfill.

4. **SANITARY SEWER FACILITIES**

- 4.1. **Description**. Furnish all labor, materials, equipment and incidentals required and install sanitary sewer systems and adjustments as shown on the plans and as specified.

Verification of Utilities. The data furnished on the plans regarding the size and location of utility lines has been obtained from field surveys and the various utility companies. Verify the location of all utilities before commencing sewer construction. Perform all work within public right of way. Do not extend into or encroach upon private property including basements, residences, and places of business.

Coordination with City. Coordination with City and Nacogdoches County Municipal Utility District No. 1 (M.U.D.) is required for sewer line tie-ins and bypassing, where indicated in the specifications and on the plans.

Water Main Crossing. Where gravity or force main sewers are constructed in the vicinity of water mains, ensure that the most current requirements of the Texas Commission on Environmental Quality (TCEQ) are met.

- 4.2. **Materials**.

- 4.2.1. **Polyvinyl Chloride (PVC) Flexible Pipe**. These standard specifications designate the requirements for furnishing and installing PVC pipe for sanitary sewage, with a standard dimension ratio (SDR) as shown on the plans and/or specified herein. Furnish all materials, equipment, tools, labor, superintendence, and incidentals required for the complete construction of the work designated.

Quality Assurance. Color code all PVC pipe "GREEN" to provide positive identification and prevent accidental damage to or interruption of the sanitary sewer facilities. Only provide pipe manufactured in the United States of America. Provide new materials including all pipe, fittings, and accessories. Perform manufacturer's physical and chemical tests according to the ASTM standard applicable to the respective PVC pipe type and diameter herein specified, to demonstrate pipe quality.

Submittals. Submit documentation on pipe products, fittings, and related materials as may be required by the Contract documents or the Engineer. Review all submittals before submission. Submit in a timely manner so as not to delay the project. Allow enough time for the Engineer's review and resubmission, if necessary. Include certifications from manufacturer that the product complies with appropriate ASTM standards.

Standards. Comply with applicable following requirements:

- ASTM D-1784 Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
- ASTM D-2321 Specification for Underground Installation of Flexible Thermoplastic Sewer Pipe
- ASTM D-2241 Specification of Poly(Vinyl Chloride) (PVC) Pressure-Rated (SDR Series)
- ASTM D-3034 Specification for Type PSM Poly (Vinyl Chloride) (PVC) Large Diameter Plastic Gravity Sewer Pipe and Fittings
- ASTM D-3212 Joints for Drain and Sewer Pipes Using Flexible Elastomeric Seals
- ASTM F-477 Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
- ASTM F-679 Specification for Poly (Vinyl Chloride) (PVC) Large Diameter Plastic Gravity Sewer Pipe and Fittings
- ASTM F-789 Specification for Type PS-46 Poly (Vinyl Chloride) (PVC) Plastic Gravity Flow Sewer Pipe and Fittings
- ASTM F-794 Specification for Poly (Vinyl Chloride) (PVC) Large Diameter Ribbed Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter
- AWWA C-900 Specification for Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings
- AWWA C-110 Specifications for Ductile-Iron and Gray-Iron Fittings

Delivery and Storage. Inspect pipe, fittings, and accessories upon delivery and during progress of the work. Any material found defective will be rejected. Remove rejected material promptly from site.

Replace, at no additional cost to Department, any material found to be defective in manufacture or damaged.

Unload at point of delivery all pipe, fittings, and other accessories, haul to and distribute at the worksite. In loading and unloading, lift materials by hoists or rolled on skidways so as to avoid shock or damage. Do not incorporate materials that have been dropped into the work. Do not skid or roll pipe handled on skidways against pipe already on the ground.

Do not store PVC pipe outside exposed to prolonged periods of sunlight. Any discoloration of pipe due to such exposure is an indication of reduced pipe impact strength, and will be enough cause for rejection of the pipe. Remove rejected all pipe from the jobsite.

- 4.2.1.1. Pipe Schedule. All PVC gravity sewer pipe and fittings must meet and/or exceed all of the requirements of ASTM D-3034 for pipe sizes 4-in. thru 15-in. and ASTM F-679 for pipe sizes 18-in. thru 27-in., unless otherwise noted on the plans or on the Bid Form. Pipe and fittings must have an integral bell with elastomeric seal joints. All PVC pressure rated sewer pipe and fittings must meet and/or exceed all of the requirements of ASMT D-2241 for pipe sizes 4-in. thru 12-in. and/or AWWA C-900 for pipe sizes 4-in. thru 12-in. Underground Utility Locator System (For Forcemain Only).

Tracer Wire: Tracer wire must be 12 gauge minimum solid copper clad steel with minimum 30 mil HDPE thermoplastic insulation recommended for direct burial. Tracer wire will have a minimum break load of 380 pounds. THNN Nylon Thermoplastic insulated solid or stranded copper wire is **NOT** permitted. Tracer wire for open ditch installations should be Copperhead HS-CCS HDPE 30 MIL or approved equal. Tracer wire for boring installations should be Copperhead SoloShot EHS-CCS HDPE 45 MIL or approved equal.

Wire Connectors: Wire connectors should be Copperhead Snakebite, or approved equal, suitable for underground service and must be watertight to provide electrical continuity. Electrical wire nut connectors or taped twisted wire splices are **NOT** permitted.

Fiberglass Utility Markers: Fiberglass utility markers should be Carsonite CRM, or approved equal.

Construction.

- Tracer wire will be installed on all waterlines. The wire will be installed in such a manner as to be able to properly trace all mains without loss or deterioration of signal or without the transmitted signal migrating off the tracer wire.
- Tracer wire must be installed in the same trench and inside bored holes and casing with pipe during installation. It must be secured to the pipe as required to ensure that the wire remains adjacent to the pipe. The tracer wire must be securely bonded together at all wire joints with an approved watertight connector to provide electrical continuity and it should be accessible at all tracer wire access points.
- At the point of connection between ductile iron water mains and non-iron water mains, the tracer wire must be properly connected to the ductile iron water main with a cad weld of approved equivalent. Tracer wire welds must be completely sealed through the use of an approved mastic type sealer specifically manufactured for underground use. Mastic should be applied in a thick coat a minimum of 2 in. thick and must be protected from contamination by the backfill material with the use of a plastic membrane.
- Tracer wire should be laid flat and securely affixed to the pipe at 10 ft. intervals at the springline of the pipe. The wire must be protected from damage during the execution of the works. No breaks or cuts in the tracer wire or tracer wire insulation must be permitted. At water service saddles, the tracer wire shall not be allowed to be placed between the saddle and the water main.
- Except for approved splice-in connections, tracer wire will be continuous and without splices from each tracer wire access point.
- At all utility main end caps, a minimum of 6 feet of tracer wire must be installed beyond the end of the pipe, coiled and secured for future connections.
- Spliced connections between the main line tracer wire and branch connection tracer wire shall only be allowed at tees, crosses or at iron or copper services where a portion of the branch connection or service is replaced with a non-iron or non-copper material. The branch connection tracer wire shall be a single tracer wire properly connected to the main line tracer wire without cutting the main line tracer wire by means of a Copperhead DryConn Direct Bury Lug or approved equal. Where the existing branch connection is neither iron nor copper, then the new branch connection tracer wire must be properly spliced to the existing tracer wire on the branch connection using approved connectors as noted above.
- Fiberglass utility markers must be installed at all mainline valves, air valves, and flush valves, and at all horizontal bends. Markers should also be placed at each end of all road and railroad crossings. Each marker must have a label in accordance with the plan details.

Joints. Joints must be rubber ring sealed and must allow for thermal expansion and contraction joint assemblies must be capable of withstanding a one (1) hour 25 psi internal hydrostatic test with no

leakage. Joints must meet requirements of ASTM 03212. Rubber gaskets must be "Fluid-Type", "Ring-Tite", or equal and must be marked to indicate nominal pipe size and proper insertion direction. Gaskets must meet requirements of ASTM F477 and manufacturing tolerances of Rubber Manufacturers Association. Lubricants for joint components must have no deteriorating effect on gasket or pipe material, as recommended by pipe manufacturer.

Pipe Materials. Provide pipe and fittings made from polyvinyl chloride compounds that comply with the requirements for minimum cell classification defined by ASTM D-1784. Provide PVC fittings, service risers, and laterals with a SDR 26 rating.

Force Main Valves. Provide non-rising stem (NRS) gate valves that are resilient seated, non-rising stem and have a minimum rated gauge working pressure of 200 psig that comply with AWWA C-509 "Resilient-Seated Gate Valves for Water Supply Service" and AWWA C-550 "Protective Interior Coatings for Valves and Hydrants". Valve designed with recesses, insets in the bottom of the waterway that would promote build-up or collection of residue and debris are not acceptable. Provide NRS Gate Valves the size specified. Acceptable manufacturers are listed:

- American Darling
- M&H
- US Pipe
- Mueller

Submittals. Provide records of all tests performed in accordance with Section 5.1 of AWWA Standard C-509 along with an affidavit and certificate of testing for the valve assembly as outlined in Section 6.3 of AWWA Standard C-509.

Markings. Cast markings on the bonnet or body of each valve. Include the manufacturer's name or mark, the year the valve casting was made, the size of the valves, and the designated working pressure.

Valve Ends. Provide mechanical joint or flanged ends as specified.

Valve Body and Bonnet. Provide in cast iron conforming to ASTM A-126 Class B, or ductile iron conforming to ASTM A-395 or ASTM A-536.

Bolts. Provide all bonnet and seal plate bolts that are factory installed and made from stainless steel ASTM A-276 with either regular-square or hexagonal heads with dimensions conforming to ANSI B18.2.1.

Gate. Manufacture in ASTM A-126 Class B Cast Iron, ASTM A-395/A-536 Ductile Iron, or ASTM B-763 Copper Alloy No. C99500. Resilient seats must be bonded or mechanically attached to the gate.

Valve Stem. Construct of low zinc bronze CDA Copper Alloy No. C99500 with a minimum yield strength of 40,000 psi and minimum elongation in 2 in. of 10%. Minimum number of turns to open is three times the valve diameter.

Stem Seals. Provide two O-rings such that the seal above the stem collar can be replaced with the valve under pressure in the fully open position meeting the requirements of ASTM D-2000 and have physical properties suitable for the application.

Valve Operator. Provide a cast iron, ASTM A-126 Class B, wrench nut that has a 2 in. square base, a 1 15/16 in. square top and 1 3/4 in. high, opening counterclockwise (left). Paint wrench nut black with and cast an arrow indicating direction of opening in accordance with AWWA C-509.

Protective Coating. Apply an epoxy coating to all exterior and all stationary interior ferrous surfaces including all interior openings in the valves body in accordance with AWWA C-550 and with a minimum dry film thickness of 8 mils. After the coating is completely cured, test coated surface for porosity, holidays, and pinholes using a holiday detector. Repair all holidays or irregularities and test the coating again. Do not apply coating to the gasket surfaces of the end flanges.

Valve Boxes. Provide a cast-iron valve box for all underground valves. The boxes shall be cast-iron, tow piece screw type with a shaft diameter of not less than 5-1/4 in. and shall have the word "SEWER" stamped on the lid.

Provide extension stem for all buried valves terminating in a standard 2-in. square AWWA nut within four feet of valve box cover.

The valve box shall not transmit shock or stress to the valve and shall be centered over the operating nut of the valve. The box cover shall be set flush with the surface of the finished area or other such level as directed.

Force Main Fittings. Provide ductile iron (DI) fittings for use with ductile iron and polyvinyl chloride (PVC) for water pressure or transmission pipe that are smooth cement lined in accordance with AWWA C-104 and outside asphaltic coated per AWWA C-110. The size, body type, type of joint ends, and applicable reference standard are shown on plans or are specified.

Standards. Comply with the following applicable requirements:

ANSI B16.1 "Cast Iron Pipe Flanges and Fittings"

AWWA C-104 "Cement-Mortar Lining for Ductile-Iron Pipe and Fittings"

AWWA C-105 "Polyethylene Encasement for Ductile Iron Pipe Systems"

AWWA C-110 "Ductile-Iron and Gray-Iron Fittings"

AWWA C-111 "Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings "

AWWA C-153 "Ductile-Iron Compact Fittings"

Minimum Requirements. Apply minimum requirements of shown Table 10 to the specified fittings.

Table 10.
Standard Short-Body Fittings per AWWA C-110

TYPE OF JOINT	DIAMETER	RATE WORKING PRESSURE	MATERIAL
Mechanical (Rubber Gasket/C-111)	4-24 in.	350 psi	DI
Mechanical (Rubber Gasket/C-111)	30-48 in.	250 psi	DI
Flanged	4-48 in.	250 psi	DI

Provide all joint accessories such as gaskets, glands, bolts, and nuts with mechanical joints in enough quantity for assembly of each joint.

Provide polyethylene wrapped fittings in accordance with AWWAC-105.

Provisions for Thrust. Block all underground piping with concrete, bearing solidly against undisturbed trench walls, at all changes in direction, fittings, and valves subsidiary to the installation of fittings, valves, and all other appurtenances requiring provisions for thrust restraint.

Place concrete blocking against undisturbed trench walls with a minimum 18 in. between trench wall and pipe. Extend blocking a minimum of 0.75 times pipe diameter below and above the centerline of pipe and do not extend beyond any joints. Place blockings in accordance with the recommendations of "Thrust Restraint Design for Ductile Iron Pipe" published by the Ductile Iron Pipe Research Association and according to details shown on the plans.

If directed, contain the ends of the thrust blocks in wood or metal forms as provided for under Item 420, "Concrete Structures". Where upward thrusts are to be resisted, reinforce concrete anchor with reinforcing conforming to the provisions of Item 440, "Reinforcing Steel".

Use Class A concrete used for blocking in accordance Item 421, "Portland Cement Concrete" and Table 12 depicting the minimum area of concrete bearing against undisturbed trench bank. The information in Table 12 is based upon internal test pressure of 100 psi and soil bearing capacity of 1,000 psf. Concrete shall not be placed in a manner that interferes with the removal of any joint accessories.

Table 12.
Bearing Surface Per Bend

PIPE SIZE	TEE, DEAD END, 90 DEGREE BEND	45 AND 22-1/2 DEGREE BEND	TEES AND PLUGS
6 In.	6 sq. ft.	3 sq. ft.	3.9375 sq. ft.
8 In.	9.625 sq. ft.	5 sq. ft.	6.5 sq. ft.
10 In.	13.75 sq. ft.	7.5 sq. ft.	10 sq. ft.
12 In.	19.5 sq. ft.	11 sq. ft.	14.625 sq. ft.

Install mechanical joint restrainers as specified that are manufactured by EBAA Iron, Uni-Flange or approved equal.

NOTE: At connection of new force main to existing main, both concrete thrust blocking in accordance with this Specification and thrust restraint devices must be used, regardless of main size.

Thrust restraint devices must be used for enough distance from each bend or other fitting to resist thrust which will be developed at the test pressure of the pipe. For the purposes of thrust restraint, test pressure will be 50 psi greater than the design working pressure indicated. Length of pipe with restrained joints to resist thrust forces will be determined by pipe manufacturer.

Steel Casing Pipe. Encasement pipe shall conform to all requirements set forth in ASTM A139 for welded steel pipe, Grade A and be of the diameter and wall thickness as specified on the Plans. Any variation of diameter and wall thickness, as required for various types of carrier pipe, shall be approved by the Engineer before installation. Casing spacers shall be Raci type or approved equal as shown on the Plans. End seals shall be minimum 1/8" thick synthetic rubber with stainless steel bands. Other methods of sealing the end of the encasement pipe shall be constructed only upon pre-approval by the Engineer. Carrier pipes shall conform to all requirements set forth in this specification and be of the diameter and as specified on the Plans.

Pipe Trenching, Installation and Backfill. Except as noted, Pipe Trenching, Installation and Backfill of PVC gravity sewer pipe will be in accordance with ASTM D-2321 and Article 6 of this specification.

- Trench Width: Minimum trench width shall equal the outside pipe diameter plus one foot
- Pipe Installation: Following the preparation of the trench bottom and trench bracing installed where required, proceed up grade with spigot ends pointing down grade. Lay pipe true to lines and grades as shown on plans. Grade may be established by laser beam, or batter boards (not exceeding 50 ft. intervals), and string line may be used with each pipe set to grade, from the string line, with a grade rod equipped with a "shoe" designed to fit into the flow line of the pipe

Testing. Inspect PVC and test for leakage and deflection in accordance with Article 4.3.3.

- 4.2.1.2. **Pipe Service Identification Colors.** The pipe service identification color for the exterior shell must be, green for pipes used as sanitary sewer, (gravity or force mains), and lavender (shade Pantone 522 or approved equal) for pipes used to carry recycled water. The coloring agent used must be resistant to the effects of sunlight and must allow the color to be stable for a period of at least six months in full sunlight.
- 4.2.2. **Cutting and Restoring Pavement.** Where sewer facilities must be installed in streets or other paved areas beyond limits of the roadway improvements, the work includes saw-cutting of the pavement and base to neat lines and prompt replacement of these materials after water excavation and backfill are completed. The replacement materials, as to type and thickness, are shown on the plans.
- 4.3. **Sanitary Sewer System.** Furnish labor, materials, equipment and incidentals to install sewer service lines as indicated on the plans.
- 4.3.1. Sewer Service Connections.

Materials. Conform to the material requirements of the City. Fittings, service risers, and laterals are as specified for the material type used. Where additional service connections are required on an existing main line, install an approved service saddle compatible to the size and type of both the collection line and service lateral. Encase saddles with Class B (2500 psi) concrete where PVC saddles with rubber seals and stainless steel bands are used in accordance with Department Standards to protect the steel bands from corrosion and to add stability.

Tees and Riser. Install tee or wye fittings for future house service connections. Use bell-type fittings and seal on the branch outlet with an approved plug that can be easily removed for service riser or lateral line installation.

Where ground water is encountered, install the tee and enough service line RISER, thereby raising the final bell above the ground water level. In deep trenches, extend the RISER to the depth of the intersecting service line, or to within 6 feet of the surface, whichever is designated on the plans or appropriate for field conditions.

Service Connections and Laterals. Provide new sewer service laterals and re-connections of all existing sewer service laterals to new lines installed to replace lines to be abandoned where required on the plans. Verify location of laterals indicated on the plans and ensure service is not interrupted to homes or other establishments.

The service must be completely and functionally tied into the customers sanitary plumbing and must include all fittings and clean-outs. A four-inch clean-out must be installed at each connection to an existing service. Service line cleanouts must have a 4-in. threaded plug installed flush with the ground surface. Services must be reconnected to the mains immediately upon completion and acceptance of pressure testing. In no case must any service be left unconnected overnight. Use proper specials and fittings to suit the actual conditions for connections between new work and existing work, where required. When it is necessary to interrupt service to existing facilities to make connection to an existing line, connections may need to be made at some time other than during normal working hours at no additional cost to the Department.

Install new services lines at a minimum slope of 2.08 (1/4" per foot) percent. Uniformly support service pipe on bedding having a density of not less than 90% of maximum density per ASTM D-1557. Carefully place and compact backfill on service lines in accordance with the requirements of Article 6.3.4. Plug the terminus of the service line with an approved universal end cap compatible with the pipe size and material.

4.3.2.

Manhole Structures. Furnish all labor, materials, equipment and incidentals necessary to provide all manholes as required. Provide manholes for the various sized lines as listed.

Quality Assurance. Provide manholes free of visible leakage and test each structure for leaks. Repair all leaks in a manner subject to approval.

Submittals. Provide complete manufacturer's shop drawings on the manhole section(s), to include the joints, for approval. Revise shop drawings that do not meet specifications and re-submit approval. Include manufacturer's specification data and recommendations on the lifters and joint material. Submit documentation of compliance with ASTM C-478. Failure to provide either the detailed shop drawings, specification data and recommendation on lifters and joint material, or the letter certifying that all material provided meets specification is enough grounds to reject material.

Standards. Comply with the following applicable requirements:

- ASTM A-48 Specification for Gray Iron Castings
- ASTM A-82 Specification for Steel Wire, Plain, for Concrete Reinforcement
- ASTM A-185 Specification for Steel Welded Wire, Fabric, Plain, for Concrete Reinforcement
- ASTM A-615 Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement

- ASTM C-33 Specification for Concrete Aggregates
- ASTM C-144 Specification for Aggregate for Masonry Mortar
- ASTM C-150 Specification for Portland Cement
- ASTM C-309 Specification for Liquid Membrane-Forming Compounds for Curing Concrete
- ASTM C-478 Specification for Pre-cast Reinforced Concrete Manhole Sections
- ASTM C-923 Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures and Pipe
- ASTM D-1557 Test Methods for Moisture-Density Relations of Soils and Soil Aggregate Mixtures Using 10-lb (4.54-kg) Rammer and 18-in (457-mm) Drop

4.3.2.1. Manhole Structure Materials.

Frame and Cover: Provide manhole frame and cover of cast iron of the weight, dimensions, and pattern indicated by the City Standard Details with self sealing ring and cover (400 lb ring and cover) – East Jordan Iron Works Cover EJIW No. V1430C DI with City of Nacogdoches Logo (ring EJIW No. V1430C DI). Provide casting made from superior quality, gray cast iron conforming to the requirements of ASTM A-48 with no holes in the cover, but edge notches for embedded rings used for lifting. Machine mating surfaces to assure a snug fit of the cover and frame.

Manhole Rings. Provide manhole rings used for a maximum 2 ft. final grade in conformance to the applicable requirements of ASTM Specifications C-32, Grade MS.

Cement. Provide Portland Cement conforming to ASTM Specifications C-150, Type V.

Mortar Sand. Provide mortar sand conforming to ASTM Specifications C-144.

Concrete Aggregates. Provide concrete aggregates conforming to ASTM Specifications C-33 except that the requirement for gradation will not apply to concrete manhole conical and riser sections.

Steel Reinforcement. Provide billet-steel bars conforming to ASTM Specifications A-615 and welded steel wire fabric conforming to ASTM Specifications A-82 or to ASTM Specifications A-185.

Water. Provide water that is clean, clear, free from oil, acid or organic matter and injurious amounts of alkali, salts or other chemicals or deleterious materials.

Mortar. Provide mortar that is composed of 1 part Portland Cement Type V and 3 parts mortar sand mixed in an approved manner with water to form a workable mixture.

4.3.2.2.

Pre-Cast Concrete Manholes. Design manhole riser and conical section for sewer and water installations in the diameters specified or shown. Provide all manhole sections with 5 in. wall thickness and tongue and groove, unless otherwise specified. Rings will be available in various lengths from one foot to four feet. Design the conical sections to be concentric and adapted to the ring at one end and standard cast iron frame at the other. Provide the base ring with a flat bottom joint. Steps or rungs are not required. Manufacture manhole section(s) in conformance with ASTM C-478 and any additional specifications listed here forth.

Concrete. Concrete to have a minimum 28 days compressive strength of 4000 psi. Water cement ratio to be 0.5 or less by weight or not more than 5.5 gallons per sack.

Aggregates. Conform to specifications outlined by ASTM C-33 except for lightweight aggregate. Aggregates will be free of deleterious substances causing reactivity with oxidized hydrogen sulfide. Grade both types of aggregates to produce a homogeneous concrete mix. Accurately weight all materials at a central batching facility for mixing.

Cement. Provide Portland Cement conforming to ASTM C-150, Type V (sulfate resistant) for sewer applications and enough to produce a minimum strength of 4,000 PSI, or other design strengths required.

Placing. Handle all concrete from the mixer or transport vehicle to the place of final deposit in a continuous manner, as rapidly as practicable, and without segregation or loss of ingredients, until (the approved unit operation) is completed. Place concrete in layers not to exceed two feet deep. Compact each layer by mechanical internal or external vibrating equipment. Limit duration of the vibration cycle to the time necessary to produce satisfactory consolidation without causing objectionable segregation.

Quality Assurance. The Engineer reserves the right to inspect the manufacturing process at any time to make tests on materials used, and to have cores cut out of the completed manholes for compressive strength testing and placement of reinforcement.

Curing. For purposes of early re-use of forms, the concrete may be heated in the mold after the initial set has taken place. Do not exceed a temperature of 160° and raise from normal ambient temperature at a rate not to exceed 40° per hour. Do not remove the cured unit from forms until enough strength is obtained for the unit to withstand any structural strain that may be subjected during the form stripping operation. After the stripping of forms, further curing by means of water spraying or a membrane curing compound of a clear or white type, conforming to ASTM C-309-58 may be used.

Steel Reinforcement. Use reinforcing steel as outlined in ASTM C-478 and any additional specifications herein. Apply the minimum steel area of 0.12 square in. to both risers and cone sections and the maximum center to center spacing of 6 in. as well. Place reinforcing steel for one line circumferential reinforcement on the tension side of the wall (the inner half part of the wall with a minimum 1-in. cover) for two lines circular reinforcement, refer to ASTM C-478. Sufficiently tie all reinforcing to withstand any displacement during the pouring operation.

Joint Reinforcement. Both tongue and groove will contain a #4 rebar.

Lifters. Design lifters to handle the imposed weights placed per manufacturer's requirements.

Joint Material. Seal all joints using Ram-Nek joint sealer in enough quantities by the vendor as part of the manhole section(s) in sizes per manufacturer's recommendations.

4.3.2.3. **Cast-In-Place Concrete Manholes.** In special circumstances, construct cast-in-place concrete manholes as shown on the plans, and provide the wall thickness not less than 6 in. Ensure that the concrete is of good quality and well vibrated and the method of construction materials and type of forms used are approved.

4.3.2.4. **Manhole Connectors.** At manholes, a water-tight resilient connection will be made between the wall and the pipe by use of an Engineering approved manhole waterstop adaptor such as Indiana Seal Manhole Adaptor, Kor-N-Seal, or approved equal, meeting the requirements of ASTM C-923. The connector must be compatible to both the type of pipe wall and manhole wall, and be installed in strict accordance with the recommendations of the connector manufacturer.

- 4.3.2.5. Installation. Construct manholes at the location and details shown on the plans or as. After the excavation has been completed, pour the concrete base or bottom.

The riser work may proceed when the concrete has set enough. Neatly form the invert in the bottom of the manhole with concrete after the manhole rise has been completed. Construct invert with a true curve of as large a radius as the size of the manhole will permit and with a smooth trowel finish.

- 4.3.3. **Inspection and Testing.** Test all piping as specified herein unless otherwise directed.

Standards. Adhere to the following requirements when inspecting and testing sewer lines and manholes.

- ASTM C-1103 Standard Practice for Joint Testing of Installed Pre-Cast Concrete Pipe Sewer Line
- ASTM D-3034 Specification for Type PSM Poly(Vinyl Chloride)(PVC) Sewer Pipe and Fittings
- ASTM F-679 Specification for Poly(Vinyl Chloride)(PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings
- UNI-BELL-6 Standards and Practices for Low-Pressure Air Testing of Installed Sewer Pipe
- UNI-BELL-9 Polyvinyl Chloride (PVC) Large Diameter Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter (Nominal Pipe Sizes 18-48 Inch)

Manufactured Products. Provide all testing apparatus including pumps, compressors, hoses, gauges and fittings, mandrels, and other equipment necessary to perform the required tests.

Manholes must be tested for leakage separately and independently of the wastewater lines by either hydrostatic exfiltration testing or vacuum testing, in accordance with TCEQ regulations.

- 1) Hydrostatic Exfiltration Test -All wastewater lines coming into the manhole must be sealed with an internal pipe plug, then the manhole must be filled with water and maintained full for at least one hour. For concrete manholes a wetting period of 24 hr. may be used before testing to allow saturation of the concrete. Test period must be for a minimum of 4 hr. Maximum leakage must be 0.025 gallons per foot diameter per foot of manhole depth per hour. If a manhole fails a leakage test, the manhole must be made watertight and retested by the same procedures.
- 2) Vacuum Test -All wastewater lines coming into the manhole must be sealed with plugs braced to prevent them from being drawn into the manhole. The test head must be placed inside the frame at the top of the manhole and inflated in accordance with the manufacturer's recommendations. A vacuum of 10 in. mercury must be drawn and the vacuum pump must be turned off. With the valve closed, the level of vacuum must be read after the required test time. If the drop in the level is less than 1 in. of mercury (final vacuum is greater than 9 in. of mercury), the manhole will have passed the vacuum test. The required test time is determined from the following table.

Minimum Time Required for a Vacuum Drop of 1" Hg (10" Hg - 9" Hg)(min:sec)			
Manhole Depth	48" Manhole	60" Manhole	72" Manhole
0 - 20'	0:40	0:50	1:00
22'	0:44	0:55	1:06

24'	0:48	1:00	1:12
26'	0:52	1:05	1:18

Any manhole which fails the initial test must be repaired and retested until a successful test is made.

- 4.3.3.1. **Leakage Testing.** To ensure the integrity of the pipe and joints, test all sewer lines installed under these specifications for leakage using the guidelines established by ASTM C-828 and UNI-BELL B6, and the methods and procedures here forth described.

General. Provide all testing apparatus including pumps, compressors, hoses, gauges and fittings and other equipment necessary to perform the required tests. Acceptable equipment can be as manufactured by Cherne Industries Incorporated or approved equal.

Conduct tests in the presence of the Engineer unless otherwise approved. Notify the Engineer 48 hr. in advance of testing. Record test results on standard utility forms provided by.

Low pressure air testing may be conducted by Contractor or an approved independent testing firm with the full understanding to all persons conducting an Air Test that an Air Test may be dangerous if conducted improperly.

Test sewer lines after the "pipe zone" backfilling is completed and before construction of finished surfacing.

Where house laterals are included as integral part of the project, perform testing on the main and laterals after the risers or laterals have been completed and backfilled.

Thoroughly clean pipes before conducting leakage tests. Repair pipelines that exceed the allowable leakage rate and retest at no additional cost to the Department.

- 4.3.3.1.1. **Exfiltration Air Testing.** A Low Pressure Air Test is the standard method for testing sewer lines. Seal test pneumatic plugs above ground using a random pipe section pressurized to 5 psig. Plugs should remain intact without bracing or movement out of the section. Test procedure is as follows:
- Seal off each end of the section of pipe to be tested at a manhole connection. Securely brace test plugs.
 - Introduce air slowly into the test section through the test plug until an internal pressure of 4.0 psi is reached. Allow internal air temperature to stabilize. Adjust the internal air pressure to 3.5 psi, disconnect the air supply and begin the test.
 - Maintain the test pressure through section without losing more than 1.0 psi for a length of time as determined by Table 15. Sections losing more than 1.0 psi fail test and must be repaired and re-tested for acceptance. If the section being tested includes more than one size of pipe, calculate the test time for each size and add to determine the total test time for the section. .

Table 15.
Total Test Time

Nominal Pipe Size (d)	Time (t).
Inches	Minutes/100 ft.
4	0.3

6	0.7
8	1.2
10	1.5
12	1.8
15	2.1
18	2.4
21	3.0
24	3.6
30	4.8
36	6.0
42	7.3

- 4.3.3.1.2. Infiltration Test._Infiltration testing of sewer lines under groundwater is mandatory. Perform this test before initiating any service connections and after backfilling. At testing time, maintain the level of the groundwater over the entire section of the pipe or near its maximum level.

Measure the allowable infiltration for any portion of the sewer system by a weir or current meter placed in the appropriate manhole and do not exceed 50 gallons per inch of internal pipe diameter per mile per day, including manholes.

Provide suitable plugs or other facilities to measure the amount of infiltration. If infiltration is excessive, immediately proceed to locate the source of leakage. Once located, seal the source of leakage by grouting, cementing and rebuilding as required, or by approved methods.

- 4.3.3.1.3. Joint Testing._As directed, perform individual joint testing of pipe larger than 24 in. in diameter in accordance with ASTM C-1103 for special conditions not covered by other test methods.

- 4.3.3.1.4. Inspection of Sewer Manholes. Visually inspect manholes installed under groundwater for infiltration leakage through all joints and the manhole base. Repair all leaks or cracks with an approved hydro-cement grout.

- 4.3.3.2. **Deflection Testing.** As a condition for acceptance of the pipeline, perform a mandrel test (deflection test) to verify the roundness and proper installation of the flexible pipeline. Within 30 days, but not less than 7 days after the installation and backfilling of the flexible sewer line, including any service connections, in the presence of the Engineer, test deflection of the pipe with a mandrel (GO-NOGO device).

Mandrel Fabrication. Provide mandrels of high quality fabrication and precision as commercially available by Cherne Industries Incorporated, or approved equal. Mandrels require approval and must be equipped with proven rings and meet the following requirements:

- Fabricate mandrel outside diameter (gauge dimension):

Mandrel O.D. = Pipeline Base I.D. - (% deflection limit x Pipeline Base I.D.) in accordance with ASTM D-3034, F-679, or UNI-BELL-9

- Design mandrel open preventing debris buildup between channels of adjacent fins. Include a minimum of nine fin sets that are removable from the mandrel core. Assemble gauges of various diameters by substituting fin sets of appropriate dimension. Provide a length of the minimum radius portion of the mandrel not less than one-third of the nominal diameter of the pipe being tested.

Execution. Before testing, flush pipe and clean. Flow is not permitted in the pipeline throughout the duration of the deflection test. Manually pull mandrel through the pipeline with a suitable rope or cable that is connected to an eyebolt at one end of the gauge. Attach a similar rope or cable to the eyebolt at the opposite end of the mandrel and apply tension to it. This will ensure that the mandrel maintains its correct position during testing, while providing easy removal of the mandrel should it become lodged in an excessively deflected pipeline. Winching or other methods of forcing the mandrel through the pipeline is unacceptable.

For pipeline tested within 30 days of installation, do not exceed a deflection of 5% of the base inside pipe diameter as established by ASTM Standards D-3034 and F-679 listed in Table 16.

Table 16.
Deflection Gauge Dimensions: SDR35 OR RSC 160

Nominal Size	Average I.D.	Base I.D.	5% Deflection Gauge
6"	5.893	5.742	5.46
8"	7.891	7.665	7.28
10"	9.864	9.563	9.08
12"	11.737	11.361	10.79
15"	14.374	13.898	13.20
18"	17.564	16.976	16.13
21"	20.707	20.004	19.00
24"	23.296	22.480	21.36
27"	26.258	25.327	24.06

For pipeline tested beyond 30 days of installation, do not exceed a deflection of 7.5% of the nominal inside diameter or as established otherwise by the applicable governing body. Adjust mandrel gauge for 7.5% and seek approval. Make every effort to test for deflection before the 30 day expiration.

Maintain a permanent record of all testing with locations where excessive pipeline deflections occur and forward to the Engineer after completion of testing on each line.

Replace all sections of pipe that deflect more than 5% (or 7.5%). Lay pipelines with acceptable ovality such that the larger diameter is situated in the vertical direction. All expenses for re-trenching, backfill, compaction, paving, and related work necessary due to failure to satisfy deflection test requirements are Contractor's responsibility.

4.3.3.3.

Force Main Testing. As a condition for acceptance of the pipeline, perform a hydrostatic or pressure test of the force main.

Filling and Flushing. After the line has been properly cleaned, it shall be filled slowly with potable water at a maximum velocity of 1 ft/sec while venting air. Precautions shall be taken to prevent entrapping air in the lines as this will affect testing. After filling, the lines shall be flushed at the discharge at a minimum of 3 ft/sec to cause a minimum of three changes of potable water in the force main. Flushing water shall be discharged without causing erosion damage, nuisance, or disruption of traffic. Discharge of potable water shall comply with the requirements of all regulatory authorities.

Hydrostatic Testing. After the force main is completely installed, with all valves and fittings, but before connection to the existing main or pump station, a minimum 4 hour hydrostatic test must be conducted in accordance with TCEQ 217.68. Force Main Testing.

Test Pressure. A minimum test pressure of 50 pounds per square inch above the normal operating pressure of the force main shall be used. However, in no case shall the test pressure exceed the pipe or thrust restraint pressure rating.

Testing Allowance. The testing allowance shall be defined as the quantity of water that must be supplied to the pipe section being tested to maintain a pressure within ± 5 psi of the specified hydrostatic test pressure. No installation will be accepted if the quantity of makeup water is greater than that determined by the following formula:

$$L = (SD\sqrt{P})/155,400$$

Where:

L = Acceptable leakage rate, in gallons/hour/1,000 feet of pipe,

S = Length of pipe test section, in feet

D = nominal diameter of the pipe, in inches

P = average test pressure during the hydrostatic test, in pounds per square inch (gauge)

This formula is based on a leakage rate of 10.0 gallons per inch of diameter per mile of pipe per day. The duration of the test shall be a minimum of 4 hr.

- 4.4. **Sewer Line Bypassing and Draining.** This section specifies the requirements for temporary bypassing, draining, flushing and abandonment of sewer lines. Keep excavations free from water during construction. Do not damage property or create a public nuisance when disposing water. Provide hand pumping equipment and machinery in good working condition for emergencies and have workers available for its operation.
- 4.4.1. Requirements. Provide labor, equipment, materials and supervision to temporarily bypass flow around work during sewer construction and/or during work associated with sewer construction when necessary. Drain and flush all sewers to be abandoned with a minimum of twice the sewer's volumes of water. Drain all sewers lines to be abandoned. Coordinate all work with the Engineer.
- 4.4.2. Submittals. Twenty-one (21) calendar days before commencement of construction activities, then submit for review and approval drawings and complete design data showing methods and equipment proposed to use in sewer bypassing and draining. Include the following information:
- Drawings indicating the location of temporary sewer plugs and bypass discharge lines
 - Schedule times for bypasses
 - Capacities of pumps, prime movers, and standby equipment
 - Design calculations proving adequacy of the system and selected equipment
- 4.4.3. Job Conditions. If available, existing sewer system map of the project area can be obtained from the Engineer.

Protection. Where bypassing or draining of the contents of a line is required, ensure that service for connecting sewer laterals are not disrupted. Discharge all flow into the nearest downstream manhole and only after consultation with City/Department operations to coordinate the discharge. Do not surcharge sewers or interfere with normal operation of related sewer facilities when bypassing and draining of the contents of a line. Discharging to the ground surface, receiving streams, storm drains, or discharging that result in groundwater contamination or potential health hazards is not permitted. In the event accidental discharging is caused by the Contractor's operations, City/Department is immediately entitled to employ others to stop the discharging without giving written notice to the Contractor.

Contractor is responsible for penalties imposed on the City/Department as a result of any discharge by the actions of Contractor's employees or subcontractors including legal fees and other expenses to the City/Department resulting directly or indirectly from the discharge.

Scheduling. Do not shut down the bypassing systems between shifts, on holidays or weekends, or during work stoppages without written permission from the ENGINEER. Submit a detailed outage plan and time schedule for operations when necessary to remove a sewer line or structure from service. Coordinate schedule with the Engineer and meet the restrictions and conditions specified in this section. In the detailed plan, describe the method for preventing accidental discharges, the length of time required to complete said operation, the necessary plan and equipment to be used to prevent accidental discharges. Observe the following restrictions:

- Systems or individual equipment items will be isolated, drained, decommissioned, de-energized, or depressurized in accordance with the detailed outage plan and schedule.
- Notify the Engineer, in writing, at least one week in advance of the planned operation.

4.4.4. Sewer Line Draining. Flush sewers to be abandoned with two pipeline volumes of water and allow to drain fully before abandoning.

4.4.5. Sewer Bypassing. Accomplish sewer bypassing by pumping or diverting the upstream flow around the proposed work and as directed. Provide temporary pumps, conduits, and other equipment to bypass the sewer flow.

Furnish the necessary labor, equipment and material, and supervision to set up and operate the pumping and bypass system. Equip engines with mufflers and/or enclosed to keep the noise level within local ordinance requirements. Provide pumps and bypass lines of adequate capacity and size to handle the flows.

Unless otherwise directed, bypass flow around proposed work whenever the depth of flow, as measured at the inlet pipe to the upstream manhole adjacent to proposed work, exceeds the crown elevation of the pipe; or whenever the equipment operating in the sewer provides an obstruction that restricts flow and causes the depth of flow to exceed the crown elevation.

4.4.6. Standby Equipment. Maintain on site enough equipment and materials to ensure continuous and successful operation of the bypass and dewatering systems. Maintain standby pumps fueled and operational at all times. Maintain on site a enough number of valves, tees, elbows, connections, tools, sewer plugs, piping and other parts or system hardware to ensure immediate repair or modification of any part of the system as necessary.

4.4.7. Damages. Repair, without additional cost to the Department, any damage that may result from negligence, inadequate or improper installation, maintenance, and operation of bypassing and draining equipment, including mechanical or electrical failures.

- 4.5. **Flowable Backfill.** When indicated on the plans, backfill trenches to the elevations shown with stabilized backfill meeting requirements of Item 401.
- 4.6. **Cutting and Restoring Pavement.** Where sewers must be installed in streets or other paved areas, the work includes saw cutting of the pavement and base to neat lines and prompt replacement of these materials after sewer excavation and backfill are completed. The replacement materials, as to type and thickness, are shown on the plans. Any work done or damage to base and/or pavement outside the limits shown on the plans will not be measured for payment and must be restored at no additional cost to the Department.
- 4.7. **Measurement.**
- 4.7.1. **Force Main and Sanitary Sewer Mains (PVC).** Longitudinal measurement of sanitary sewers will be made along the centerline of the sewer by the foot of the various sizes of sewers in place, in accordance with these specifications, complete and approved. The lengths of sewer mains will be measured center of manholes where the installation involves connection of the sewer into a manhole at each end of the line being measured. Where the installation involves a connection to an existing sewer line, the measurement will be made from the end of the existing sewer line to the center of the manhole on the work being measured.
- 4.7.2. **Steel Sewer Casing Pipe.** Longitudinal measurement of sanitary sewer steel casing pipe installed by open cut will be made along the centerline of the casing pipe by the foot of the various sizes of casing pipe in place, in accordance with these specifications, complete and approved. The lengths of casing pipe for sewer mains will be measured from end to end of casing pipe installed.
- 4.7.3. **Valves.** This Item will be measured in place per each installation of the sizes and types shown on the plans.
- 4.7.4. **Fittings (Force Main).** This Item will not be measured individually and is subsidiary to the installation of the various sanitary sewer force mains and related appurtenances.
- 4.7.5. **Sanitary Sewer Manhole.** All sanitary sewer manholes satisfactorily completed in accordance with the plans and specifications will be measured by each of the various manhole types.
- 4.7.6. **Sanitary Sewer Air Release Valve (2").** All sanitary sewer air release valves satisfactorily completed in accordance with the plans and specifications will be measured by each of the various air release valve types.
- 4.7.7. **Standard Cleanout (6").** Standard Cleanout (6") will be measured by each cleanout installed and accepted.
- 4.7.8. **New Sewer Service (4").** New Sewer Service (4") will be measured by each new sewer service connection of a particular size installed and accepted.
- 4.7.9. **Abandon and Fill Existing Sanitary Sewer Pipe.** This Item will be measured by the foot of existing sanitary sewer main that is abandoned in place.
- 4.7.10. **Remove Existing Manholes.** Existing manhole structures to be completely abandoned and removed as identified on the plans will be measured for each manhole removed.
- 4.7.11. **Abandon Existing Manholes.** Existing manhole structures to be completely abandoned as identified on the plans will be measured for each manhole removed.

- 4.7.12. **Abandon Existing Air Release Valve Manholes.** Existing air release valve manhole structures to be completely abandoned as identified on the plans will be measured for each manhole removed.
- 4.7.13. **Connect Proposed Sanitary Sewer Main to Existing Manhole.** This Item will be measured per each connection of the proposed sanitary sewer main of the type and size shown on the plans to existing manhole, complete in place.
- 4.7.14. **Connect Existing Sanitary Sewer Main to Proposed Manhole.** This Item will be measured per each connection of the existing sanitary sewer main of the type and size shown on the plans to proposed manhole, complete in place.

4.8. **Payment.**

- 4.8.1. **Force Main, Sanitary Sewer Mains (PVC) and Sanitary Sewer Pipe Casing (Steel).** Longitudinal measurement of sanitary sewers will be made along the centerline of the sewer by the foot of the various sizes of sewers in place, in accordance with these specifications, complete and approved. The lengths of gravity sanitary sewer mains will be measured center of manholes where the installation involves connection of the sewer into a manhole at each end of the line being measured. Where the installation involves a connection to an existing sewer line, the measurement will be made from the end of the existing sewer line to the center of the manhole on the work being measured. For force main installation this price is full compensation for furnishing all required materials, including all pipe, fittings and accessories; mechanical joint restraints; and all appurtenances defined herein to include, but not limited to the following items: concrete collars, end plugs, bends, tees, couplings, reducers, fiberglass markers, tracer wire, concrete thrust blocks, thrust restraint devices and all other items for the project not indicated as being covered under the other specific bid items shown on the proposal.

For gravity sanitary sewer, force mains and steel casing pipe installed by open trench, each will also include furnishing all required labor, including coordination, traffic control, potholing, excavation, including hand-digging, if needed; embedment and backfilling; compaction and compaction testing; pressure testing, dewatering of groundwater, or uncased bore (as required and shown) where required.

- 4.8.2. **Steel Casing Pipe.** The work performed and the materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "SEWER CASING (ASTM A139)(STEEL)(SIZE) BY OPEN CUT" of the size specified. This price is full compensation for furnishing all required materials, labor, and equipment, including but not limited including all pipe (steel casing pipe and carrier pipe), fittings and accessories and all appurtenances defined herein to include, but not limited to the following items: stainless steel casing spacers, end seals, concrete collars, end plugs, and all other items for the project not indicated as being covered under the other specific bid items shown on the proposal; furnishing all required labor, including coordination, traffic control, potholing, excavation, including hand-digging, if needed; embedment and backfilling; compaction and compaction testing; disinfection, pressure testing, and dewatering of groundwater where required.

Trench excavation protection will not be paid directly but will be subsidiary to the casing pipe installation.

- 4.8.3. **Fittings (Force Main).** The work performed and the materials furnished in accordance with this Item and measured as provided under "Measurement" will be not paid for individually as it is considered subsidiary to the various force main pay items. All fittings shown on the plans, including fittings not shown on the plans as required for a complete installation of the proposed force main, are subsidiary to the different pay items for force mains and services and include all costs associated with coordination; excavation; disposal of excess

material; backfill, compaction, compaction testing for utilities, all labor, equipment and materials required for furnishing and installing all fittings shown on the plans to include those required as part of the different pay items, complete in place, including but not limited to: thrust blocking, mechanical joint restrainers, concrete anchoring, polyethylene wrapping, and provisions for corrosion protection. Use of mechanical joint restrainers instead of or in conjunction with concrete thrust blocking will not be considered for additional compensation.

- 4.8.4. **Valves.** The work performed and the materials furnished in accordance with this Item and measured as provided under "GATE VALVE & BOX (SIZE)" will be paid for individually complete in place. Valves of the sizes and types shown on the plans are per each installation and include all costs associated with coordination; excavation; disposal of excess material; backfill, compaction, compaction testing for utilities, all labor, equipment and materials required for furnishing and installing all valves shown on the plans to include those required as part of the different pay items, complete in place, including but not limited to: thrust blocking, mechanical joint restrainers, concrete anchoring, polyethylene wrapping, and provisions for corrosion protection. Use of mechanical joint restrainers instead of or in conjunction with concrete thrust blocking is not be considered for additional compensation.
- 4.8.5. **Sanitary Sewer Manhole.** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" herein will be paid for at the unit price bid for "SAN SEWER MANHOLE (STANDARD) (4' DIA)" or "SAN SEWER MANHOLE (CROSS COUNTRY) (4' DIA)" of the size and type specified or indicated on the plans. This price is full compensation for furnishing all required materials, labor, gaskets, rings, covers, concrete collars, pipe penetrations, grout, groundwater dewatering, testing, concrete, excavation and backfill, grouting of inverts, coating interior and exterior where required, adjustment of new manhole to both temporary and finished grades, and tools and incidentals necessary to complete the work in accordance with the plans and specifications.
- 4.8.6. **Sanitary Sewer Air Release Valve (2").** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" herein will be paid for at the unit price bid for "SANITARY SEWER AIR RELEASE VALVE (2")" of the size and type specified or indicated on the plans. This price is full compensation for furnishing all required materials, labor, air release valve, manhole, piping, gaskets, rings, covers, concrete collars, pipe penetrations, grout, groundwater dewatering, testing, concrete, excavation and backfill, grouting of inverts, coating interior and exterior where required, adjustment of new air release valve and manhole to both temporary and finished grades, and tools and incidentals necessary to complete the work in accordance with the plans and specifications.
- 4.8.7. **New Sewer Service (4").** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" herein will be paid at the unit price bid for each "NEW SEWER SERVICE (4")" of the particular size installed. This price is full compensation for furnishing all required materials and labor; excavation and backfill; fittings; cutting; bypassing; coordination; testing; and plugging/capping of abandoned utilities; draining of lines; vertical and horizontal adjustments; connections to existing sewers; and all other incidentals necessary to complete the work in accordance with the plans and specifications.
- 4.8.8. **Standard Cleanout (6").** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" herein will be paid at the unit price bid for each "STANDARD CLEANOUT (6")" of the particular size installed. This price is full compensation for furnishing all required materials and labor; excavation and backfill; fittings; cutting; bypassing; coordination; testing; and plugging/capping of abandoned utilities; draining of lines; vertical and horizontal adjustments; connections to

existing/proposed sewers; and all other incidentals necessary to complete the work in accordance with the plans and specifications.

- 4.8.9. **Abandon and Fill Existing Sanitary Sewer Pipe.** The work performed and the materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "ABAND/FILL EXIST SAN SEWER PIPE" of the size specified. This price is full compensation for furnishing all required materials, labor, and equipment, including but not limited to the following items: coordination, traffic control, potholing, excavation, complete flushing and draining (dewatering) of pipe, flowable backfill, cutting, capping/plugging, complete filling with approved flowable backfill of sanitary sewer mains to be abandoned, proper abandonment of all manhole structures with flowable backfill as indicated on the plans, and all other items for the project not indicated as being covered under the other specific bid items.
- 4.8.10. **Abandon Existing Manholes and Air Release Valve Manholes.** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" herein will be paid for at the unit price bid for "ABANDON SANITARY SEWER MANHOLE" or "ABANDON AIR RELEASE VALVE MANHOLE". This payment will be for all labor, materials, plugs (temporary and permanent), excavation and backfill, cement stabilized backfill, groundwater dewatering, removal, disposal of materials, and all other incidentals necessary to complete the work in accordance with the plans and specifications.
- 4.8.11. **Connect Proposed Sanitary Sewer Main to Existing Manhole.** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" herein will be paid for at the unit price bid for "CONNECT PRO SSWR MAIN TO EX MANHOLE (SIZE)" of the size and type specified or indicated on the plans. This price is full compensation for furnishing all required materials, labor, gaskets, rings, covers, concrete collars, pipe, pipe penetrations, grout, groundwater dewatering, testing, concrete, excavation and backfill, grouting of inverts, and tools and incidentals necessary to complete the work in accordance with the plans and specifications.
- 4.8.12. **Connect Existing Sanitary Sewer Main to Proposed Manhole.** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" herein will be paid for at the unit price bid for "CONNECT EX SSWR MAIN TO PRO MANHOLE (SIZE)" of the size and type specified or indicated on the plans. This price is full compensation for furnishing all required materials, labor, gaskets, rings, covers, concrete collars, pipe, pipe penetrations, grout, groundwater dewatering, testing, concrete, excavation and backfill, grouting of inverts, and tools and incidentals necessary to complete the work in accordance with the plans and specifications.
- 4.8.13. **Connect Proposed Sanitary Sewer Force Main to Existing Sanitary Sewer Force Main.** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" herein will be paid for at the unit price bid for "CON TO EX SSWR FORCE MAIN (SIZE)" of the size and type specified or indicated on the plans. This price is full compensation for furnishing all required materials, labor, gaskets, rings, covers, fittings, concrete collars, pipe, pipe penetrations, grout, groundwater dewatering, testing, concrete, excavation and backfill, grouting of inverts, and tools and incidentals necessary to complete the work in accordance with the plans and specifications.

5. HORIZONTAL DIRECTIONAL DRILLING

- 5.8. **Description.** This item shall consist of furnishing, installing, testing, disinfection, and placing in service all materials, equipment, tools, supplies, and appurtenances and performing all necessary labor and supervision

to provide the complete pipe using Horizontal Directional Drilling (HDD) in accordance with the plans and specifications.

5.9. **Construction Methods**

5.9.11. **Submittals.** The Contractor shall provide the department with 2 copies of each of the following required submittals.

5.9.11.1. **HDD Contractor Qualifications.** Qualifications include the following items.

- Contact Information. Name, business, address, and telephone number of the Contractor.
- Experience in successfully constructing horizontal directional drilling operations.
- Similar Projects. List of similar projects performed over the last two years including the name of contact person and telephone number.
- Training. Certification of workman training.
- Supervisory Personnel. Name(s) of all supervisory personnel to be directly involved with the project.
- Certification. The Contractor shall sign and date the information provided and certify that to the extent of his knowledge, the information is true and accurate, and that the supervisory personnel for the HDD operations will be directly involved with this project.

5.9.11.2. **Work Plan.** Before beginning the Work, Contractor shall submit a Work Plan detailing the construction procedures and schedule to be used to execute the project. The Work Plan shall include the following.

Construction Information. Written descriptions of the construction method and equipment to be used, and access pit sizes and locations required for equipment and material access.

List of personnel and their qualifications and experience.

List of subcontractors.

Schedule of work activity.

Safety Plan including Material Safety Data Sheets (MSDS) of any potentially hazardous substances to be used.

Environmental Protection Plan and contingency planning for possible problems.

Grouting techniques to be used for over-excavation if any, including equipment, pumping procedures, grout types, and mixtures.

Line and Grade Control. Description of line and grade control.

Lubrication. Proposed procedures, materials, and equipment for lubricating the exterior of the pipe during pulling.

Spoil Removal. Details of spoil removal system, including equipment type, number, and disposal location.

Obstruction Removal and Clearing. Proposed methods, materials, and equipment for removing and clearing obstructions so that the HDD can advance forward.

Direction Control. Procedures for locating and controlling the direction of the drilling operation.

5.9.11.3. Bore Plan. Before beginning work, the Contractor must submit to the Engineer for review and approval, a scaled drawing of the proposed pilot bore plan that has been signed and sealed by a surveyor licensed in the State of Texas (maximum vertical scale 1 in. = 3 ft. and maximum horizontal scale 1 in. = 30 ft.). The proposed plan shall show the ground surface profile along the path of the proposed bore (including the bottom profile under water bodies and the elevation of the water surface), finished grade, deflection and radii of the pilot bore, and all existing utilities with minimum vertical and horizontal clearances. The plan shall also address the location of the drill rig setups and the lengths of each bore based on soil conditions, equipment used, topography, and other pertinent conditions. The proposed vertical and horizontal clearances between the proposed pipe and any existing/proposed conflicting pipes, conduits or obstructions shall be subject to review and approval by the Engineer.

5.9.11.4. Equipment. Submit specifications on horizontal directional drilling equipment to be used to ensure that the equipment will be adequate to complete the project. Equipment list shall include but not be limited to: drilling rig, mud system, mud motors, down hole tools, guidance system, and rig safety systems. Calibration records for guidance equipment shall be included. Specifications for any drilling fluid additives that the Contractor intends to use or might use shall also be submitted.

5.9.11.5. Geotechnical Investigations. When geotechnical investigations are conducted by the Contractor, submit results to the Engineer System for record purposes.

5.9.11.6. Assessment Reports. Preconstruction and post construction assessment reports shall be provided for critical structures, within the zone of active drilling from the proposed drilling centerline. Photographs or a video of any existing damage to structures in the vicinity of the alignment shall be included in the assessment report.

5.9.12. **Quality Assurance.**

All horizontal directional drilling operations shall be performed by a qualified horizontal directional drilling Contractor with experience involving work of a similar nature to the work required of this project. A list of project references is required before job commencement.

All personnel shall be fully trained in their respective duties as part of the horizontal directional drilling crew and in safety. Each person must have at least two years horizontal directional drilling experience.

A competent and experienced supervisor representing the Contractor and drilling Subcontractor shall be present at all times during the actual drilling operations. A drill rig superintendent who is thoroughly familiar with the equipment and type of work to be performed must be in direct charge and control of the operation at all times. The superintendent shall have no less than 5 years' experience in the installation of systems of similar type and equal complexity as the proposal. In all cases, the supervisor must be continually present at the job site during the actual Horizontal Directional Drilling operation. The Contractor and Subcontractor

shall have a sufficient number of competent workers on the job at all times to insure that the Horizontal Directional Drill is made in a timely and satisfactory manner.

Personnel who are unqualified, incompetent, or otherwise not suitable for the performance of this project shall be removed from the job site and replaced with suitable personnel.

A professional land surveyor registered in the State of Texas shall be required to prepare and certify "as-builts" as required by this specification.

All work shall be scheduled through the Engineer. Contractor shall notify the Engineer a minimum of 5 days in advance of the start of work.

All work shall be performed in the presence of the Engineer.

All applicable permits and applications must be in place before start of work.

5.9.13. **Project/Site Conditions.**

The Contractor shall be required to perform his own subsurface investigation.

The Contractor shall not assume that materials other than those disclosed by the borings will not be encountered or that the proportions and character of the various materials will not vary from those indicated in the boring logs.

5.9.14. **Equipment.** The horizontal directional drilling equipment shall consist of a horizontal directional drilling rig of sufficient capacity to perform the bore and pull back the pipe, a drilling fluid mixing, delivery and recovery system of sufficient capacity to successfully complete the installation, a drilling fluid recycling system to remove solids from the drilling fluid so that the fluid can be reused (if required), a Magnetic Guidance System (MGS) to accurately guide boring operations, a vacuum truck of sufficient capacity to handle the drilling fluid volume, trained and competent personnel to operate the system. All equipment shall be in good, safe condition with sufficient supplies, materials, and spare parts on hand to maintain the system in good working order for the duration of the project.

5.9.14.1. **Drilling Rig.** The horizontal directional drilling machine shall consist of a hydraulically powered system to rotate and push hollow drilling pipe into the ground at a variable angle while delivering a pressurized fluid mixture to a guidable drill (bore) head. The machine shall be anchored to the ground to withstand the pulling, pushing and rotating pressure required to complete the installation. The hydraulic power system shall be self-contained with sufficient pressure and volume to power drilling operations. The hydraulic system(s) shall be free of leaks. The rig shall have a system to monitor and record maximum pullback pressure during pullback operations. There shall be a system to detect electrical current from the drill string and an audible alarm that automatically sounds when an electrical current is detected.

5.9.14.2. **Instrumentation.** The Contractor shall at all times provide and maintain the instrumentation which will accurately and continuously locate the pilot hole, measure drill string axial and torsional loads and measure drilling fluid discharge rate and pressure. The Engineer shall have access to these instruments and their readings at all times.

5.9.14.3. **Drill Head.** The drill head shall be steerable by changing its rotation and shall provide necessary cutting surfaces and drilling fluid jets.

- 5.9.14.4. Mud Motors. Mud Motors (if required) shall be of adequate power to turn the required drilling tools.
- 5.9.14.5. Drill Pipe. Drill pipe shall be constructed of high quality 4130 seamless tubing, grade D or better, with threaded box and pins. Tools joints should be hardened to 32-36 RC.
- 5.9.14.6. Magnetic Guidance System (MGS). A Magnetic Guidance System (MGS) probe or proven (non-experimental) gyroscopic probe and interface shall be used to provide a continuous and accurate determination of the location of the drill head during the drilling operation. The guidance system shall be capable of tracking at all depths up to fifty feet and in any soil condition, including hard rock. It shall enable the driller to guide the drill head by providing immediate information on the tool face, azimuth (horizontal direction), and inclination (vertical direction) and depth. The guidance system shall be accurate and calibrated to manufacturer's specifications.

The Contractor shall supply all components and materials to install, operate, and maintain the guidance system.

The MGS shall be set up and operated by personnel trained and experienced with the system. The Contractor shall be aware of any geo-magnetic anomalies and shall consider such influences in the operation of the guidance system.

Tru-Tracker technology will be used in conjunction with MGS.

- 5.9.14.7. Drilling Fluid (MUD) System.
- 5.9.14.7.1. Mixing System. A self-contained, closed, drilling fluid mixing system shall be of sufficient size to mix and deliver drilling fluid composed of bentonite clay, potable water, and appropriate additives. The mixing system shall be able to molecularly shear individual bentonite particles from the dry powder to avoid clumping and ensure thorough mixing. The drilling fluid reservoir tank shall be minimum of 6,000 gallons. Mixing system shall continually agitate the drilling fluid during drilling operations.
- 5.9.14.7.2. Drilling Fluids. The composition of all drilling fluids proposed for use shall be submitted for review and approval in accordance with the submittal process. No fluid will be approved or utilized that does not comply with permit requirements and environmental regulations. Drilling fluid shall be composed of potable water and bentonite clay. Water shall be from an authorized source with a pH of 8.5 – 10. Water of a lower pH or with excessive calcium shall be treated with the appropriate amount of sodium carbonate or equal. No additional material may be used in drilling fluid without prior approval from the Engineer. The bentonite mixture used shall have the minimum viscosities as measured by a March funnel:

Rocky Clay	60 seconds
Hard Clay	40 seconds
Soft Clay	45 seconds
Sandy Clay	90 seconds
Stable Sand	80 seconds

Loose Sand	110 seconds
------------	-------------

Wet Sand	110 seconds
----------	-------------

These viscosities may be varied to best fit the soil conditions encountered, or as determined by the Contractor.

- 5.9.14.7.3. Delivery System. The drilling fluid pumping system will have a minimum capacity of 350 gal. per minute (GPM) and be capable of delivering the drilling fluid at a constant minimum pressure of 1200 lb. per square inch (psi). The delivery system must have filters in-line to prevent solids from being pumped into drill pipe. Used drilling fluid and drilling fluid spilled during operations must be contained and conveyed to the drilling fluid recycling system or will be removed by vacuum trucks or other methods acceptable to the Engineer. A berm, minimum of 12-in. high, must be maintained around drill rigs drilling fluid mixing system, entry and exit pits and drilling fluid recycling system to prevent spills into the surrounding environment. Pumping equipment and/ or vacuum truck(s) of sufficient size must be in place to convey drilling fluid from containment areas to storage and recycling facilities or disposal.
- 5.9.14.7.4. Disposal of Excess Drilling Fluid. Disposal of excess drilling fluid and cost associated with disposal shall be responsibility of the Contractor and will be conducted in compliance with all environmental regulations, right-of-way and permit requirements.
- 5.9.14.8. Pipe Rollers. Pipe rollers will be used for pipe assembly during final product pull back.
- 5.9.15. **General Requirements.**
- 5.9.15.1. Performance Based Contract. This is a performance-based contract and as such, it is the Contractor's responsibility to determine the actual drill path, alignment, elevation, and depth of crossing. The Contractor is responsible for selecting the appropriate HDPE pipe to safely carry the loads imposed during installation by horizontal directional drilling with the minimum size and thickness being that herein specified or as shown on the plans. The final design and associated construction should be based on the specified parameters in the drawings and specifications and conform to the requirements of all applicable permits.
- 5.9.15.2. Deviations. Furnish completely all work, and methods of construction to complete the work, based on the minimum proposed standards in the design drawings and this specification. Whenever necessary, the Contractor may request in writing from the Engineer, permission to deviate from the proposed design, if actual site conditions vary from the pre-determined conditions. If the deviation is non-substantial and does not violate the minimum proposed standards in the design drawings and specifications, it is only the Contractor's responsibility to accurately show the change in the certified as-built records.
- 5.9.15.3. Start of Construction. The Directional Bore must not begin until the Engineer is present at the job site and agrees that proper preparations for the operation have been made. The Engineer's approval for beginning the installation must in no way relieve the Contractor of the ultimate responsibility for the satisfactory completion of the work as authorized under the Contract. It will be the responsibility of Engineer to provide inspection personnel at such time as appropriate without causing undue hardship by reason of delay to the Contractor. A copy of the approved construction drawings must be on the job site during construction.
- 5.9.15.4. Requirements of Property, Right-of-Way, or Easement Owners. All work under this specification shall be carried out to the full satisfaction of the owners of all property, rights-of-way, and easements upon which the

HDD work occurs or passes under. The Contractor will fully inform himself of all requirements as they pertain to this specific project and shall conduct all its work accordingly.

- 5.9.15.5. Suitable Equipment. All equipment used by the Contractor may be inspected by the Engineer and shall not be used if considered unsatisfactory by the Engineer.
- 5.9.15.6. Damage. The Contractor will be fully responsible for all damages arising from his failure to comply with all applicable regulations and the requirements of this specification.
- 5.9.16. **Preparation.**
- 5.9.16.1. Trench Safety. Excavation, trenching, dewatering, sheeting, shoring, and bracing must comply with all applicable requirements of OSHA, SAWS, TCEQ, and this specification.
- 5.9.16.2. Utility Protection. Contractor will locate and protect existing utilities. Coordinate utility protection with the respective utility companies.
- 5.9.16.3. Examination. Contractor will examine excavation and bore before pipe placement to ensure that the borehole is complete to elevations and slopes indicated, and that no obstructions exist to interfere with pipe installation.
- 5.9.16.4. Inspections. Contractor will inspect all pipe, fittings, and joints before installation. Remove defective pipe. Replace with sound pipe.
- 5.9.17. **Horizontal Directional Drilling Operations.**
- 5.9.17.1. Alignment and Elevation. The Contractor must provide all material, equipment, and facilities required for horizontal directional drilling. Proper alignment and elevation of the borehole must be consistently maintained throughout the horizontal directional drilling operation. The method used to complete the horizontal directional drill must conform to the requirements of all applicable permits.
- 5.9.17.2. Survey. The Contractor must have the entire drill path accurately surveyed by a Registered Surveyor with entry and exit stakes placed in the appropriate locations within the areas indicated on drawings. If Contractor is using a magnetic guidance system, drill path must be surveyed for any surface geo-magnetic variations or anomalies.
- 5.9.17.3. Environmental Protection. Contractor will place silt fence between all drilling operations and any drainage, well-fields, wetland, waterway or other area designated for such protection as required by documents, state, federal and local regulations. Additional environmental protection necessary to contain any hydraulic or drilling fluid spills must be put in place, including berms, liners, turbidity curtains and other measures. Contractor must adhere to all applicable environmental regulations.
- 5.9.17.4. Plot of Drill Path. Readings will be recorded after advancement of each successive drill pipe (no more than 30') and the readings plotted on a scaled drawing. Access to all recorded readings and plan and profile information must be made available to the Engineer. At no time will the deflection radius of the drill pipe exceed the deflection limits of the carrier pipe.
- 5.9.17.5. Drilling Fluid Additives and Mixtures. A complete list of all drilling fluid additives and mixtures to be used in the horizontal directional drilling operation will be submitted to the Engineer, along with their respective

Material Safety Data Sheets. All drilling fluids and loose cuttings must be contained in pits or holding tanks for recycling or disposal, no fluids must be allowed to enter any unapproved areas or natural waterways. Upon completion of the horizontal directional drilling project, the drilling mud and cuttings will be disposed of by the Contractor at an approved dumpsite.

- 5.9.17.6. Pilot Hole. The pilot hole will be drilled on the approved, signed and sealed, bore path with no deviations greater than 5% of depth over the length of the bore unless previously agreed to by the Engineer. In the event that pilot **does** deviate from the bore path more than 5% of depth over the length of the bore, Contractor will notify the Engineer which may require the Contractor to pull-back and re-drill from the location along bore path before the deviation.
- 5.9.17.7. Water Body Frac-Out. While HDD activities are being conducted, surface observers must be positioned in a boat near the location of the drill or reaming tool. The observers, using polarized sunglasses to decrease glare and increase monitoring effectiveness, will visually observe a 100 ft. wide area, centered along the corridor alignment, for any evidence of drilling lubricant release (frac-out). In the event that excessive turbidity is noted, SCUBA divers will be deployed to conduct an underwater investigation of the bore alignment and to photographically document the cause of the increased turbidity. In the event that the HDD Contractor has a loss in drill head pressure, observation personnel will conduct an underwater inspection of the pipeline corridor using SCUBA equipment. Observation will include the area defined by the HDD Contractor as the approximate location of the drill head or reaming equipment along the corridor. SCUBA divers will visually inspect the pipe corridor to determine if a frac-out, undetected by the surface observers, has occurred. If no evidence of frac-out is observed the next phase of the project will be initiated.

In the event a frac-out does occur, the following events must take place:

Cease Activity. All construction activity will immediately be ceased and the appropriate authorities will be notified.

Mark Impact Site and Assess Impact. A buoy will be placed at the impact site and Texas State Plane coordinates will be obtained from the observation vessel. Divers will assess the impact site including the approximate dimensions and type of habitat impacted.

Cleanup. A qualified contractor will be used to perform the appropriate sub-aqueous cleanup activities. The Contractor will be notified immediately upon detection of a frac-out, assessment must begin within 4 hr., and cleanup activities will be initiated within 24 hr.

Filter Bags. The escaped drilling lubricant will be pumped into filter bags, while underwater divers guide the suction hose of the pump to minimize the removal of natural bottom material.

Filter Bag Disposal. Once the spill is contained or the filter bag is full, the bag will be raised to the surface and properly disposed of in an approved upland disposal site. The process will be repeated as necessary to contain all drilling lubricant.

Land Frac-Out. In the event of inadvertent surface returns of drilling fluids occur on land, immediately contain drill fluid with hand placed barriers (i.e. hay bales, sand bags, silt fencing etc.) and collect using pumps as practical. If the amount of surface returns is not enough to allow for practical collection the area must be diluted with water and the fluid allowed to dry and dissipate naturally. If the return exceeds that which cannot be contained and collected using small sumps drilling operations will be suspended until

surface return volumes can be brought under control. If mud fracture or surface return continues, Contractor will discuss additional options with the Engineer and work will then proceed as agreed.

- 5.9.17.8. **As-Builts.** Upon completion of pilot hole phase of the operation, a complete set of "as-built" records will be submitted in duplicate to the Engineer. These records will include copies of the pilot bore path plan and profile record drawing, as well as directional survey reports as recorded during the drilling operation.
- 5.9.17.9. **Hole Reaming.** Upon approval of the pilot hole location by the Engineer, the hole-reaming phase of the installation will begin. The type of back reamer to be utilized in this phase will be determined by the types of subsurface soil conditions that have been encountered during the pilot hole drilling operation.
- 5.9.17.10. **Borehole Stabilization.** The open borehole must be stabilized by means of bentonite drilling slurry pumped through the inside diameter of the drill rod and through openings in the reamer. The drilling slurry must be in a homogenous/flowable state serving as an agent to carry the loose cuttings to the surface through the annulus of the borehole. The volume of bentonite mud required for each pullback must be calculated based on soil conditions, largest diameter of the pipe system component, capacity of the bentonite mud pump, and the speed of pullback as recommended by the bentonite drilling fluid manufacturer. The bentonite slurry is to be contained at the exit or entry side of the directional bore in pits or holding tanks. The slurry may be recycled at this time for reuse in the hole opening operation, or will be hauled by the Contractor to an approved dumpsite for proper disposal.
- 5.9.17.11. **Pipe Assembly.** Sections of high density polyethylene pipe will be joined into continuous lengths at the job site. The joining method must be performed in strict accordance with the pipe manufacturer's recommendations. The equipment used in the joining procedures should be capable of meeting all conditions recommended by the pipe manufacturer. The ends of the pipe must be inspected to ensure that each joint assembly is free of any dirt or sand. The pipe must be free of any chips, scratches, or scrapes.
- 5.9.17.12. **Swivel and Metal Detection Wire.** A swivel will be used to connect the pull section to the reaming assembly to minimize torsional stress imposed on the section. Metal detection wire (#8) solid coated copper wire shall be attached to the pulling eye and the crown of the pipe with duct tape, at 24 in. O.C., and with a minimum of two full wraps around the pipe. Upon completion of the pullback the Contractor shall provide certification that the metal detection wire(s) is intact and functioning properly.
- At ductile iron mechanical joint fittings, Contractor will wrap the end of the wire 1 1/4 turn around the head of a fitting bolt and tighten bolt onto the wire at both ends of each section. The Contractor must leave some slack, approximately one to two inches, between taped or anchored ends.
- 5.9.17.13. **Pipe Pullback.** Damage to the pipe during the pullback will be the responsibility of the Contractor, including cost for replacement and labor and materials. The product pipe must be elevated to the approximate angle of entry and supported by means of a sideboom with roller arm, or similar equipment, to allow for the "free stress" situation as the pipe is pulled into the exit hole toward the drill rig. The product pullback phase of the horizontal directional drilling operation will be carried out in a continuous manner until the pipe reaches the original entry side of the bore. There should be at least a 24-hour relaxation period after the pullback before any work is done on the ends of the pipe. The pipe manufacturer's recommendations on installation, pipe stretch allowances, bending radius, and tensile strength must be observed. The Contractor must include an additional amount of pipe that is sufficient to accommodate the stretch allowances.
- 5.9.17.14. **Monitoring.**

Surface Settlement Monitoring.

Make a visual inspection of all features along the drill path to look for signs of settlement during the time of active drilling.

Monitor ground settlement directly above and 10 ft. on either side of an intersection with any utility or pipeline.

Report any loss of ground, depression or settlement or other unusual activities immediately.

HDD operations must limit vibrations transmitted to surrounding structures so as not to cause damage.

5.9.17.15. **Disposal of Wastes and Groundwater.** The Contractor will dispose of all waste soils, slurries, and other wastes in accordance with applicable regulations. No waste will be left on-site following completion of the work. The Contractor will dispose of all groundwater generated by dewatering operations and any surface water entering access pits in accordance with applicable regulations.

5.9.17.16. **Ground Surface Movements and Tolerances.** Settlement or heave of the ground surface along the HDD alignment must not exceed 0.5 in.

5.9.17.17. **Tolerances.**

When the initial bore deviates from the design line or grade by amounts greater than that specified, return the pipe to design line or grade plus or minus the specified tolerance at a rate of not more than 1in. per 25 ft.

If the pipe is off design line or grade by an amount that requires redesign of the pipeline or associated structures, the Contractor shall do so at no additional cost to the department.

5.9.17.17.1. **Site Restoration.**

Work Site. Following drilling operations, Contractor will de-mobilize equipment and restore the work site to the original conditions or better.

Surface Restoration. Surface restoration will be completed in accordance with the requirements of the contract, approvals, or permits to a condition as good as or better than existing before construction.

5.9.17.18. **Record Keeping and As-Builts.** Daily Log. Contractor must maintain a daily project log of drilling operations and a guidance system log with a copy given to the Engineer at the completion of the project.

The guidance system data must be recorded during the actual drilling operation. The Contractor will furnish to the Engineer, "as-built" plan and profile drawings based on these recordings showing the actual location horizontally and vertically of the installation, and all utility facilities found during the installation. The guidance data must be certified accurate, by the Contractor, to the capability of the guidance System.

5.10. **Measurement.** This Item will be measured by the linear foot between the ends of the pipe that has been installed by the horizontal directional drilling (HDD) method from the beginning of drill to end of drill, all depths, complete in place, except that the length should not be more than the maximum length specified on the plans unless a change has been specified by the Engineer.

- 5.11. **Payment.** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "UNCASED BORE (SIZE)" of the type and size specified. This Item includes conveyance pipe of the size and type shown on the plans, pits, mud systems, guidance systems, monitoring, cleanup, and related items necessary for completion of the work and adherence to this specification.

6. BORING AND TUNNELING

- 6.1. **Description.** Where the utility line crosses under railroad tracks and state highways, the Contractor will give proper notice of the time he expects to begin work on each crossing to the proper highway official at the proper time. At each of these crossings, the Contractor will furnish and install casing under the highway and install the sewer or water line inside the casing. The payment for this item will be made by the length of casing furnished and installed.

In places where other underground utility lines are encountered or where sewer or water lines cross under sidewalks, curbs or storm sewers, the Contractor will be required to tunnel under these and all other obstructions without additional payment. In the case of tunneling, the void space around the pipe must be refilled by tamping in earth or by pumping cement grout in the opening in such a manner as to fill completely the void space, or by jacking the pipe through a pilot hole.

Grout or wrap-around casing end seals will be used to seal the ends of casing. Stainless steel casing spacers must be used to support pipe inside the casing in accordance with manufacturer's recommendations.

- 6.2. **Casing.** Sewer or water lines that are installed under highways must be installed in casing in a bore hole. The casing will be standard wall steel pipe. The minimum casing sizes and minimum wall thickness for casing must be in accordance with the following table. Steel pipe will be made of steel with a minimum yield of 35,000 psi.

Casing Requirement

<u>Size of Utility Pipe</u>	<u>Minimum Size Of Casing</u>	<u>Minimum Wall Thickness Steel Pipe</u>
6"	12"	0.365"
8"	14"	0.375"
10"	16"	0.375"
12"	18"	0.375"
14"	20"	0.375"
16"	24"	0.375"
18"	24"	0.500"

- 6.2.1.1. **Measurement and Payment.** Casing required will be measured from end to end and paid for at the bid price per foot. This payment must be complete payment for making the bore hole or tunnel for the casing, digging and backfilling the approaches, disposing of the surplus earth, furnishing and installing the casing, the extra work for installing the pipe inside the casing, furnishing and installing the required blocking for the

pipe inside the casing, furnishing and installing the grout or end seal to fill the casing or tunnel after the pipe has been installed (where required), furnishing and installing stainless steel casing spacers, furnishing and installing carrier pipe within the casing pipe, all associated fittings and appurtenances complete in place, and making the final cleanup. The work performed and materials furnished in accordance with this Item will be paid for at the unit price bid for "CASING (STEEL)(BY DRY BORE)(SIZE)" of the type and size specified.