SECTION 02200

BAR WRAPPED STEEL CYLINDER PIPE

PART I: GENERAL

1.1 GENERAL REQUIREMENTS

A. Furnishing and installing new bar wrapped steel cylinder pipe and fittings for buried water lines for sizes twenty inches (20 In) to sixty inches (60 In).

1.2 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. No separate payment will be made for bar wrapped steel cylinder pipe under this Section. Include cost in price for water lines.

2. Maintain, on site, minimum of two (2) – three degree (3°) and two – five degree (5°) grade angle adapters. Adapters are considered "extra unit price." When used during construction, adapter shall be paid at the unit price bid.

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

B. Stipulated Price (Lump Sum):

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

1.3 REFERENCES

A. AASHTO – American Association of State Highway and Transportation Officials.

1. Standard Specifications for Highway Bridges.

B. AREMA – American Railway Engineering and Maintenance-of-Way Association.

1. Manual of Railway Engineering, Volume II, Chapter 15.

C. ASTM – American Society for Testing and Materials.

1. ASTM A615 – Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.

2. ASTM C33 – Standard Specification for Concrete Aggregates.

3. ASTM C35 – Standard Specification for Inorganic Aggregates for Use in Gypsum Plaster.

4. ASTM C150 – Standard Specification for Portland Cement.

5. ASTM C497 – Standard Test Method for Concrete Pipe, Manhole Sections or Tile, Testing.

6. ASTM C1107 (CRD C-621) – Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).

7. ASTM D512 – Standard Test Methods for Chloride Ion in Water.

8. ASTM D1293 – Standard Test Methods for pH of Water.

9. ASTM E165 – Standard Test Methods for Dye Penetration.

10. ASTM E340 – Standard Test Method for Macroetching Metals and Alloys.

11. ASTM E709 – Standard Test Methods for Magnetic Particle Testing.

12. ASTM E1032 – Standard Test Methods for Radiographic Examination of Weldments.

D. ANSI – American National Standards Institute.

1. ANSI/AWS A3.0 – Standard Welding Terms and Definitions.

E. AWWA – American Water Works Association.

1. AWWA C206 – Standard for Field Welding of Steel Water Pipe.

2. AWWA C207 – Standard for Steel Pipe Flanges for Waterworks Service – Sizes 4 in. through 144 in.

3. AWWA C301 – Standard for Prestressed Concrete Pressure

Pipe, Steel-Cylinder Type, for Water and Other Liquids.

4. AWWA C303 – Standard for Concrete Pressure Pipe, Bar-Wrapped, Steel-Cylinder Type.

5. AWWA C304 – Standard for Design of Prestressed Concrete Cylinder Pipe.

6. AWWA M9 – Concrete Pressure Pipe.

F. CFTS – City of Friendswood Technical Specifications.

1. Section 01270 – Measurement and Payment.

2. Section 01330 – Submittal Procedures.

3. Section 02125 – Excavation and Backfill for Utilities.

4. Section 02250 – Steel Pipe and Fittings.

5. Section 02255 – Steel Pipe and Fittings for Large Diameter Water Lines.

6. Section 02275 – Pipe and Casing Augering for Sanitary Sewers.

7. Section 02285 – Cathodic Protection.

8. Section 02400 – Water Lines.

G. NSF – National Science Foundation.

1. NSF 61 – Drinking Water System Components – Health Effects.

H. SSPC – Steel Structures Painting Council.

1. SSPC SP 7 – Surface Preparation Specification No. 7 Brush Off Blast Cleaning.

1.4 SUBMITTALS

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

B. Submit shop drawings and certification signed and sealed by a Professional Engineer registered in the State of Texas showing

following:

1. Manufacturer's pipe design calculations.

2. Lay schedule of pictorial nature indicating alignment and grade, laying dimensions, welding procedures, fabrication, fitting, flange and special details, with the plan view of each pipe segment sketched, detailing pipe invert elevations, horizontal bends, welded joints and other critical features. Indicate station numbers for pipe and fittings corresponding to the Drawings. Do not start production of pipe and fittings prior to review and approval by the Project Manager. Provide final approved lay schedule on CD-ROM in Adobe portable document format (*PDF).

3. Include hot tapping procedure.

4. Submit certification from manufacturer that design was performed for project in accordance with requirements of this Section.

C. Submit inspection procedures to be used by manufacturer and for quality control and assurance for materials and welding. Submit standard repair procedures that describe in detail shop and field work to be performed. Repair defects such as substandard welds, excessive radial offsets (misalignment), pitting, gouges, cracks, etc.

D. Submit following within forty-five days (45 D) after manufacturing of pipe and fittings:

1. Steel:

   a. Steel reports as required in AWWA C303, Section 5.2.5.

   b. Results of other tests of steel reinforcement required in AWWA C303, Section 5.2.

2. Test Results.

   a. Hydrostatic testing, acid etching, magnetic particle and x-ray weld test reports as required.

   b. Compressive strength [seven day (7 D) and twenty-eight day (28 D)] test results for each type of coating and lining mix design.

3. Submit pipe manufacturer's certification that Bar Wrapped Steel Cylinder Pipe:

   a. Cylinder assembly has been hydrostatically tested at factory.

   b. Mortar coatings and linings were applied and allowed to cure at temperature above thirty-two degrees Fahrenheit (32° F).

E. Submit the following for nonshrink grout for special applications:

1. Manufacturer's technical literature including the specifications for mixing, placing and curing grout.

2. Results of tests performed by certified independent testing laboratory showing conformance to ASTM C1107, Nonshrink Grout and requirements of this Technical Specification.

3. Certification that product is suitable for use in contact with potable water.

F. Submit certification for welder and welding operator demonstrating their certification within past six months (6 Mos) in accordance with AWWA C206. Indicate certified procedures and position each welder is qualified to perform.

G. Calibration within last twelve months (12 Mos) for equipment such as scales, measuring devices and calibration tools used in manufacture of pipe. Each device used in manufacture of pipe is required to have tag recording date of last calibration. Devices are subject to inspection by the Project Manager.

1.5 QUALITY CONTROL

A. Manufacturer is to have permanent quality control department and laboratory facility capable of performing inspection and testing required. Inspection procedures and manufacturing process are subject to inspection by the Project Manager. Perform manufacturer tests and inspections required by AWWA C303 as modified by these Technical Specifications. Correct nonconforming conditions.

1. Cylinder and Joint Ring Assembly:

   a. Review mill certifications for conformance to

requirements of these Technical Specifications.

b. Perform physical testing of each heat of steel for conformance to applicable ASTM standards.

c. Inspect physical dimensions and overall condition of joint rings and cylinder/joint ring assembly to verify compliance with requirements of AWWA C303. Maximum allowable thickness variation of cylinder shall not be less than the determined thickness.

1) Cylinders with a nominal diameter of ten inches (10 In) to sixteen inches (16 In) shall have a tolerance of plus or minus three-sixteenths inch (±3/16 In).

2) Cylinders with a nominal diameter of eighteen (18) inches to sixty inches (60 In) shall have a tolerance of plus or minus one-quarter of an inch (±1/4 In).

d. Test cylinder/joint ring weld for tensile strength. Test one specimen for each five hundred (500) cylinder/joint ring assemblies in addition to those tests required by AWWA C301.

e. Reject pipe with dented steel cylinders.

2. Bar Rod

a. Review mill certifications for conformance to requirements of Technical Specifications.

b. Inspect rod spacing during placement on cylinder.

c. Test rod splices for each production run or minimum of once a week, whichever is less, for conformance with minimum strength criteria.

3. Pipe Lining Coating:

a. Review mill certificates for each load of cement for conformance to ASTM C150.

b. Perform sieve analyses weekly for each source of coarse and fine aggregate for conformance to ASTM

C33.

c. Inspect kiln recorder charts daily to confirm proper curing environment.

d. Verify mortar thickness on each size of pipe to a tolerance of one-sixteenth of an inch (1/16 In) more or less that the required thickness.

e. Perform absorption tests in accordance with ASTM C497, Method A, on cured mortar samples taken from pipes.

f. Check mortar batch proportions, moisture content and slurry application rate. Check coating thickness over wire on each pipe.

g. Check physical integrity of cured mortar coating. Check cured mortar coating for soundness on every pipe in field in addition to manufacturing plant.

h. Reject pipe with cracks in mortar coating exceeding one hundredth inches (0.01 In) wide.

4. Protective Coatings: Check daily application rate and resulting dry film thickness.

B. Gaskets:

1. Randomly test rubber cord for diameter, tensile strength, elongation, compression set, hardness and specific gravity after oven aging on one (1) out of one hundred (100) gaskets.

2. Stretch test each gasket splice to twice its unstretched length and inspect for defects.

C. Weld Testing

1. Perform macroetching tests for complete penetration production welds on normal production weld tests. Complete joint penetration welds are defined in ANSI/AWS A3.0. Verify complete joint penetration by means of macroetch of joint weld cross section. Macroetch technique in accordance with ASTM E340.

2. Perform ultrasonic or x-ray testing of manual welds for fittings

and special pipes. Perform dye penetration testing of manual lap welds for fittings and special pipes and for joint ring weld onto cylinder.

3. Perform minimum of one (1) set of weld test specimens in accordance with ANSI/AWS A3.0 on each size, grade and wall thickness at minimum of every three thousand feet (3000 Ft) of pipe manufactured; but perform no less than one (1) test per project by each welding machine and each operator.

D. Cast four (4) standard test cylinders each day for each fifty cubic yards (50 Cy) of concrete mortar coating or portion thereof for each coating and lining mix design placed in each day. Perform compressive strength test at twenty-eight days (28 D). No cylinder test result shall be less than eighty percent (80%) of specified strength. Reject pipe that does not meet minimum strength requirements.

E. Make available copy of Physical and Chemical testing reports for steel cylinders and provide reports at request of the Project Manager.

F. Check physical dimensions of pipe and fittings: Physical dimensions to include at least pipe lengths, pipe I.D., pipe O.D. and bend angles.

PART II: PRODUCTS

2.1 MATERIALS

A. Furnish pipe by same manufacturer.

B. Provide bar wrapped steel cylinder pipe in conformance with AWWA C303 and AWWA M9, except as modified herein. Produce pipe cylinder to conform to AWWA C303 except modify Section 4.5 to require that total cross-sectional area of bell ring plus cross-sectional area of bar reinforcement over bell ring exceed circumferential steel area in like length of barrel area by one-third (1/3).

C. Use of pipe from inventory is permitted only if the specifications and certifications are met. Provide testing records for such pipe.

D. Do not use bar wrapped steel cylinder pipe in aerial crossings, exposed or other unburied areas.

E. Pipe Manufacturer:

1. Must have minimum of five years (5 Yrs) of manufacturer's pipe installations that have been in successful and continuous

service.

2. Must maintain on site or in plant minimum of four (4) – twenty-two and one-half degree (22-1/2°) bends per ten thousand linear feet (10000 Lf) of water line. Any combination of bends may be substituted at manufacturer's option [i.e. two (2) – eleven and one-fourth degree (11-1/4°) bends are equivalent to one (1) – twenty-two and one-half degree (22-1/2°) bend and shall be counted as one (1) fitting]. Must be capable of delivering bends to job site within twelve hours (12 Hrs) of notification. These fittings are in addition to any fittings called out on the Drawings and must be available at all times.

F. Pipe Design Conditions:

1. Working pressure: One hundred pounds per square inch (100 psi).

2. Hydrostatic field test pressure: One hundred fifty pounds per square inch (150 psi).

3. Maximum pressure due to surge: One hundred fifty pounds per square inch (150 psi).

4. Minimum pressure due to surge: Minus five pounds per square inch (-5 psi).

5. Unit weight of soil: One hundred twenty pounds per cubic foot (120 pcf) minimum, unless otherwise specified.

6. Minimum trench width: O.D. of pipe + four feet (+4 Ft).

7. Pipe and Fittings: Designed to withstand most critical simultaneous application of external loads including construction loads and internal pressures.

8. Design: Design pipe and fittings to withstand most critical simultaneous application of external loads and internal pressures. Base design on minimum of AASHTO HS-20 loading, AREA E-80 loads and depths of bury as indicated on the Drawings. Design pipes with Marston's earth loads for transition width trench for all heights of cover.

   a. Calculate moments and thrusts in wall based on earth load.

9. Increase longitudinal steel area (cylinder thickness) to prevent cylinder stress from exceeding forty percent (40%) of minimum yield point at rated working pressure and sixty-seven percent (67%) of minimum yield point at rated maximum surge pressure where pipe and fittings are subjected to longitudinal stresses induced by restrained joints or thrust blocks.

10. Groundwater Level: Design for most critical ground water level condition.

11. Modulus of elasticity (E) = Thirty million pounds per square inch (30000000 psi).

12. Design stress due to working pressure shall be no greater than fifty percent (50%) of minimum yield and stress not to exceed sixteen thousand five hundred pounds per square inch (16500 psi) for mortar coated pipe.

13. Design stress due to maximum hydraulic surge pressure shall be no greater than seventy-five percent (75%) of minimum yield and stress shall not exceed twenty-four thousand seven hundred fifty pounds per square inch (24750 psi) for mortar coated pipe.

14. Modulus of soil reaction (E) < One thousand five hundred pounds per square inch (1500 psi). If E > One thousand pounds per square inch (1000 psi), do not use silty sand (SM) for embedment.

15. Deflection lag factor (Dl) = One and two tenths (1.2).

16. Bedding constant (K) = One tenth (0.1).

17. Fully saturated soil conditions: hw = h = depth of cover above top of pipe.

18. Provide minimum inside clear diameter for casing in accordance with Section 02275 - Pipe and Casing Augering for Sanitary Sewers.

19. Design pipe for transmitting potable water, unless otherwise shown on the Drawings.

20. Augered Sections: Provide constant outside diameter from bell to spigot end for pipe. Design pipe and pipe joints to carry loads including but not limited to: overburden and lateral earth

pressures, subsurface soil, grouting, other conditions of service, thrust of jacks and any stress anticipated during handling and installation.

G. Coatings and Linings:

1. Provide Portland cement; ASTM C150, Type I or II. Provide one type of cement for entire project.

2. Water Absorption Test: ASTM C497, Method A; perform on samples of cured mortar coating taken from each working shift. Cure mortar coating samples in same manner as pipe.

   a. Test Value: Average minimum of three (3) samples taken from same working shift, no greater than nine percent (9%) for average value and eleven percent (11%) for individual value.

   b. Test Frequency: Perform tests each working shift until conformance to absorption requirements has been established by ten (10) consecutive passing test results, at which time testing may be performed weekly. Resume testing for each working shift if absorption test results fail until conformance to absorption requirements is reestablished by ten (10) consecutive passing test results.

3. Apply one (1) coat of primer to exposed steel parts of steel bell and spigot rings. Prior to coating, blast clean in accordance with SSPC-SP7 (Brush Off Blast Cleaning). Apply primer in accordance with manufacturer's recommendations.

4. Coat and line access inlets, service outlets and test inlets with same coating and lining of water line pipe in accordance with AWWA C303, Section 4, unless otherwise indicated on the Drawings.

5. Do not defer placing of coating of any portion of pipe length. Verify cement mortar coating thickness on each size of pipe by nondestructive method before removing pipe from coating machine.

6. Remove and replace disbonded lining or coating. Reject pipe requiring patches larger than one hundred square inches (100 SqIn) or twelve inches (12 In) in greatest dimension. Allow no more than one (1) patch on either lining or coating of pipe.

Provide WELD-CRETE Probond Epoxy Bonding Agent ET-150, parts A and B; Sikadur 32 Hi-Mod or approved equal bonding agent for pipe patching.

H. Fittings and Specials:

1. Design fittings to same internal and external loads as straight pipe.

2. Manufacture in accordance with Section 02255 – Steel Pipe and Fittings for Large Diameter Water Lines.

3. Provide fabricated bends or fittings with minimum radius of two and one-half (2-1/2) times pipe diameter.

4. Design test plugs to withstand forces generated by hydrostatic test and test pressure from either side. Do not exceed fifty percent (50%) of minimum yield for design stresses due to hydrostatic pressure. Assume opposite side of plug does not contain water.

5. Provide no specials less than four feet (4 Ft) in length unless indicated on the Drawings or approved by the Project Manager.

6. Butt Straps for Closure Piece: Provide at locations indicated on the Drawings or authorized by the Project Manager. Minimum twelve inch (12 In) wide split butt strap; minimum plate thickness equal to thinnest member being joined; fabricated from material equal in chemical and physical properties to thinnest member being joined. Permit no angular deflection at butt-strap joints.

7. Provide minimum six inch (6 In) welded outlet for inspecting each closure section, unless access manway is within forty feet (40 Ft) of closure section.

8. Provide Densco petroleum based tape or approved equal for exposed portions of nuts and bolts.

I. Joints:

1. AWWA C303 rubber-gasketed or welded bell-and-spigot type except where flanged joints are required for valves and fittings as shown on the Drawings. Refer to Section 02400 – Water Lines for details on joints and jointing.

2. Rubber-Gasketed Joints: Single weld bell and spigot ring onto steel cylinder. In thrust areas, double weld bell and spigot onto steel cylinder.

3. Restrained Joints: Restrain joints by welding or harnessing joints.

   a. Design Pressure: One and one-half (1.5) times working pressure.

   b. Harnessed Joints: AWWA M9, clamp or snap ring type, except where prohibited.

   c. Groundwater Level: Assumed to be equal to natural ground surface.

   d. Provide restrained joint pipe with adequate cylinder thickness to transmit full thrust generated by internal pressure across joints.

      1) Calculate distance of restrained joints based on resistance along each leg of bend with thrust based on bend angle.

      2) Cylinder thickness shall not be less than that defined in AWWA C303, Table 2 and minimum nominal cylinder thickness.

      3) Allow cylinder thickness to reduce linearly from maximum calculated thickness to minimum thickness required by design over required length (as determined in Paragraph 2.1.I.3.d.1) of restrained joints.

      4) Provide full circumferential welds at joints required to be welded.

J. Use only fully circumferentially welded joints in areas considered potentially petroleum contaminated, within tunnels and under foreign pipelines. Perform welding in accordance with Section 02250 – Steel Pipe and Fittings and Section 02255 – Steel Pipe and Fittings for Large Diameter Water Lines.

K. Pipe Flanges: AWWA C207 for standard steel flanges of pressure class corresponding to pipe class.

L. Pipe lengths: Provide pipe sections in standard lengths with minimum length of sixteen feet (16 Ft) and maximum length of twenty-five feet (25 Ft) and as indicated on approved shop the Drawings or approved by the Project Manager. Gasketed joints are allowed on standard lengths of pipe. Nonstandard pipe lengths shall be approved by the Project Manager and joints must be welded as specified herein to achieve equal to or greater than standard pipe length before gasketed joints can be used. Internally and externally mark pipe section with durable marking to show location and pipe pressure.

M. Hydrostatic Test of Cylinder: In accordance with AWWA C303, at point of manufacture. Hold test for minimum two minutes (2 Min) for thorough inspection of cylinder. Repair or reject cylinders revealing leaks or cracks.

N. Transport fittings with end caps. Remove end caps just prior to installation.

O. Transport fittings thirty-six inches (36 In) in diameter and larger with stulls. Remove stulls after completion of backfill.

P. Provide radius of curve as indicated on the Drawings unless approved by the Project Manager. Make curves and bends by deflecting joints, by use of beveled joints or by combination of two (2) methods, unless otherwise indicated on the Drawings. Do not exceed deflection angle recommended by pipe manufacturer. Provide beveled pipe sections of standard length used in curved alignment, except when shorter sections are required to limit radius of curvature. In such case, provide sections throughout curve of substantially equal length.

Q. When manufacturing straight pipe sections, manual welding is allowed for following:

1. Tack welding of coils and plates during continuous pipe making process.

2. Rewelding and repairing structural defects in plate and automatic machine welds.

3. Attaching new coil of steel to previous coil.

2.2 BAR ROD

A. Conform to requirements of ASTM A615, AWWA C303 and this Technical Specification.

B. Test foreign manufactured rod by local independent laboratory.

C. Rod manufacturer shall be responsible for performing mechanical tests required in ASTM A615.

D. Pipe manufacturer shall be responsible for requiring rod manufacturer to submit certified results of chemical and mechanical tests, performed by rod manufacturer. Pipe manufacturer is responsible for performing mechanical tests and is required to attest to such in affidavit of compliance.

E. Do not use rod with visible pitting.

2.3 GROUT FOR JOINTS AND SPECIAL APPLICATION

A. Joint Grout:

1. Cement Grout Mixture: One (1) part cement to two (2) parts of fine, sharp clean sand. Mix interior joint mortar with as little water as possible until very stiff but workable. Mix exterior joint mortar with water until it has consistency of thick cream.

2. Water: Potable water with total dissolved solids less than One thousand milligrams per liter (1000 mg/l); ASTM D512 chloride ions less than one hundred milligrams per liter (100 mg/l) for slurry and mortar cure; ASTM D1293 pH greater than 6.5. Use potable water with two hundred fifty parts per million (250 ppm) limit on chlorides and sulfates.

3. Portland Cement: ASTM C150, Type I or II. Provide one type of cement for entire project.

4. Sand:

a. Interior joints: ASTM C35 fine graded plaster sand.

b. Exterior joints: ASTM C33 natural sand with one hundred percent (100%) passing No. 16 sieve.

5. Mix cement grout to specific gravity of nineteen pounds per gallon (19 Lb/Gal) or greater as measured by grout/slurry balance. Use balance manufactured grout/slurry balance manufactured by Baroid or approved equal. Perform test in presence of and as requested by the Project Manager. Add additional cement grout or water to mixed cement grout to bring mix to proper moisture content or specific gravity. Discard

cement grout mixed more than twenty minutes (20 Min) that is not at proper moisture content or specific gravity.

B. Nonshrink Grout for Special Applications, Patches and Repairs.

1. Conform to requirements of ASTM C1107, Nonshrink Grout.

2. Pre-blended factory-packaged material manufactured under rigid quality control.

3. Contain non-metallic natural aggregate, be nonstaining and noncorrosive.

4. Meeting NSF 61 Standard suitable for use in contact with potable water supply.

5. Exterior: Highly flowable to fill joint wrapper without leaving voids or trapped air. Interior capable of being placed with plastic consistency.

6. Non-bleeding and non-segregating at fluid consistency.

7. Contain no chlorides or additives which may contribute to corrosion of bar wrapped steel cylinder pipe.

8. Free of gas-producing, gas-releasing agents.

9. Resist attack by oil or water.

10. Mix, place and cure in accordance with manufacturer's recommendations. Upon seventy-two hours (72 Hrs) notice, provide services of qualified representative of nonshrink grout manufacturer to aid in use of product under job conditions.

11. Mix nonshrink grout to specific gravity of seventeen and seven-tenths pounds per gallon (17.7 Lb/Gal) or greater as measured by grout/slurry balance. Use grout/slurry balance manufactured by Baroid or approved equal. Perform test in presence of and as requested by the Project Manager. Add additional non-shrink grout to mixed non-shrink grout to bring to proper moisture content or specific gravity. Discard grout mixed more than twenty minutes (20 Min) that is not at proper moisture content or specific gravity.

12. Compressive strength: ASTM C1107 two thousand five hundred pounds per square inch (2500 psi) minimum seven

day (7 D) unconfined; five thousand pounds per square inch (5000 psi) minimum twenty-eight day (28 D) unconfined.

C. Finished surface of lining and interior joint shall be comparable to surface rubbed with No. 16 Carborundum stone. Rub joint mortar sufficiently to bring paste to surface, to remove depressions and projections and to produce smooth, dense surface. Add cement to form surface paste as necessary. Leave interior with clean, neat and uniform-appearing finish.

D. Joint Wrapper: Minimum width of nine inches (9 In) for thirty-three inch (33 In) diameter and smaller; minimum width of twelve inches (12 In) for diameters greater than thirty-three inch (33 In) hemmed at edge to allow threading with minimum five-eights inch (5/8 In) wide steel strap. Provide minimum six inch (6 In) wide Ethafoam strip sized, positioned and sewn such that two circumferential edges of Ethafoam are one and one-half inches (1-1/2 In) from outer edge of wrapper.

2.4 CATHODIC PROTECTION

A. Conform to requirements of Section 02285 – Cathodic Protection.

B. Connect each joint of pipe with bonding straps or approved devices to maintain continuity of current. Provide bonding straps free of foreign material.

C. Electrically isolate water line from other connections. Use insulating type joints or nonmetallic pipe unless otherwise indicated on the Drawings.

D. Provide flange adapter with insulating kit as required when connecting new piping to existing piping.

2.5 INSPECTION AND SHIPPING

A. Permit the Project Manager to inspect pipes or witness pipe manufacturing. Inspection shall not relieve manufacturer of responsibilities to provide products that comply with applicable standards and these Technical Specifications. Should the Project Manager elect not to inspect manufacturing, testing or finished pipes, it shall in no way imply approval of products or tests.

B. Manufacturer's Notification to Customer: Should the Project Manager wish to see specific pipes during manufacturing process, manufacturer shall provide the Project Manager with minimum of three weeks (3 Wks) advance notice of when and where production of those pipes shall take

place.

C. Repair damage to pipe or protective lining per manufacture specifications before final acceptance.

D. Shipping: Where required, provide pipe and fittings with sufficient interior strutting or cross bracing to prevent deflection under their own weight.

PART III: EXECUTION

3.1 INSTALLATION

A. Conform to requirements of Section 02400 – Water Lines. Do not install pipe without approved lay schedule.

B. Install pipe within six months (6 Mos) of pipe being manufactured.

C. Manufacturer shall make available services of representative, throughout project duration when deemed necessary by the Project Manager, to advise aspects of installation including but not limited to handling, storing, cleaning and inspecting, coatings and linings repairs and general construction methods affecting pipe.

D. Bedding and Backfilling

1. Conform to requirements of Section 02125 – Excavation and Backfill for Utilities.

2. Take necessary precautions during bedding and backfilling operations to prevent deformation or deflection of cylindrical shape of pipe by more than allowable pipe deflection.

3. Do not move trench support system (trench safety system) once bedding material is compacted.

4. Align pipe at proper grade prior to joint connection and do not shift after jointing operation has been completed.

5. Excavate outside specified trench section for bell holes and for spaces sufficient to permit removal of slings. Provide bell holes at proper locations for unrestricted access to joint. Form bell holes large enough to facilitate joint wrapping and to permit visual examination of process. Enlargement of bell holes shall be as required or directed by the Project Manager. Subsequent backfilling thereof shall not be considered as authorized

additional excavation and backfill. Backfill bell holes and spaces to satisfaction of the Project Manager.

6. Remove blocking after placing sufficient backfill to hold pipe in position.

E. Follow nonshrink grout manufacturer's specifications for nonshrink grouting.

F. Store pipe at job-site with securely-fastened plastic end caps to maintain moist pipe interior. Promptly replace damaged end caps to avoid shrinkage or cracking of cement-mortar lining. Immediately replace damaged plastic end caps. Do not leave uncapped for more than four hours (4 Hrs).

G. Deviation of installed pipe in any one (1) pipe section from line and grade shown on approved shop drawing layout shall not exceed two inches (2 In) from grade and three inches (3 In) from line. No deviation from line and grade at contact interfaces are allowed.

H. Use adequate surveying methods, procedures and employ competent surveying personnel to ensure pipe sections are laid to line and grade and within stipulated tolerances. Measure and record, in form approved by the Project Manager, in-place survey data for pipe laid each day and submit copy of data to the Project Manager at end of that day. Survey data to include unique pipe number, deflection angle at pipe joint and whether beveled ends were used, invert elevation at pipe joint, deviation of joint from project line, deviation of joint from project grade, inside pipe joint lap measured at top, bottom and at springline (each side).

I. Static Electricity:

1. Properly ground steel pipeline during construction as necessary to prevent buildup of static electricity.

2. Electrically test where required after installation of pipeline is complete.

3.2 DEFLECTION

A. Allowable deflection from specified diameter determined as follows: Allowable Deflection = $(D)_2/4000$, (D= Nominal inside pipe diameter in inches).

B. Deflection shall be measured by the Project Manager at location along

pipe. Arithmetical averages of deflection are not acceptable.

C. If deflection exceeds that specified, remove entire portion of deflected pipe section and install new pipe as directed by the Project Manager at no cost to the City.

3.3 CLOSURES AND APPROVED PIPE MODIFICATIONS.

A. No modifications of standard pipe for closures shall be permitted in field. No field cutting of pipe or exposure of bar wire shall be permitted without written approval from the Project Manager.

B. Pipe manufacturer's representative and the Project Manager to entirely witness closures and approved pipe modification efforts.

C. Provide minimum lap of four inches (4 In) between member being joined and edge of butt strap. Weld on both interior and exterior, unless otherwise approved by the Project Manager.

D. Provide full circumferential welds on joints required to be welded. Employ independent certified testing laboratory, approved by the Project Manager, to perform weld tests on field welds. Include cost of such testing in contract unit price for water line. Use magnetic particle test method for lap welds or X-ray methods for butt welds, for one hundred percent (100%) of joint welds. Maintain records of tests. If defective weld is revealed, repair defective weld and retest. Use wire and flux from same manufacturer throughout entire project.

E. Fill wrapper in field and allowing excess grout water to seep out. Refill wrapper as necessary. When joint mortar level has stabilized and begun to mechanically stiffen, lap Ethafoam wrapper over top of joint and secure in place.

F. Stretch test each gasket splice to twice its unstretched length and inspect for defects.

3.4 VISIBLE CRACKS

A. No visible cracks longer than six inches (6 In), measured to be within fifteen degrees (15°) of line parallel to pipe longitudinal axis, shall be permitted except:

1. In surface laitance of centrifugally cast concrete,

2. In sections of pipe with steel reinforcing collars or wrappers or

3. Within twelve inches (12 In) of pipe ends.

B. Repair interior lining cracks that exceed one-sixteenth inch (1/16 In), (0.0625 inches), wide.

C. Reject pipe with exterior coating cracks that exceed one hundredth inches (0.01 In) wide.

D. Immediately remove pipe from site if pipe has cracks exceeding limitations and cracks are not repairable.

3.5 FIELD REPAIR PROCEDURES FOR COATING/LINING

A. Areas less than or equal to six inches (6 In) in diameter: Patch honeycomb and minor defects in concrete surfaces with nonshrink grout conforming to section 2.3.B. Use only manual or small (low pressure) air chisels to chip away mortar coating or lining. Cut out unsatisfactory material and replace with nonshrink grout, securely bonded to existing coating or lining. Finish junctures between patches and existing concrete as inconspicuous as possible. Strike off nonshrink grout flush with surrounding surface after patch has stiffened sufficiently to allow for greatest portion of shrinkage. Finish surface in accordance with lining requirements.

B. Pipe with defective coating areas greater than six inches (6 In) in diameter shall not be used. Immediately remove pipe from project.

C. Reject pipe if steel cylinder is dented while making field repair. Immediately remove pipe from project.

END OF SECTION

SECTION 02205

COPPER TUBING

PART I: GENERAL

1.1 GENERAL REQUIREMENTS

A. Copper tubing for water service lines.

1.2 MEASUREMENT AND PAYMENT

A. Unit Prices:

1. No separate payment will be made for copper tubing under this Section. Include cost in unit price for water taps and service lines.

2. Refer to Section 01270 – Measurement and Payment for unit price procedures.

B. Stipulated Price (Lump Sum):

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

1.3 REFERENCES

A. ASTM – American Society for Testing and Materials.

1. ASTM B88 – Standard Specification for Seamless Copper Water Tube.

B. AWWA – American Water Works Association.

1. AWWA C800 – Standard for Underground Service Line Valves and Fittings.

C. CFTS – City of Friendswood Technical Specifications.

1. Section 01270 – Measurement and Payment.

2. Section 01330 – Submittal Procedures.

3. Section 02430 – Water Tap and Service Line Installation.

1.4 SUBMITTALS

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

B. Submit certified test results of ASTM B88.

C. Submit manufacturer's testing certification that copper tubing conforms to requirements of ASTM B88. Number of samples for testing of each size of tubing is modified as follows:

1. For each seven thousand five hundred feet (7500 Ft) of tubing: One (1) sample.

2. For each set of tubing less than thousand five hundred feet (7500 Ft): One (1) sample

1.5 QUALITY ASSURANCE

A. Provide manufacturer's affidavits that pipe was manufactured in compliance with standards referenced in this Section.

PART II: PRODUCTS

2.1 MATERIALS

A. Provide Type K annealed, seamless, copper tubing, one inch (1 In) to two inch (2 In) in diameter conforming to requirements of ASTM B88.

B. Provide one inch (1 In) tubing in coils of minimum sixty feet (60 Ft) in length and one and one-half inch (1-1/2 In) and two inch (2 In) tubing in coils forty feet (40 Ft) in length.

C. Provide tubing manufactured in United States of America. Tubing shall be inspected and tested by laboratory designated by the Project Manager at point of manufacture or locally. Furnish tubing, at no additional cost to designated testing laboratory along with mill compliance certificates.

D. Provide flared or compression-type brass fittings for use with Type K annealed copper tubing in accordance with AWWA C800.

PART III: EXECUTION

3.1 INSTALLATION

A. Conform to installation requirements of Section 02430 – Water Tap and Service Line Installation, except as modified in this Section.

3.2 JOINTS

A. Minimum joint spacing for one inch (1 In) tubing shall be sixty feet (60 Ft), for one and one-half inch (1-1/2 In) and two inch (2 In) tubing shall be forty feet (40 Ft).

B. Cut copper tubing squarely by using cutting tools designed specifically for purpose and avoid procedures that cause pipe to bend or pipe walls to flatten.

C. After tubing has been cut, but before flaring, use reamer to remove inside rolled lip from tubing. Expand flared ends by use of flaring tool using care to avoid splitting, crimping or over stressing metal. Provide at least ten inches (10 In) of straight pipe adjacent to fittings.

D. When compression fittings are used, cut copper tubing squarely prior to insertion into fitting. Assemble in accordance with manufacturer's recommended procedure.

3.3 BENDS

A. Bend tubing by using appropriate sized bending tool. No kinks, dents, flats or crimps shall be permitted. Cut out and replace damaged section. Install no bends with radius smaller than radius of coil of tubing as packaged by manufacturer. Copper tubing shipped in straight lengths conforms to the following:

1. For two inch (2 In) diameter: Maximum of one (1) – forty-five degree (45°) bend per four foot (4 Ft) section.

2. For one and one-half inch (1-1/2 In) diameter: Maximum of one (1) – forty-five degree (45°) bend per three foot (3 Ft) section.

END OF SECTION

SECTION 02210

CORRUGATED METAL PIPE (CMP)

PART I: GENERAL

1.1 GENERAL REQUIREMENTS

A. Corrugated metal pipe (CMP).

B. Corrugated metal pipe with smooth interior (CMPSI).

1.2 MEASUREMENT AND PAYMENT

A. Unit Prices:

1. No separate payment will be made for corrugated metal pipe in open cut under this Section. Include payment in the unit price for Section 02600 – Storm Sewers.

2. No separate payment will be made for corrugated metal pipe in non-open cut under this Section. Include payment in the unit price for applicable tunneling section.

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

B. Stipulated Price (Lump Sum):

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

1.3 REFERENCES

A. AASHTO – American Association of State Highway and Transportation Officials.

1. AASHTO M36 – Corrugated Steel Pipe, Metallic-Coated, for Sewers and Drains.

2. AASHTO M 90 – Bituminous Coated Corrugated Metal Culvert Pipe and Pipe Arches.

3. AASHTO M196 – Corrugated Aluminum Pipe for Sewers and Drains.

4. AASHTO M197 – Aluminum Alloy Sheet for Corrugated Aluminum Pipe.

5. AASHTO M218 – Steel Sheet, Zinc Coated (Galvanized) for Corrugated Steel Pipe.

6. AASHTO M232 – Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

7. AASHTO M245 – Corrugated Steel Pipe, Polymer Precoated, for Sewers and Drains.

8. AASHTO M246 – Steel Sheet, Metallic-Coated and Polymer Precoated for Corrugated Steel Pipe.

9. AASHTO M274 – Steel Sheet, Aluminum-Coated (Type 2) for Corrugated Steel Pipe.

B. ASTM – American Society for Testing and Materials.

1. ASTM B633 – Standard Specification for Electro deposited Coatings of Zinc on Iron and Steel.

2. ASTM A760 – Standard Specifications for Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains.

C. CFTS – City of Friendswood Technical Specifications.

1. Section 01270 – Measurement and Payment.

2. Section 01330 – Submittal Procedures.

3. Section 02125 – Excavation and Backfill for Utilities.

4. Section 02600 – Storm Sewers.

1.4 SUBMITTALS

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

B. Submit shop drawings with following information:

1. Design dimensions and details for pipe and fittings indicating alignment, grade and laying dimensions.

2. Fabrication details, details of fittings and flanges, details of specials and proposed welding procedures.

3. Show station numbers for pipe and fittings corresponding to the Drawings.

1.5 QUALITY ASSURANCE

A. Provide manufacturer's affidavits that pipe was manufactured in compliance with standards referenced in this Section.

PART II: PRODUCTS

2.1 PIPE AND FITTINGS

A. Corrugated metal pipe may be galvanized steel, aluminized steel, aluminum or precoated galvanized steel as indicated on the Drawings and conforming to TABLE 4.1 – AASHTO STANDARDS in this Section.

1. Reference to gauge of metal is to U.S. Standard Gauge for uncoated sheets. Tables in AASHTO M218 and AASHTO M274 list thicknesses for coated sheets in inches. Tables in AASHTO M197 list thicknesses in inches for clad aluminum sheets.

B. Coupling bands and other hardware for galvanized or aluminized steel pipe shall conform to requirements of AASHTO M36 for steel pipe and AASHTO M196 for aluminum pipe.

1. Coupling bands shall be not more than three (3) nominal sheet thicknesses lighter than thickness of pipe to be connected and in no case lighter than fifty-two thousandths inch (0.052 In) for steel or forty-eight thousandths inch (0.048 In) for aluminum.

2. Coupling bands shall be made of same base metal and coating (metallic or otherwise) as pipe.

3. Minimum width of corrugated locking bands shall be as shown below for corrugations which correspond to end circumferential corrugations on pipes being joined:

a. Ten and one-half inches (10-1/2 In) wide for two and two-thirds inch by one-half inch (2-2/3 In x 1/2 In) corrugations.

b. Twelve inches (12 In) wide for three inch by one inch (3

In x 1 In) corrugations.

4. Helical pipe without circumferential end corrugations shall be permitted only when it is necessary to join new pipe to existing pipe which was installed with no circumferential end corrugations. In this event pipe furnished with helical corrugations at ends shall be field jointed with either helically corrugated bands or with bands with projections (dimples). Minimum width of helical corrugated bands shall conform to following:

   a. Twelve inches (12 In) wide for one-half inch (1/2 In) deep helical end corrugations.

   b. Fourteen inches (14 In) wide for one inch (1 In) deep helical end corrugations.

5. Bands with projections shall have circumferential rows of projections with one (1) projection for each corrugation. Width of bands with projections shall be not less than following:

   a. Twelve inches (12 In) wide for pipe diameters up to and including seventy-two inches (72 In). Bands shall have two (2) circumferential rows of projections.

   b. Sixteen and one-quarter inches (16-1/4 In) wide for pipe diameters of seventy-eight inches (78 In) and greater. Bands shall have four (4) circumferential rows of projections.

6. Bolts for coupling bands shall be one-half inch (1/2 In) diameter. Bands twelve inches (12 In) wide or less shall have minimum of two (2) bolts per end at each connection and bands greater than twelve inches (12 In) wide shall have minimum of three (3) bolts at each connection.

7. Galvanized bolts may be hot dip galvanized in accordance with requirements of AASHTO M232, mechanically galvanized to provide same requirements as AASHTO M232 or electro galvanized per ASTM B633, Type RS.

C. Coat bituminous coated pipe or pipe arch inside and out with bituminous coating which shall meet these performance requirements and requirements of AASHTO M190.

1. Uniformly coat pipe inside and out to minimum thickness of five

hundredths inch (0.05 In), measured on crests of corrugations.

2. Adhere bituminous coating to metal so that it shall not chip, crack or peel during handling and placement; and to protect pipe from corrosion and deterioration.

3. Where paved invert is shown on the Drawings, pipe or pipe arch, in addition to fully-coated treatment described above, shall receive additional bituminous material, same as specified above, applied to bottom quarter of circumference to form smooth pavement. Maintain minimum thickness of one-eight inch (1/8 In) above crests of corrugations.

D. Furnish fittings and specials required for bends, end sections, branches, access manholes and connections to other fittings. Design fittings and specials in accordance with the Drawings and ASTM A760. Fittings and specials are subject to same internal and external loads as straight pipe.

2.2 PIPE FABRICATION

A. Steel Pipe:

1. Galvanized or aluminized steel pipe shall be full circle or arch pipe conforming to AASHTO M36, Type I, Type IA or Type II, as indicated on the Drawings.

2. Fabrication with circumferential corrugations, lap joint construction with riveted or spotwelded seams, helical corrugations with continuous helical lock seam or ultra-high frequency resistance butt-welded seams is acceptable.

B. Aluminum Pipe:

1. Conform to requirements of AASHTO M196, Type I, Type IA, circular pipe or Type II, pipe arch as indicated on the Drawings.

2. Fabrication with circumferential corrugations, lap joint construction with riveted or spotwelded seams or helical corrugations with continuous helical lock seam.

3. Portions of aluminum pipe that is to be in contact with concrete or metal other than aluminum shall be insulated from these materials with coating of bituminous material meeting requirements of AASHTO M190. Extend coating minimum distance of one foot (1 Ft) beyond area of contact.

C. Precoated Galvanized Steel Pipe:

1. Pipe shall be full circle or arch pipe conforming to AASHTO M245, Type I, Type IA or Type II as indicated on the Drawings.

2. Fabrication with circumferential corrugations, lap joint construction with riveted seams or helical lock seams is acceptable.

3. Inside and outside coating shall be minimum of ten (10) mils.

PART III: EXECUTION

3.1 PREPARATION

A. Repair damaged spelter coating by thoroughly wire brushing damaged area and removing all loose, cracked or weld-burned spelter coating. Paint cleaned area with zinc dust-zinc oxide paint conforming to Federal Specifications TT-P-641g.

B. Repair damaged aluminized or polymer coating in accordance with manufacturer's recommendations.

3.2 EARTHWORK

A. Excavate in accordance with requirements of Section 02125 – Excavation and Backfill for Utilities, except where tunneling or jacking methods are shown on the Drawings. When pipes are laid in trench, trench when completed and shaped to receive pipe, shall be of sufficient width to provide free working space for satisfactory bedding and jointing and thorough tamping of backfill and bedding material under and around pipe.

B. Bed pipe in accordance with the Drawings. When requested by the Project Manager, furnish simple template for each size and shape of pipe for use in checking shaping of bedding. Template shall consist of thin plate or board cut to match lower half of cross section.

C. Where rock in either ledge or boulder form exists below pipe, remove rock below grade and replace with suitable materials so slightly yielding compacted earth cushion is provided below pipe minimum of twelve inches (12 In) thick.

D. Remove and replace where soil encountered at established grade is quicksand, muck or similar unstable materials in accordance with

requirements of Section 02125 – Excavation and Backfill for Utilities. Do not allow cement stabilized materials for backfill to come into contact with uncoated aluminum or aluminized pipe surface.

E. After metal pipe structure has been completely assembled on proper line and grade and headwalls constructed when required by drawing details, place selected material from excavation or borrow along both sides of completed structures equally, in uniform layers not exceeding six inches (6 In) in depth (loose measurement), wetted when required and thoroughly compacted between adjacent structures and between structure and sides of trench or for distance each side of structure equal to diameter of pipe. Compact backfill material to same density requirements as specified for adjoining sections of embankment in accordance with the specifications. Above three-fourths (3/4) point of structure, place uniformly on each side of pipe in layers not to exceed twelve inches (12 In).

F. Only hand operated tamping equipment shall be allowed within vertical planes two feet (2 Ft) beyond horizontal projection of outside surface of structure for backfilling, until minimum cover of twelve inches (12 In) is obtained. Remove and replace damaged pipe.

G. Do not permit heavy earth moving equipment to haul over structure until minimum of four feet (4 Ft) of permanent or temporary compacted fill has been placed.

H. During backfilling, obtain uniform backfill material and uniform compacted density throughout length of structure to avoid unequal pressure. Provide proper backfill under structure.

I. Prior to adding each new layer of loose backfill material, inspection shall be made of inside periphery of structure for local or unequal deformation caused by improper construction methods. Evidence of deformation shall be reason for corrective measures as may be directed by the Project Manager.

3.3 PIPING INSTALLATION

A. Place pipes on prepared foundation starting at outlet end. Join sections firmly together, with side laps or circumferential joints pointing upstream and with longitudinal laps on sides.

B. Coat metal in joints not protected by galvanizing or aluminizing with approved asphaltum paint.

C. Provide proper equipment for hoisting and lowering sections of pipe into

trench without damaging pipe or disturbing prepared foundation and sides of trench. Take up and re-lay pipe which is not in alignment or which shows undue settlement after laying or is damaged.

D. Lay multiple installations of corrugated metal pipe and pipe arches with center lines of individual barrels parallel. Unless otherwise indicated on the Drawings, maintain following clear distances between outer surfaces of adjacent pipes as specified in TABLE 4.2 – PIPE CLEARANCE DISTANCES in this Section.

E. Where extensions are attached to existing structures, install proper connection between structure and existing as indicated on the Drawings, coat connection with bituminous material when required.

F. When existing headwalls and aprons are indicated for reuse on the Drawings, sever portion to be reused from existing culvert and relocate to prepared position. Restore damaged headwalls, aprons or pipes attached to headwall to their original condition.

3.4 JOINTING

A. Use field joints to maintain pipe alignment during construction and prevent infiltration of side material.

B. Lap coupling bands equally on pipes being connected to form tightly-closed joint.

C. Use corrugated locking bands to field join pipes furnished with circumferential corrugations including pipe with helical corrugations having reformed circumferential corrugations on ends. Fit locking bands into minimum of one (1) full circumferential corrugation of pipe ends being coupled.

PART IV: TABLES

4.1 AASHTO STANDARDS

Corrugated Metal Pipe Type	**AASHTO Standard**
Galvanized Steel	AASHTO M218
Aluminized Steel	AASHTO M274
Aluminum	AASHTO M197
Precoated Galvanized Steel	AASHTO M246

4.2 PIPE CLEARANCE DISTANCES

Diameter of Pipe	Clear Distance Between Pipes Full Circle and Pipe Arch	Pipe Arch Design No.
18”	1’ – 2”	2
24”	1’ – 5”	3
30”	1’ – 8”	4
36”	1’ – 11”	5
42”	2’ – 2”	6
48”	2’ – 5”	7
54”	2’ – 10”	5
60” – 84”	3’ – 2”	9
90” – 120”	3’ – 5”	10 & Over

END OF SECTION

SECTION 02215

DUCTILE IRON PIPE (DIP) AND FITTINGS

PART I: GENERAL

1.1 GENERAL REQUIREMENTS

A. Ductile Iron Pipe (DIP) and fittings for water lines, wastewater force mains, gravity sanitary sewers and storm sewers.

1.2 MEASUREMENT AND PAYMENT

A. Unit Prices:

1. No separate payment will be made for Ductile Iron Pipe (DIP) and fittings under this Section, with the exception of extra fittings in place. Include cost in unit prices for work as specified in the following Sections, as applicable:

   a. Section 02400 – Water Lines.

   b. Section 02500 – Gravity Sanitary Sewers.

   c. Section 02510 – Sanitary Sewer Force Mains.

   d. Section 02600 – Storm Sewers.

2. Refer to Section 01270 – Measurement and Payment for unit price procedures.

B. Extra Ductile Iron Pipe (DIP) Compact Fittings in Place shall be for additional fittings required to complete job. This is not to exclude extension of pipe across driveway or intersection for purpose of terminating line in more advantageous position. This determination shall be at discretion of the Project Manager. This bid item includes additional fittings as may be necessary to complete job in conformance with intent of the Drawings.

C. Stipulated Price (Lump Sum):

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

1.3 REFERENCES

A. AASHTO – American Association of State Highway and Transportation Officials.

B. AREMA – American Railway Engineering and Maintenance-of-Way Association.

1. Manual for Railway Engineering.

C. ANSI – American National Standards Institute.

1. ANSI A21.4 (AWWA C104) – Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings, for Water.

2. ANSI A21.10 (AWWA C110) – Standard for Ductile-Iron and Gray-Iron Fittings, 3-in. through 48-in.

3. ANSI A21.11 (AWWA C111) – Standard for Rubber Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

4. ANSI A21.15 (AWWA C115) – Standard for Flanged Ductile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges.

5. ANSI A21.16 (AWWA C116) – Protective Fusion Bonded Epoxy Coating for the Interior and Exterior Surfaces of Ductile Iron and Grey iron Fittings for Water Supply Service.

6. ANSI A21.50 (AWWA C150) – Standard for Thickness Design of Ductile-Iron Pipe.

7. ANSI A21.51 (AWWA C151) – Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water and Other Liquids.

8. ANSI A21.53 (AWWA C153) – Standard for Ductile Iron Compact Fittings, 3 inches through 24 inches and 54 inches through 64 inches for Water Service.

D. ASME – American Society of Mechanical Engineers.

1. ASME B16.1 – Cast Iron Pipe Flanges and Flanged Fittings.

E. ASTM – American Society for Testing and Materials.

1. ASTM D1248 – Standard Specification Polyethylene Plastics Molding and Extrusion Materials for Wire and Cable.

2. ASTM F477 – Elastomeric Seals (gaskets) for Joining Plastic Pipe.

3. ASTM G62 – Standard Test Methods for Holiday Detection in Pipeline Coatings.

F. AWWA – American Water Works Association.

1. AWWA C102 – American National Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems.

2. AWWA C300 – Standard for Prestressed Concrete Pressure Pipe, Steel-Cylinder Type, for Water and other Liquids.

3. AWWA C600 – Standard for Installation of Ductile-Iron Water Mains and Their Appurtenances.

G. CFTS – City of Friendswood Technical Specifications.

1. Section 01270 – Measurement and Payment.

2. Section 01330 – Submittal Procedures.

3. Section 02250 – Steel Pipe and Fittings.

4. Section 02255 – Steel Pipe and Fittings for Large Diameter Water Lines.

5. Section 02260 – Polyethylene Wrap.

6. Section 02265 – Polyurethane Coatings on Steel or Ductile Iron Pipe.

7. Section 02285 – Cathodic Protection.

8. Section 02400 – Water Lines.

9. Section 02450 – Hydrostatic Testing of Waterlines.

10. Section 02500 – Gravity Sanitary Sewers.

11. Section 02510 – Sanitary Sewer Force Mains.

12. Section 02540 – Sanitary Sewer Point Repairs.

13. Section 02560 – Sanitary Sewer Obstruction Removal.

14. Section 02600 – Storm Sewers.

H. SSPC – Steel Structures Painting Council.

1. SSPC-SP 6 – Steel Structures Painting Council, Commercial Blast Cleaning.

1.4 SUBMITTALS

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

B. For pipes sixteen inches (16 In) and greater submit shop drawings signed and sealed by a Professional Engineer registered in the State of Texas showing the following:

1. Manufacturer's pipe design calculations

2. Lay schedule of pictorial nature indicating alignment and grade, laying dimensions, fitting, flange and special details, with plan view of each pipe segment sketched, detailing pipe invert elevations, horizontal bends, restrained joints and other critical features. Indicate station numbers for pipe and fittings corresponding to the Drawings. Do not start production of pipe and fittings prior to review and approval by the Project Manager. Provide final approved lay schedule on CD-ROM in Adobe portable document format (*.PDF).

3. Calculations and limits of thrust restraint

4. Class and length of joint

C. Submit manufacturer's certifications that Ductile Iron Pipe (DIP) and fittings meet provisions of this Section and have been hydrostatically tested at factory and meet requirements of ANSI A21.51.

D. Submit certifications that pipe joints have been tested and meet requirements of ANSI A21.11.

E. Submit affidavit of compliance in accordance with ANSI A21.16 for fittings with fusion bonded epoxy coatings or linings.

1.5 QUALITY ASSURANCE

A. Provide manufacturer's affidavits that pipe was manufactured in

compliance with standards referenced in this Section.

PART II: PRODUCTS

2.1 DUCTILE IRON PIPE (DIP)

A. Ductile Iron Pipe (DIP) Barrels: ANSI A21.15, ANSI A21.50 or ANSI A21.51; bear mark of Underwriters' Laboratories approval; minimum thickness Class 51 for water lines and thickness Class 52 for sanitary sewers or as shown on the Drawings. Provide minimum thickness Class 53 for flanged pipe.

B. Provide pipe sections in standard lengths, not less than eighteen feet (18 Ft) long, except for special fittings and closure sections as indicated on shop drawings.

C. Modify pipe for cathodic protection in accordance with Section 02285 – Cathodic Protection. In lieu of furnishing Ductile Iron Pipe (DIP) with cathodic protection system, furnish Ductile Iron Pipe (DIP) with polyethylene encasement, provided the following criteria is met:

1. Provide minimum thickness class

2. Provide polyethylene encasement material and installation in accordance with AWWA C105 and backfill as specified. Minimum of two (2) complete wraps of eight (8) mil thick polyethylene.

3. Use polyethylene encasement for open cut installations only. For augered sections or sections installed inside a casing, provide coating in accordance with paragraph 2.5.D.1.

4. Adhere to other requirements specified herein (e.g., insulation kits, etc.).

D. For use of pressure class pipe for water lines, design pipe and fittings to withstand most critical simultaneous application of external loads and internal pressures. Base design on minimum of AASHTO HS-20 loading, AREMA E-80 loads and depths of bury as indicated on the Drawings. Design pipes with Marston's earth loads for a transition width trench for zero feet (0 Ft) to sixteen feet (16 Ft) of cover. Use Marston's earth loads for a trench width of O.D. (of pipe) plus four feet (+4 Ft) for pipe greater than sixteen feet (16 Ft) of cover. Use Marston's equations for a trench condition in both open-cut and tunnel applications. Design for most critical groundwater level condition. Pipe

design conditions:

1. Working pressure = One hundred pounds per square inch (100 psi).

2. Hydrostatic field test pressure = One hundred fifty pounds per square inch (150 psi).

3. Maximum pressure due to surge = One hundred fifty pounds per square inch (150 psi).

4. Minimum Pressure due to surge = Minus five pounds per square inch (-5 psi).

5. Design tensile stress due to surge or hydrostatic test pressure: No greater than fifty percent (50%) minimum yield.

6. Design bending stress due to combined earth loads and surge or hydrostatic test pressure: No greater than forty-eight thousand pounds per square inch (48,000 psi).

7. Unit weight of fill ≥ One hundred twenty pounds per cubic foot (120 pcf).

8. Deflection lag factor (D_l) = One and two tenths (1.2).

9. Bedding constant (K) = One tenth (0.1).

10. Moment coefficient = Sixteen hundredths (0.16).

11. Fully saturated soil conditions hw=h=depth of cover above top of pipe.

E. Hydrostatic Test of Pipe: AWWA C151, Section 5.2.1, at point of manufacture. Hold test for a minimum two minutes (2 Min) for thorough inspection of pipe. Repair or reject pipe revealing leaks or cracks.

F. Pipe Manufacturer for large diameter water lines: Minimum of five years (5 Yrs) of successful pipe installations in continuous service. Manufacturer must maintain on site or in plant enough fittings to satisfy the requirements as specified in TABLE 4.1 – REQUIRED BENDS in this Section.

Manufacturer or supplier must be capable of delivering bends to job site within twelve hours (12 Hrs) of notification. Use fittings at direction of the Project Manager where unforeseen obstacles are encountered

during construction. These fittings are in addition to any fittings called out in construction documents and must be available at all times.

G. Provide flange adapter with insulating kit as required when connecting new piping to existing piping and piping of different materials, unless otherwise approved by the Project Manager.

H. Clearly mark pipe section to show location and thickness/pressure class color coded.

2.2 JOINTS

A. Joint Types: ANSI A21.11 push-on; ANSI A21.11 mechanical joint; or ANSI A21.16 flanged end. Provide push-on joints unless otherwise indicated on the Drawings or required by these specifications. For bolted joints, conform to requirements of AWWA C111; provide minimum 304 stainless steel for restraint joints.

B. Where required by the Drawings, provide approved restrained joints for buried service.

C. Threaded or grooved-type joints which reduce pipe wall thickness below minimum required are not acceptable.

D. Provide for restrained joints designed to meet test pressures required under Section 02450 – Hydrostatic Testing of Waterlines or Section 02510 – Sanitary Sewer Force Mains, as applicable. Provide restrained joints for test pressure or maximum surge pressure as specified, whichever is greater for water lines. Do not use passive resistance of soil in determining minimum restraint lengths.

E. Bond rubber gasketed joints to provide electrical continuity along entire pipeline, except where insulating flanges are required by the Drawings.

F. Make curves and bends by deflecting joints. Do not exceed maximum deflection recommended by pipe manufacturer for pipe joints or restraint joints. Submit details of other methods of providing curves and bends for consideration by the Project Manager. When other methods are deemed satisfactory, install at no additional cost to the City.

2.3 GASKETS

A. Furnish, when no contaminant is identified, plain rubber (SBR) gasket material in accordance with ANSI A21.11 or ASTM F477 (One Bolt only); for flanged joints one-eight inch (1/8 In) thick gasket in accordance with ANSI A21.15.

2.4 FITTINGS

A. Use fittings of same size as pipe. Reducers are not permitted to facilitate an off-size fitting. Reducing bushings are also prohibited. Make reductions in piping size by reducing fittings. Line and coat fittings as specified for pipe they connect to.

B. Push-on Fittings: ANSI A21.10; Ductile Iron Pipe (DIP) ANSI A21.11 joints, gaskets and lubricants; pressure rated at two hundred pounds per square inch (250 psi).

C. Flanged Fittings: ANSI A21.10; Ductile Iron Pipe (DIP) ANSI A21.11 joints, gaskets and lubricants; pressure rated at two hundred fifty pounds per square inch (250 psi).

D. Mechanical Joint Fittings: ANSI A21.11; pressure rated at two hundred fifty pounds per square inch (250 psi).

E. Ductile Iron Pipe (DIP) Compact Fittings for Water lines: ANSI A21.53; four inch (4 In) through twelve inch (12 In) diameter fusion bonded epoxy-lined or cement mortar lining.

2.5 COATINGS AND LININGS

A. Water line Interiors: ANSI A21.4, cement lined with seal coat; ANSI A21.16 fusion bonded epoxy coating for interior; comply with NSF 61.

B. Sanitary Sewer and Force Main Interiors:

1. Preparation: Commercial blast cleaning conforming to SSPC-SP6.

2. Liner thickness: Nominal forty (40) mils, for pipe barrel interior; minimum six (6) mils to ten (10) mils at gasket groove and outside spigot end to six inches (6 In) back from end.

3. Testing: ASTM G62, Method B for voids and holidays; provide written certification.

4. Acceptable Lining Materials:

a. Provide approved virgin polyethylene conforming to ASTM D1248, with inert fillers and carbon black to resist ultraviolet degradation during storage; heat

bonded to interior surface of pipe and fittings.

b. Ceramic Epoxy – Protecto 401

C. Sanitary Sewer Point Repair Pipe: For pipes which will be lined with high density polyethylene liner pipe or cured-in-place liner, provide cement-lined with seal coat in accordance with ANSI A21.4. For pipes which will not be provided with named liner, provide pipe as specified in Paragraph 2.5.B.4, Sanitary Sewer and Force Main Interiors.

D. Exterior:

1. Water Lines:

a. Auger Holes: Conform to requirements of Section 02265 – Polyurethane Coatings on Steel or Ductile Iron Pipe.

b. Above Ground (or Exposed): Conform to requirements of Section 02250 – Steel Pipe and Fittings, Paragraph 2.3.

c. Tunnel, Casing or Direct Bury: Conform to requirements of Paragraph 2.5.E.

2. Sanitary Sewers: Prime coat and outside asphaltic coating conforming to ANSI A21.10, ANSI A21.15 or ANSI A21.51 for pipe and fittings in open cut excavation and in casings.

E. Polyethylene Wrap: For buried pipes not cathodically protected, provide polyethylene wrap unless otherwise specified or shown. Conform to requirements of Section 02260 – Polyethylene Wrap.

F. For flanged joints in buried service, provide petrolatum wrapping system, Denso or equal, for the complete joint and alloy steel fasteners. Alternatively, provide bolts made of Type 304 stainless steel.

G. Pipe to be installed in potentially contaminated areas shall have coatings and linings recommended by the manufacturer for maximum resistance to the contaminants identified in the Phase II Environmental Site Assessment Report.

H. For water lines cathodically protected, supply Ductile Iron Pipe (DIP) with either tape coatings or some other bonded dielectric coating as specified in Section 02255 – Steel Pipe and Fittings for Large Diameter Water Lines.

PART III: EXECUTION

3.1 INSTALLATION

A. Conform to installation requirements of Sections 02400 – Water Lines, 02500 – Gravity Sanitary Sewers, 02510 – Sanitary Sewer Force Mains 02600 – Storm Sewers, 02540 – Sanitary Sewer Point Repairs and 02560 – Sanitary Sewer Obstruction Removal, except as modified in this Section.

B. Install in accordance with AWWA C600 and manufacturer's recommendations.

C. Install all Ductile Iron Pipe (DIP) in double polyethylene wrap, unless cathodic protection is provided. Do not use polyethylene wrap with a cathodic protection system.

D. Holiday Testing:

1. Polyurethane: Conform to requirements of Section 02265 – Polyurethane Coatings for Steel or Ductile Iron Pipe.

2. Fusion Bonded Epoxy: Conform to requirements for new fittings in ANSI A 21.16.

3.2 FIELD REPAIR OF COATINGS

A. Polyurethane: Conform to requirements of Section 02265 – Polyurethane Coatings for Steel or Ductile Iron Pipe.

B. Fusion Bonded Epoxy: Conform to requirements for new fittings in ANSI A 21.16.

PART IV: TABLES

4.1 – REQUIRED BENDS

Line Diameter	Required Bends*
20 and 24 inches	Four 45° bends per 5,000 LF of water line
> 24 inches	Four 22.5° bends per 10,000 LF of water line

*Based on total length of contract [minimum of four (4)]. Any combination of bends may be substituted at manufacturer's option [i.e. two (2) – twenty-two and one half degree (22.5°) bends are equivalent to one (1) – forty-five degree (45°) bend] and shall be counted as one (1) fitting.

END OF SECTION

SECTION 02220

HIGH DENSITY POLYETHYLENE (HDPE) PIPE

PART I: GENERAL

1.1 GENERAL REQUIREMENTS

A. High density polyethylene (HDPE) pipe for gravity sewers and drains, including fittings.

B. High density polyethylene (HDPE) pipe for sanitary sewer force mains, including fittings.

C. High density polyethylene (HDPE) pipe for storm sewers culverts.

1.2 MEASUREMENT AND PAYMENT

A. Unit Prices:

1. No separate payment will be made for HDPE pipe under this Section. Include cost in unit prices for work, as specified in following sections:

   a. Section 02500 – Gravity Sanitary Sewers.

   b. Section 02510 – Sanitary Sewer Force Mains.

   c. Section 02600 – Storm Sewers.

2. Refer to Section 01270 – Measurement and Payment for unit price procedures.

B. Stipulated Price (Lump Sum):

1. If Contract is Stipulated Price Contract, payment for work in this Section is included in Total Stipulated Price.

1.3 REFERENCES

A. AASHTO – American Association of State Highway and Transportation Officials.

1. AASHTO M294 – Standard Specification for Corrugated

Polyethylene Drainage Pipe, 18"- 48" diameter.

2. AASHTO Section 18 – Soil Thermoplastic Pipe Interaction Systems.

3. AASHTO Section 30 – Standard Practice for Underground Installation of Thermoplastic Pipe for Sewer and Other Gravity Flow Applications.

B. ASTM – American Society for Testing and Materials.

1. ASTM D618 – Standard Practice for Conditioning Plastics for Testing.

2. ASTM D1248 – Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable.

3. ASTM D2321 – Standard Recommended Practice for Underground Installation of Flexible Thermoplastic Pipe.

4. ASTM D2657 – Standard Practice for Heat Fusion Joining Polyolefin Pipe and Fittings.

5. ASTM D2837 – Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials.

6. ASTM D3035 – Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter.

7. ASTM D3212 – Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.

8. ASTM D3350 – Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.

9. ASTM F477 – Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

10. ASTM F714 – Standard Specification for Polyethylene Plastic (PE) Pipe (SDR-PR) Based on Outside Diameter.

11. ASTM F894 – Standard Specification for Polyethylene (PE) Large-Diameter Profile Wall Sewer and Drain Pipe.

C. CFTS – City of Friendswood Technical Specifications.

1. Section 01270 – Measurement and Payment.

2. Section 01330 – Submittal Procedures.

3. Section 01475 – Quality Control Testing Procedures.

4. Section 02125 – Excavation and Backfill for Utilities.

5. Section 02500 – Gravity Sanitary Sewers.

6. Section 02510 – Sanitary Sewer Force Mains.

7. Section 02525 – Acceptance Testing of Gravity Sanitary Sewer Lines.

8. Section 02600 – Storm Sewers.

1.4 SUBMITTALS

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

B. Submit shop drawings showing design of pipe and fittings, laying dimensions, fabrication, fittings, flanges and special details.

1.5 QUALITY CONTROL

A. Provide manufacturer's certificate of conformance to Technical Specifications.

B. Furnish pipe and fittings that are homogeneous throughout and free from visible cracks, holes, foreign inclusions or other injurious defects. Provide pipe as uniform as commercially practical in color, opacity, density and other physical properties.

C. The Project Manager reserves the right to inspect pipes or witness pipe manufacturing. Inspection shall in no way relieve manufacturer of responsibilities to provide products that comply with applicable standards and these Technical Specifications.

1. Manufacturer's Notification: Should the Project Manager wish to witness manufacture of specific pipes, manufacturer shall provide the Project Manager with a minimum of three weeks (3 Wks) notice of when and where production of those specific pipes will take place.

2. Failure to Inspect: Approval of products or tests shall not be implied by the Project Manager's decision not to inspect manufacturing, testing or finished pipes.

D. Hydrostatic testing of Force Mains and Water Lines using HDPE Pipe shall use testing procedures as outlined in paragraph 3.11 of Section 01475 – Quality Control Testing Procedures.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the products specified in this section with documented experience of a minimum five years (5 Yrs) of pipe installations that have been in successful, continuous service for same type of service as the proposed Work.

PART II: PRODUCTS

2.1 GENERAL

A. For new construction gravity sanitary sewer pipe provide HDPE pipe as specified in TABLE 4.1 SANITARY SEWER FOR DIRECT BURY in this Section.

B. For rehabilitation of gravity sanitary sewer pipe provide HDPE pipe as follows for new construction as specified in TABLE 4.2 SANITARY SEWER FOR SLIPLINING in this Section.

C. For Residential Driveway Culverts provide HDPE as follows:

1. N-12 and N-12 HC by Advanced Drainage Systems, Inc. (ADS).

2. Sure-Lok F477 by Hancor, Inc.

D. Furnish solid wall pipe with plain end construction for heat joining (butt fusion) conforming to ASTM D2657. Utilize controlled temperatures and pressures for joining to produce fused leak-free joint.

E. Furnish profile-wall gravity sewer pipe with bell-and-spigot end construction conforming to ASTM D3212. Joining shall be accomplished with elastomeric gasket in accordance with manufacturer's recommendations. Use integral bell-and-spigot gasketed joint designed so that when assembled, elastomeric gasket, contained in machined groove on pipe spigot, is compressed radially in

pipe bell to form positive seal. Design joint to avoid displacement of gasket when installed in accordance with manufacturer's recommendations.

F. Furnish solid wall pipe for sanitary sewer force mains with a minimum working pressure rating of one hundred fifty pounds per square inch (150 psi) and with inside diameter equal to or greater than nominal pipe size indicated on the Drawings.

G. Furnish corrugated polyethylene pipe (CPP) for gravity storm sewer pipe. Joints shall be installed such that connection of pipe sections shall form continuous line free from irregularities in flow line. Suitable joints are:

1. Integral Bell and Spigot: Bell shall overlap a minimum of two (2) corrugations of spigot end when fully engaged.

2. Exterior Bell and Spigot: Bell shall be fully welded to exterior of pipe and overlap spigot end so that flow lines and ends match when fully engaged.

H. Jointing:

1. Gaskets:

a. Meet requirements of ASTM F477. Use gasket molded into circular form or extruded to proper section and then spliced into circular form. When no contaminant is identified, use gaskets of properly cured, high-grade elastomeric compound. Basic polymer shall be natural rubber, synthetic elastomer or blend of both.

b. Pipes allowed to be installed in potentially contaminated areas, where free product is found near elevation of proposed sewer, shall have gasket materials for noted contaminant as specified in TABLE 4.3 – GASKET MATERIAL REQUIRED FOR CONTANIMANTS in this Section.

2. Lubricant: Use lubricant for assembly of gasketed joints which has no detrimental effect on gasket or on pipe, in accordance with manufacturer's recommendations.

2.2 MATERIALS FOR SANITARY SEWER

A. Pipe and Fittings: High density, high molecular weight polyethylene

pipe material meeting requirements of Type III, Class C, Category 5, Grade P34, as defined in ASTM D1248. Material meeting requirements of cell classification in accordance with ASTM D3350 are also suitable for making pipe products under these specifications.

B. Other Pipe Materials: Materials other than those specified in Paragraph 2.2.A, Pipe and Fittings, may be used as part of profile construction, e.g., as core tube to support shape of profile during processing, provided that these materials are compatible with base polyethylene material and are completely encapsulated in finished product and in no way compromise performance of pipe products in intended use. Examples of suitable material include polyethylene and polypropylene.

2.3 MATERIALS FOR RESIDENTIAL DRIVEWAY CULVERTS

A. Pipe and Fittings: High density, high molecular weight polyethylene HDPE virgin compound material meeting requirements of cell class outlined in AASHTO M294, AASHTO MP7 and ASTM D3350.

B. Types: CPP shall meet one (1) or both of following:

1. Type S: Outer corrugated wall with smooth inner liner.

2. Type D: Inner and outer smooth walls braced circumferentially or spirally with projections or ribs.

C. Lubricant: Use lubricant for assembly of gasketed joints, which has no detrimental effect on gasket or on pipe, in accordance with manufacturer's recommendations.

2.4 TEST METHODS FOR SANITARY SEWER

A. Conditioning: Conditioning of samples prior to and during tests is subject to approval by the Project Manager. When referee tests are required, condition specimens in accordance with Procedure A in ASTM D618 at seventy-three and four-tenths degrees Fahrenheit (73.4°) plus or minus three and six-tenths degrees Fahrenheit (±3.6° F) and fifty percent (50%) relative humidity plus or minus five percent (5%) relative humidity for not less than forty hours (40 Hrs) prior to test. Conduct tests under same conditions of temperature and humidity unless otherwise specified.

B. Flattening: Flatten three specimens of pipe, prepared in accordance with Paragraph 2.5.A, in suitable press until internal diameter has been reduced to forty percent (40%) of original inside diameter of pipe. Rate of loading shall be uniform and at two inches (2 In) per minute. Test

specimens, when examined under normal light and with unaided eye, shall show no evidence of splitting, cracking, breaking or separation of pipe walls or bracing profiles.

C. Joint Tightness: Test for joint tightness in accordance with ASTM D3212, except replace shear load transfer bars and supports with six inch (6 In) wide support blocks that can be either flat or contoured to conform to pipe's outer contour.

D. Purpose of Tests: Flattening and joint tightness tests are not intended to be routine quality control tests, but rather to qualify pipe to a specified level of performance.

2.5 TEST METHODS FOR RESDENTIAL DRIVEWAY CULVERTS

A. Pipe stiffness at five percent (5%) deflection, when determined in accordance with ASTM D2412, shall be as specified in Section 7.4 of AASHTO M294.

B. Minimum inner wall thickness shall be as specified in Section 7.2.2 of AASHTO M294.

2.6 MARKING

A. Mark each standard and random length of pipe in compliance with these Technical Specifications with following information:

1. Pipe size.
2. Pipe class.
3. Production code.
4. Material designation.

PART III: EXECUTION

3.1 INSTALLATION

A. Conform to requirements of following Sections:

1. Section 02500 – Gravity Sanitary Sewers.
2. Section 02510 – Sanitary Sewage Force Mains.

3. Section 02525 – Acceptance Testing of Sanitary Sewers.

4. Section 02600 – Storm Sewers.

B. Install pipe in accordance with the manufacturers recommended installation procedures.

C. HDPE pipe is not approved in applications requiring augering of pipe.

D. Bedding and backfill: Conform to requirements of Section 02125 – Excavation and Backfill for Utilities.

PART IV: TABLES

4.1 SANITARY SEWER FOR DIRECT BURY

INSTALLATION SPEC NO.	GENERIC NAME	TRADE NAME OR MANUFACTURER	ASTM OR AASHTO	SDR (NUMERIC INDEX)	PIPE STIFFNESS (NUMERIC MINIMUM)	SIZE RANGE
02220	Solid Wall Polyethylene (HDPE)	Chevron Plexco Phillips 66 Quail Poly Pipe	ASTM F-714	DR 17 DR 21	115 46	8” – 10” 12” – 48”
02500	Polyethylene Profile Wall	Spirolite	ASTM F-894	n/a	46	18” – 120”

4.2 SANITARY SEWER FOR SLIPLINING

INSTALLATION SPEC NO.	GENERIC NAME	TRADE NAME OR MANUFACTURER	ASTM OR AASHTO	SDR (NUMERIC INDEX)	PIPE STIFFNESS (NUMERIC MINIMUM)	SIZE RANGE
02220	Solid Wall Polyethylene (HDPE)	Chevron Plexco Quail Poly Pipe AmeriFlow (NAPCO) AmeriFlow (KWH)	ASTM F-714	DR 21	46	8” – 48” 3” – 12” 14” – 63”
02500	Polyethylene Profile Wall	Spirolite	ASTM F-894	n/a	46	18” – 120”

4.3 GASKET MATERIAL REQUIRED FOR CONTANIMANTS

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

END OF SECTION

SECTION 02225

PRESTRESSED CONCRETE CYLINDER PIPE (PCCP)

PART I: GENERAL

1.1 GENERAL REQUIREMENTS

A. Prestressed Concrete Cylinder Pipe (PCCP) and fittings for buried water lines sizes twenty inches (20 In) and larger.

1.2 MEASUREMENT AND PAYMENT

A. Unit Prices:

1. No separate payment will be made for PCCP under this Section. Include cost in price for water lines.

2. Maintain on site minimum of two (2) – three degree (3°) and two (2) – five degree (5°) grade angle adapters. Adapters are considered "extra unit price." When used during construction, adapter will be paid at unit price.

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

B. Stipulated Price (Lump Sum):

1. If Contract is Stipulated Price Contract, payment for work in this Section is included in Total Stipulated Price.

1.3 REFERENCES

A. AASHTO – American Association of State Highway and Transportation Officials.

1. AASHTO – Standard Specifications for Highway Bridges.

B. AREMA – American Railway Engineering and Maintenance-of Way Association.

1. AREMA – Manual of Railway Engineering, Volume II, Chapter 15.

C. ASTM – American Society for Testing and Materials.

1. ASTM A648 – Standard Specification for Steel Wire, Hard Drawn for Prestressing Concrete Pipe.

2. ASTM C33 – Standard Specification for Concrete Aggregates.

3. ASTM C35 – Standard Specification for Inorganic Aggregates for Use in Gypsum Plaster.

4. ASTM C150 – Standard Specification for Portland Cement.

5. ASTM C497 – Standard Test Methods for Concrete Pipe, Manhole Sections or Tile.

6. ASTM C1107 (CRD C-621) – Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).

7. ASTM D512 – Standard Test Methods for Chloride Ion In Water.

8. ASTM D1293 – Standard Test Methods for pH of Water.

9. ASTM E165 – Standard Test Methods for Dye Penetration.

10. ASTM E340 – Standard Test Methods for Macroetching Metals and Alloys.

11. ASTM E709 – Standard Test Methods for Magnetic Particle Testing.

12. ASTM E1032 – Standard Test Methods for Radiographic Examination of Weldments.

D. AWS – American Welding Society.

1. ANSI/AWS A3.0 – Standard Welding Terms and Definitions.

E. AWWA – American Water Works Association.

1. AWWA C206 – Standard for Field Welding of Steel Water Pipe.

2. AWWA C207 – Standard for Steel Pipe Flanges for Waterworks Service – Sizes 4 in. through 144 in.

3. AWWA C301 – Standard for Prestressed Concrete Pressure

Pipe, Steel-Cylinder Type, for Water and Other Liquids.

4. AWWA C304 – Standard for Design of Prestressed Concrete Cylinder Pipe.

5. AWWA M9 – Standard for Concrete Pressure Pipe.

F. CFTS – City of Friendswood Technical Specifications.

1. Section 01270 – Measurement and Payment.

2. Section 01330 – Submittal Procedures.

3. Section 02125 – Excavation and Backfill for Utilities.

4. Section 02250 – Steel Pipe and Fittings.

5. Section 02255 – Steel Pipe and Fittings for Large Diameter Water Lines.

6. Section 02285 – Cathodic Protection.

7. Section 02400 – Water Lines.

G. NSF – National Science Foundation.

1. NSF 61 – Drinking Water System Components – Health Effects.

H. SSPC – Steel Structures Painting Council.

1. SSPC SP 7 – Surface Preparation Specification No. 7 – Brush Off Blast Cleaning.

1.4 SUBMITTALS

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

B. Submit shop drawings and certification signed and sealed by Professional Engineer registered in State of Texas showing following:

1. Manufacturer's pipe design calculations.

2. Lay schedule of pictorial nature indicating alignment and grade, laying dimensions, welding procedures, fabrication, fitting, flange and special details, with plan view of each pipe segment

sketched, detailing pipe invert elevations, horizontal bends, welded joints and other critical features. Indicate station numbers for pipe and fittings corresponding to the Drawings. Do not start production of pipe and fittings prior to review and approval by the Project Manager. Provide final approved lay schedule on CD-ROM in Adobe portable document format (*.PDF).

3. Include hot tapping procedure.

4. Submit certification from manufacturer that design was performed for project in accordance with requirements of this Section.

C. Within thirty calendar days (30 cD) following Notice to Proceed and before initiation of manufacture of prestressing wire, submit following:

1. Name and location of prestressing wire manufacturer.

2. General description of quality control procedures used by wire manufacturer. Include physical and chemical property tests utilized, testing frequency and test records; and description of methods employed to assure compliance with AWWA C301 regarding wire surface temperature, type of thermometer, location of temperature measurement, frequency of temperature tests and test records.

3. Approximate dates when wire shall be manufactured for use in pipe.

4. Hydrogen embrittlement sensitivity test report for wire.

D. Submit inspection procedures to be used by manufacturer and for quality control and assurance for materials and welding. Submit standard repair procedures that describe in detail shop and field work to be performed.

E. Submit following within forty-five days (45 D) after manufacturing of pipe and fittings:

1. Prestressing wire records.

a. ASTM A648 for wire.

b. Steel reports as required in AWWA C301, Section 4.4.7.

c. Records of testing accomplished to measure wire surface temperature as required in AWWA C301, Section 4.4.8.

d. Results of other tests of steel reinforcement required in AWWA C301, Section 4.4.

e. Wire tension records required in AWWA C301, Section 4.4.8. Indicate heat and coil of prestressing wire used.

2. Test results.

a. Hydrostatic testing, acid etching, dye penetration, magnetic particle and x-ray weld test reports as required.

b. Compressive strength twenty-eight day (28 D) test results for each type of coating, lining and core mix design.

3. Pipe manufacturer's certification that PCCP:

a. Cylinder assembly has been hydrostatically tested at factory for two minutes (2 Min) minimum in accordance with Section 2.1 J and AWWA C301.

b. Mortar coatings and linings were applied or allowed to cure at temperature above thirty-two degrees Fahrenheit (32° F).

F. Submit following for nonshrink grout for special applications:

1. Manufacturer's technical literature including specifications for mixing, placing and curing grout.

2. Results of tests performed by certified independent testing laboratory showing conformance to ASTM C1107, Nonshrink Grout and requirements of this Specification.

3. Certification product is suitable for use in contact with potable water.

G. Submit certification for welder and welding operator demonstrating their certification within past six months (6 Mos) in accordance with AWWA C301. Indicate certified procedures and position each welder is

qualified to perform.

H. Submit certification showing calibration within last twelve months (12 Mos) for equipment such as scales, measuring devices and calibration tools used in manufacture of pipe. Each device used in manufacture of pipe shall be required to have tag recording date of last calibration. Devices are subject to inspection by the Project Manager.

1.5 QUALITY CONTROL

A. Manufacturer is to have permanent quality control department and laboratory facility capable of performing inspection and testing required. Inspection procedures and manufacturing process are subject to inspection by the Project Manager. Perform manufacturer tests and inspections required by AWWA C301 as modified by these Specifications. Repair defects when as substandard welds, excessive radial offsets (misalignment), pitting, gouges, cracks, other nonconforming conditions.

1. Cylinder and Joint Ring Assembly:

a. Review mill certifications for conformance to requirements of the Technical Specifications.

b. Perform physical testing of each heat of steel for conformance to applicable ASTM standards.

c. Inspect physical dimensions and overall condition of joint rings and cylinder/joint ring assembly to verify compliance with requirements of AWWA C301.

d. Test cylinder/joint ring weld for tensile strength. Test one (1) specimen for each five hundred (500) cylinder/joint ring assemblies in addition to those tests required by AWWA C301.

e. Reject pipe with dented steel cylinders.

2. Prestressing Wire:

a. Inspect wire spacing during wire placement on core.

b. Test wire splices for each production run or a minimum of once a week, whichever is less, for conformance with minimum strength criteria.

3. Pipe Cores and Coating:

   a. Review mill certificates for each load of cement for conformance to ASTM C150.

   b. Perform sieve analysis weekly for each source of coarse and fine aggregate for conformance to ASTM C33.

   c. Inspect kiln recorder charts daily to confirm proper curing environment.

   d. Prior to prestressing, inspect each core for voids, chips, cracks, deleterious surfaces and foreign matter.

   e. Check outer core moisture of each pipe core immediately prior to applying mortar coating.

   f. Check mortar batch proportions, moisture content and slurry application rate. Check coating thickness over wire on each pipe.

   g. Check physical integrity of cured mortar coating.

   h. Reject pipe with cracks in mortar coating exceeding one hundredth inches (0.01 In) wide.

4. Protective Coatings: Check daily application rate and resulting dry film thickness.

B. Gaskets: Randomly test rubber cord for diameter, tensile strength, elongation, compression set, hardness and specific gravity after oven aging on one (1) out of one hundred (100) gaskets.

C. Weld Testing:

1. Perform macroetching tests for full-penetration production welds on normal production weld tests. Complete joint penetration welds are defined in ANSI/AWS A3.0. Verify complete joint penetration by means of macroetch of joint weld cross section. Macroetch technique in accordance with ASTM E340.

2. Perform ultra-sonic or x-ray testing of manual butt welds for fittings and special pipes. Perform dye penetration testing of manual lap welds for fittings and special pipes and for joint ring

weld onto cylinder.

3. Perform minimum of one (1) set of weld test specimens in accordance with ANS1/AWS A3.0 on each size, grade and wall thickness at minimum of every three thousands feet (3000 Ft) of pipe manufactured. Perform no less than one (1) test per project by each welding machine and each operator.

D. Cast four (4) standard test cylinders each day for each fifty cubic yards (50 Cy) of mortar coating or portion thereof for each coating and lining placed in day. Perform compressive strength test at twenty-eight days (28 D). No cylinder test result shall be less than eighty percent (80%) of specified strength.

E. Make available copy of Physical and Chemical testing reports for steel cylinders and provide reports at request of the Project Manager.

F. Check physical dimensions of pipe and fittings: Physical dimensions to include pipe lengths, pipe LD., pipe O.D. and bend angles.

PART II: PRODUCTS

2.1 PRESTRESSED CONCRETE CYLINDER PIPE

A. Furnish pipe by same manufacturer.

B. Provide Prestressed Concrete Cylinder Pipe in conformance with AWWA C301, AWWA C304 and AWWA M9 except as modified in this Section. Use of pipe from inventory is permitted only if the specifications and certifications are met. Provide testing records for pipe.

C. Do not use Prestressed Concrete Cylinder Pipe in aerial crossings, exposed or other unburied areas.

D. Pipe manufacture:

1. Must have a minimum of five years (5 Yrs) of manufacturer's pipe installations that have been in successful and continuous service.

2. Must maintain on site or in plant minimum of four (4) – twenty-two and one-half degree (22-1/2°) bends per ten thousand linear feet (10000 Lf) of water line. Any combination of bends may be substituted at manufacturer's option [i.e. two (2) –

eleven and one-quarter degree (11-1/4°) bends are equivalent to one (1) – twenty-two and one-half degree (22-1/2°) bend and shall be counted as one (1) fitting]. Must be capable of delivering bends to job site within twelve hours (12 Hrs) of notification. These fittings are in addition to fittings called out on the Drawings and shall be available at all times.

E. Pipe Design Conditions:

1. Working pressure: One hundred pounds per square inch (100 psi).

2. Hydrostatic field test pressure: One hundred fifty pounds per square inch (150 psi).

3. Maximum pressure due to surge: One hundred fifty pounds per square inch (150 psi).

4. Minimum Pressure due to surge: Minus five pounds per square inch (-5 psi).

5. Unit weight of soil: One hundred twenty pounds per cubic foot (120 pcf) minimum, unless otherwise specified.

6. Minimum trench width: O.D. of pipe + four feet (4 Ft).

7. Pipe and Fittings: Designed to withstand most critical simultaneous application of external loads including construction loads and internal pressures.

8. Design: Based on minimum of AASHTO HS-20 loading, AREA Cooper E-80 loads when under railroads and depths of bury as indicated. Design pipe with Marston's earth loads for transition width trench for all heights of cover.

   a. Calculate moments and thrusts in wall based on height of earth load.

   b. For earth load heights up to sixteen feet (16 Ft), use bedding sand as bedding material and use ninety degree (90°) Olander coefficients for earth load and water weight contained in pipe along with fifteen degree (15°) Olander coefficients for pipe weight.

   c. For earth load heights sixteen feet (16 Ft) and greater, use cement stabilized sand as bedding material below

springline of pipe and use, one hundred fifty degree (150°) Olander coefficients for earth load and water weight.

9. Groundwater level: Assume below pipe for pipe design. Assume equal to natural ground surface for other conditions.

10. Design pipe for transmitting potable water, unless otherwise shown on the Drawings.

11. Manufacture pipe for adverse environmental conditions in accordance with Section 7.5.5 of AWWA C304.

12. Design pipe for buried conditions and kept empty for up to three hundred sixty-five days (365 D).

13. Tunnel and Augured sections: Provide constant outside diameter from bell to spigot end for pipe. Exclude structural benefits associated with primary liner. Design pipe and pipe joints to carry loads including but not limited to: Overburden and lateral earth pressures, subsurface soil, grouting, other conditions of service, thrust of jacks and stress anticipated during handling and installation.

F. Coatings and Linings:

1. Provide Portland cement; ASTM C150, Type I or II. Provide one (1) type of cement for entire project.

2. Water Absorption Test: ASTM C497, Method A; perform on samples of cured mortar coating taken from each working shift. Cure mortar coating samples in same manner as pipe.

a. Test value: Average a minimum of three (3) samples taken from same working shift, no greater than nine percent (9%) for average value, eleven percent (11%) for individual value.

b. Test frequency: Perform tests each working shift until conformance to absorption requirements has been established by ten (10) consecutive passing test results, at which time testing may be performed weekly. Resume testing for each working shift when absorption test results fail until conformance to absorption requirements is reestablished by ten (10) consecutive passing test results.

3. Apply one (1) coat of primer to exposed steel parts of steel bell and spigot rings. Prior to coating, blast clean in accordance with SSPC-SP7 (Brush Off Blast Cleaning). Apply primer in accordance with manufacturer's recommendations.

4. Coat and line access inlets, service outlets, test inlets and air release/vacuum relief riser pipe with same coating and lining of water line in accordance with AWWA C301, Section 4, unless otherwise indicated on the Drawings.

5. Do not exceed two hours (2 Hrs) between application of first (1st) and last course when cement mortar is applied in more than one (1) course, otherwise do not defer placing of coating of any portion of pipe length. Verify cement mortar coating thickness on each size of pipe by nondestructive method before removing pipe from coating machine.

6. Remove and replace disbonded lining or coating. Reject pipe requiring patches larger than one hundred square inches (100 Sq In) or twelve inches (12 In) in greatest dimension. Allow no more than one (1) patch on either lining or coating of pipe. Provide WELD-CRETE Probond Epoxy Bonding Agent ET-150, parts A and B; Sikadur 32 Hi-Mod or approved equal bonding agent for pipe patching.

G. Fittings and specials:

1. Design fittings to same internal and external loads as straight pipe.

2. Manufacture in accordance with Section 02255 – Steel Pipe and Fittings for Large Diameter Water Lines.

3. Provide fabricated bends or fittings with minimum radius of two and one-half (2-1/2) times pipe diameter.

4. Design test plugs to withstand forces generated by hydrostatic test and test pressure from either side. Do not exceed fifty percent (50%) of minimum yield for design stresses due to hydrostatic pressure. Assume opposite side of plug does not contain water.

5. Provide no specials less than four feet (4 Ft) in length unless indicated on the Drawings or approved by the Project Manager.

6. Butt Straps for Closure Piece: Provide at locations indicated on the Drawings or authorized by the Project Manager. Minimum twelve inch (12 In) wide split butt strap; minimum plate thickness equal to thinnest member being joined; fabricated from material equal in chemical and physical properties to thinnest member being joined. Permit no angular deflection at butt-strap joints.

7. Provide minimum six inch (6 In) welded outlet for inspecting each closure section, unless access manway is within forty feet (40 Ft) of closure section.

8. Provide Densco petroleum based tape or approved equal for exposed portions of nuts and bolts.

H. Joints:

1. AWWA C301 rubber-gasketed or welded bell-and-spigot type except where flanged joints are required for valves and fittings as shown on the Drawings. Refer to Section 02400 – Water Lines for details on joints and jointing.

2. Rubber-Gasketed Joints: Single weld bell and spigot ring onto steel cylinder. In thrust areas, double weld bell-and-spigot onto steel cylinder. Bond as shown on the Drawings to provide electrical continuity along entire pipeline.

3. Restrained Joints: Restrain joints by welding or harnessing joints.

a. Design pressure: One and half (1.5) times working pressure.

b. Harnessed joints: AWWA M9, clamp or snap ring type, except where prohibited.

c. Groundwater level: Assumed to be equal to natural ground surface.

d. Provide restrained joint pipe with adequate cylinder thickness to transmit full thrust generated by internal pressure across joints.

1) Calculate distance of restrained joints based on resistance along each leg of bend with thrust based on bend angle.

2) Calculate cylinder thickness not to be less than that specified in TABLE 4.1 – CYLINDER THICKNESS in this Section.

3) Allow cylinder thickness to reduce linearly from maximum calculated thickness or from minimum cylinder thickness (as determined in Paragraph 2.1.H.3.d.1), whichever controls, to minimum thickness required by design over required length [as determined in Paragraph 2.1.H.3.d.1)] of restrained joints.

4. Use only fully circumferentially welded joints in areas considered potentially petroleum contaminated, within tunnels and under foreign pipelines. Perform welding in accordance with Section 02250 – Steel Pipe and Fittings and 02255 – Steel Pipe and Fittings for Large Diameter Water Lines.

5. Pipe Flanges: AWWA C207 for standard steel flanges of pressure class corresponding to pipe class.

I. Pipe lengths: Provide pipe sections in standard lengths with minimum length of sixteen feet (16 Ft) and maximum length of twenty-five feet (25 Ft) and as indicated on approved shop Drawings or approved by the Project Manager. Gasketed joints are allowed on standard lengths of pipe. Nonstandard pipe lengths shall be approved by the Project Manager and joints shall be welded as specified herein to achieve equal to or greater than standard pipe length before gasketed joints can be used. Internally and externally mark pipe section with durable marking to show location and pipe pressure.

J. Hydrostatic Test of Cylinder: AWWA C301, Section 4.6.4.3, at point of manufacture. Hold test for minimum two minutes (2 Min) for thorough inspection of cylinder. Repair or reject cylinders revealing leaks or cracks.

K. Transport fittings forty-two inches (42 In) in diameter and larger with end caps and stulls. Remove end caps just prior to installation. Remove stulls after completion of backfill operation.

L. Provide radius of curve as indicated on the Drawings unless otherwise approved by the Project Manager. Make curves and bends by deflecting joints, by use of beveled joints or by combination of two (2) methods, unless otherwise indicated on the Drawings. Do not exceed deflection angle recommended by pipe manufacturer. Provide beveled

pipe sections of standard length used in curved alignment, except when shorter sections are required to limit radius of curvature. In such case provide sections throughout curve of substantially equal length.

M. When manufacturing straight pipe sections manual welding is allowed for the following:

1. Tack welding of coils and plates during continuous pipe making process.

2. Rewelding and repairing structural defects in plate and automatic machine welds.

3. Attaching new coil of steel to previous coil.

N. Prior to arrival on project site, identify pipe sections within limits of thrust restraint with permanent, brightly colored and highly visible markings on outer pipe coating as approved by the Project Manager.

2.2 PRESTRESSING WIRE

A. General

1. Conform to requirement of ASTM A648, AWWA C301 and this Technical Specification.

2. Furnish test results from independent manufacturer (i.e., manufacturer with no legal or financial ties to pipe manufacturer). Tests shall have been performed within twelve months (12 Mos) prior to submittal or when supplier changes.

3. Test foreign manufactured wire by local independent laboratory.

4. Prestressing wire surface temperature: Not more than three hundred sixty degrees (360°) at any point in drawing process. Audit surface temperature of wire throughout length of wire drawing process daily for each working shift producing ASTM A648 wire.

5. Do not use wire with visible pitting or rust that cannot be wiped off.

6. Do not use wire that fails, for no observable mechanical reason other than tension force, during circumferential wrap. Do not splice, but reject this section of wire.

B. Perform mechanical tests per AWWA C301 – Steel Reinforcement except as modified below:

1. Retest coil for which failed torsion test sample has radial, spiral (longitudinal) split visible to unaided eye or evidenced by abrupt offset in wire surface detectable with fingernail.

2. Test sample, for mechanical requirements, from one (1) of each ten (10) consecutively produced coils or fraction thereof in each lot. Pipe manufacturer to establish procedures so samples are randomly selected from entire length of wire coils.

C. Perform hydrogen embrittlement sensitivity testing on samples of prestressing wire. Test one (1) set of pre-qualified samples for each anticipated wire manufacturing source anticipated by pipe manufacturer for project. Perform tension, wrapping and torsion tests on wire samples. Perform pre-qualification testing prior to pipe manufacturing and for each source of supply for wire. Do not use wire failing to conform to test requirements of the specification. Utilize only wire that meets both of following:

1. Passed aforementioned test.

2. Manufactured from same source and manufacturing procedures.

D. Hydrogen embrittlement sensitivity test.

1. Apply tensile force using lever apparatus, closed still frame in either vertical or horizontal orientation or stable hydraulic loading system equipped with force indicator. Use chronometer with precision of at least one tenth hour (0.1 Hr) and capable of being stopped automatically on fracture of sample.

2. Use cylindrical ammonium thiocyanate (NH_4SCN_1) cell constructed of material which is inert to ammonium thiocyanate. Expose minimum one hundred fifty millimeters (150 mm) long sample to solution. Open and closed test cells permitted. Minimum internal diameter of cell (D_i): Provide minimum five milliliter (5 ml) of solution per cm^2 of surface area of sample in contact with solution. Calculate minimum diameter as follows:

$D_i = [(200 + d) \times d]^{0.5}$ in mm, where d is wire diameter.

3. Solution replacement is recommended, but not required, during

test. When replacement is performed, continuously replace cell volume at rate not less than two (2) times per twenty-four hour (24 Hr) period.

4. Sample from lot of wire in which mechanical properties have been previously determined in accordance with ASTM A648 and AWWA C301. Provide sample consisting of minimum of one (1) full loop of wire from each of minimum of ten (10) coils. Tag each loop with appropriate heat number and coil number permanently identifying source of wire.

5. Provide certified mill report for each heat represented in sample, showing chemical composition, including as minimum:

Carbon (C)	Titanium (Ti)
Manganese (MN)	Nickel (Ni)
Silicon (SI)	Chromium (Cr)
Phosphorus (P)	Vanadium (V)
Sulfur (S)	Copper (Cu)
Nitrogen (N)	Molybdenum (Mo)
Aluminum (Al)	

6. Analyze dissolved hydrogen concentration for purposes of establishing baseline value prior to conducting hydrogen embrittlement sensitivity tests.

7. Test minimum of ten (10) pieces, at least one (1) piece chosen from each of ten (10) or more coils represented in lot, in ammonium thiocyanate solution for determination of time to failure.

8. Clean each test piece by wiping with soft cloth and degreased in acetone or in trichlorethylene and air dry. Protect test piece by varnish or similar means, as necessary, in zones where it enters test cell to prevent crevice corrosion failures at these locations. When necessary, extend protection at least twenty-five millimeter (25 mm) into cell.

9. Place ammonium thiocyanate, solution concentration of two hundred grams (200g) at ninety-nine percent (99%) pure

NH_4SCN per eight hundred milliliter (800 ml) of water, cell on test sample. Seal in place and then place cell/test sample assembly in tensioning device.

10. Apply load to test piece until force equal to seventy percent (70%) of ASTM A648 class minimum tensile load is indicated. Maintain force within plus or minus two percent (±2%) for duration of test.

11. Upon completion of application of force, fill cell with ammonium thiocyanate solution, preheated to temperature of fifty degrees Celsius (50° C) plus or minus one degree Celsius (±1° C). Fill cell within one minute (1 Min). Upon completion, set chronometer to zero (0) to indicate test starting point.

12. Check applied force and adjust as necessary to ensure force is maintained within specified range at appropriate time intervals throughout test. Record times when force was checked or adjusted.

13. Adjust temperature of test solution in cell to fifty degrees Celsius (50° C) plus or minus one degree Celsius (±1° C) within five minutes (5 Min) of starting test. Maintain temperature throughout test.

14. Test is completed on fracture of sample or test time reaching one hundred fifty hours (150 Hrs). Note time to fracture on chronometer, recorded to nearest one tenth hour (0.1 Hr).

15. When fracture occurs elsewhere than within exposed test length, test is invalid. Record no time.

E. Hydrogen embrittlement sensitivity report, include following:

1. Test samples:

   a. Wire manufacturer.

   b. Size and class of wire with heat number.

   c. Mechanical properties indicated by mean results from other required physical tests.

   d. Chemical composition.

2. Test conditions:

   a. Cell design: Open or closed, with or without solution replacement and replacement rate.

   b. Physical length of test sample (exposed).

   c. Deviations from specified procedure.

   d. Copy of this specification and statement that procedures described herein have been followed, except where noted otherwise.

3. Report results:

   a. Description of type of fracture and presence or absence of pitting and splits for each sample.

   b. Position of sample fracture in relation to test cell.

   c. Table of individual sample times to failure.

   d. Mean lifetime to failure and standard deviation for samples of diameter and class from wire manufacturer, using same wire drawing procedures.

4. Evaluate performance of wire in general and specific performance as defined by following pass/fail criterion:

   a. Pass/fail Criterion for ASTM A648 prestressing wire. Wire considered passing provided mean time to failure minus one (1) standard deviation for ten (10) samples tested exceeds seventy-five hours (75 Hrs).

   b. Time to failure in hydrogen charging test of individual sample from group of ten (10) samples tested and reported less than, seventy-five hours (75 Hrs). When one (1) sample from group of ten (10) samples tested fails in less than seventy-five hours (75 Hrs), single sample retest is permitted on sample from same loop of wire.

      1) Reject lot when retest is less than seventy-five hours (75 Hrs).

      2) When retest is greater than seventy-five hours (75

Hrs), use time (to failure) to replace rejected data in ten (10) sample groups mean and standard deviation from adjusted result.

2.3 GROUT FOR JOINTS AND SPECIAL APPLICATION

A. Joint Grout

1. Cement Grout Mixture: One (1) part cement to two (2) parts of fine, sharp clean sand. Mix interior joint mortar with as little water as possible until very stiff but workable. Mix exterior joint mortar with water until it has consistency of thick cream.

2. Water: Potable water with total dissolved solids less than one thousand milligrams per liter (1000 mg/l); ASTM D512 chloride ions less than one hundred milligrams per liter (100 mg/l) for slurry and mortar cure; ASTM D1293 pH greater than 6.5. Use potable water with two hundred fifty parts per million (250 ppm) limit on chlorides and sulfates.

3. Portland Cement: ASTM C150, Type I or II. Provide one type of cement for entire project.

4. Sand:

   a. Interior joints: ASTM C35 fine graded plaster sand.

   b. Exterior joints: ASTM C33 natural sand with one hundred percent (100%) passing No. 16 sieve.

5. Mix cement grout to specific gravity of nineteen pounds per gallon (19 Lb/Gal) or greater as measured by grout/slurry balance. Use balance manufactured grout/slurry by Baroid or approved equal. Perform test in presence of and at request of the Project Manager. Add additional cement grout or water to mixed cement grout to bring mix to proper moisture content or specific gravity. Discard cement grout that has been mixed more than twenty minutes (20 Min) and is not at proper specific gravity or moisture content.

B. Provide approved Nonshrink Grout for Special Applications, Patches and Repairs.

1. Conform to requirements of ASTM C107, Nonshrink Grout.

2. Pre-blended factory-packaged material manufactured under

rigid quality control.

3. Contain non-metallic natural aggregate, be non-staining and non-corrosive.

4. Meeting NSF 61 Standard suitable for use in contact with potable water supply.

5. Exterior: Highly flowable to fill joint wrapper without leaving voids or trapped air. Interior capable of being placed with plastic consistency.

6. Non-bleeding and non-segregating at fluid consistency.

7. Contain no chlorides or additives which may contribute to corrosion of Prestressed Concrete Cylinder Pipe.

8. Free of gas-producing, gas-releasing agents.

9. Resist attack by oil or water.

10. Mix, place and cure in accordance with manufacturer's recommendations. Upon seventy-two hours (72 Hrs) notice, provide services of qualified representative of nonshrink grout manufacturer to aid in use of product under job conditions.

11. Mix non-shrink grout to specific gravity of seventeen and seven-tenths pounds per gallon (17.7 Lb/Gal) or greater as measured by grout/slurry balance. Use grout/slurry balance manufactured by Baroid or approved equal. Perform test in presence of and at request of the Project Manager. Add additional cement grout or water to bring mix to proper moisture content or specific gravity. Discard grout that has been mixed more than twenty minutes (20 Min) and is not at proper specific gravity or moisture content.

12. Compressive strength: ASTM C1107 two thousand five hundred pounds per square inch (2500 psi) minimum seven day (7 D) unconfined; five thousand pounds per square inch (5000 psi) minimum twenty-eight day (28 D) unconfined.

C. Finished surface of lining and interior joint to be comparable to surface rubbed with No. 16 Carborundum stone. Rub joint mortar sufficiently to bring paste to surface, to remove depressions and projections and to produce smooth, dense surface. Add cement to form surface paste as necessary. Leave interior with clean, neat and uniform-appearing

finish.

D. Joint Wrapper: Minimum width of nine inches (9 In) for thirty-three inch (33 In) diameter and smaller; minimum width of twelve inches (12 In) for diameters greater than thirty-three inch (33 In) hemmed at edge to allow threading with minimum five-eighths (5/8) inch wide steel strap. Provide minimum six inch (6 In) wide wire Ethafoam strip sized, positioned and sewn circumferential in center of wrapper.

2.4 CATHODIC PROTECTION

A. Conform to requirements of Section 02285 – Cathodic Protection.

B. Connect each joint of pipe with bonding straps or approved devices to maintain continuity of current. Provide bonding straps free of foreign material.

C. Electrically isolate water line from other connections. Use insulating type joints or nonmetallic pipe unless otherwise indicated on the Drawings.

PART III: EXECUTION

3.1 INSTALLATION

A. Conform to requirements of Section 02400 – Water Lines. Do not install pipe without approved lay schedule.

B. Manufacturer shall make available services of representative, throughout project duration when deemed necessary by the Project Manager, to advise aspects of installation including but not limited to handling, storing, cleaning and inspecting, coatings and linings repairs and general construction methods affecting pipe.

C. Bedding and Backfilling:

1. Conform to requirements of Section 02125 – Excavation and Backfill for Utilities.

2. Align pipe at proper grade prior to joint connection and do not shift after jointing operation has been completed.

3. Do not move trench support system (trench safety system) once bedding material is compacted.

4. Excavate outside specified trench section for bell holes and for spaces sufficient to permit removal of slings. Provide bell holes at proper locations for unrestricted access to joint. Form bell holes large enough to facilitate joint wrapping and to permit visual examination of process. Enlargement of bell holes as required or directed by the Project Manager. Subsequent backfilling thereof shall not be considered as authorized additional excavation and backfill. Backfill bell holes and spaces to satisfaction of the Project Manager.

5. Remove blocking after placing sufficient backfill to hold pipe in position.

6. Use cement-stabilized sand in areas of trench excavation sixteen feet (16 Ft) and greater, as bedding material up to springline of pipe.

D. Follow nonshrink grout manufacturer's specifications for nonshrink grouting.

E. Deviation of installed pipe in any one (1) pipe section from line and grade shown on approved shop drawing layout shall not exceed two (2) inches from grade and three inches (3 In) from line. No deviation from line and grade at contact interfaces are allowed.

F. Install each pipe section in sequence identified on lay schedule. Deviations from lay schedule sequence shall be approved by the Project Manager and denoted on final lay schedule.

G. Use adequate surveying methods, procedures and employ competent surveying personnel to ensure pipe sections are laid to line and grade and within stipulated tolerances. Measure and record, in form approved by the Project Manager, in-place survey data for pipe laid each day and submit copy of data to the Project Manager at end of that day. Survey data shall include unique pipe number, deflection angle at pipe joint and whether beveled ends were used, invert elevation at pipe joint, deviation of joint from project line, deviation of joint from project grade, inside pipe joint lap measured at top, bottom and at springline (each side).

H. Static Electricity:

1. Properly ground steel pipeline during construction as necessary to prevent buildup of static electricity.

2. Electrically test where required after installation of pipeline is

complete.

3.2 CLOSURES AND APPROVED PIPE MODIFICATIONS

A. No modifications of standard pipe for closures shall be permitted in field. No field cutting of pipe or exposure of prestressed wire shall be permitted without written approval from the Project Manager.

B. Pipe manufacturer's representative and the Project Manager to entirely witness closures and approved pipe modification efforts.

C. Provide minimum lap of four inches (4 In) between member being joined and end of butt strap. Weld on both interior and exterior, unless otherwise approved by the Project Manager.

D. Provide full circumferential welds on joints required to be welded. Employ independent certified testing laboratory, approved by the Project Manager, to perform weld tests on field welds. Include cost of testing in contract unit price for water line. Use magnetic particle test method for lap welds or X-ray methods for butt welds, for one hundred percent (100%) of joint welds. Maintain records of tests. When defective weld is revealed, repair defective weld and retest. Use wire and flux from same manufacturer throughout entire project.

E. Fill wrapper in field and allow excess grout water to seep out. Refill wrapper as necessary. When joint mortar level has stabilized and begun to mechanically stiffen, lap Ethafoam wrapper over top of joint and secure in place.

F. Stretch test each gasket splice to twice its unstretched length and inspect for defects.

3.3 VISIBLE CRACKS

A. No visible cracks longer than six inches (6 In), measured to be within fifteen degrees (15°) of line parallel to pipe longitudinal axis, are permitted except:

1. In surface laitance of centrifugally cast concrete,

2. In sections of pipe with steel reinforcing collars or wrappers or

3. Within twelve inches (12 In) of pipe ends.

B. Repair interior lining cracks that exceed one-sixteenth inch (1/16 In) wide.

C. Reject pipe with exterior coating cracks that exceed one hundredth inches (0.01 In) wide.

D. Immediately remove pipe from site when pipe has cracks exceeding limitations and cracks are not repairable.

3.4 FIELD REPAIR PROCEDURES FOR COATING/LINING

A. Areas less than or equal to six inches (6 In) in diameter: Patch honeycomb and minor defects in concrete surfaces with non shrink grout conforming to section 2.3.B. Use only manual or small (low pressure) air chisels to chip away mortar coating or lining. Cut out unsatisfactory material and replace with nonshrink grout, securely bonded to existing coating or lining. Finish junctures between patches and existing concrete as inconspicuous as possible. Strike off nonshrink grout flush with surrounding surface after patch has stiffened sufficiently to allow for greatest portion of shrinkage. Finish surface in accordance with lining requirements.

B. Pipe with defective coating areas greater than six inches (6 In) in diameter shall not be used. Immediately remove pipe from project.

C. Reject pipe when steel cylinder is dented while making field repair. Immediately remove pipe from project.

PART IV: TABLES

4.1 – CYLINDER THICKNESS

Inside Diameter (inches)	Gauge Size
Greater than 84	6
72 to 84	8
48 to 66	10
Less than 48	12

END OF SECTION

SECTION 02230

POLYETHYLENE PLASTIC TUBING (PE)

PART I: GENERAL

1.1 GENERAL REQUIREMENTS

A. Polyethylene (PE) tubing for water service lines.

1.2 MEASUREMENT AND PAYMENT

A. Unit Prices:

1. No separate payment shall be made for Polyethylene (PE) tubing under this Section. Include cost in the unit prices for work, as specified in following sections:

   a. Section 02430 – Water Tap and Service Line Installation.

2. Refer to Section 01270 – Measurement and Payment for unit price procedures.

B. Stipulated Price (Lump Sum):

1. If Contract is Stipulated Price Contract, payment for work in this Section is included in Total Stipulated Price.

1.3 REFERENCES

A. AWWA – American Water Works Association.

1. AWWA C901 – Standard for Polyethylene (PE) Pressure Pipe and Tubing for Water Service.

B. ASTM – American Society for Testing and Materials.

1. ASTM D2737 – Standard Specification for Polyethylene (PE) Tubing.

2. ASTM D3350 – Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.

C. CFTS – City of Friendswood Technical Specifications.

1. Section 01270 – Measurement and Payment.

2. Section 01330 – Submittal Procedures.

3. Section 02125 – Excavation and Backfill for Utilities.

4. Section 02400 – Water Lines.

5. Section 02430 – Water Tap and Service Line Installation.

6. Section 02455 – Disinfection of Waterlines.

7. Section 02460 – Wet Connections.

1.4 SUBMITTALS

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

B. Submit shop drawings showing design of pipe and fittings, laying dimensions, fabrication, fittings, flanges and special details.

1.5 QUALITY CONTROL

A. Provide manufacturer's certificate of conformance to the Technical Specifications.

B. Furnish pipe and fittings that are homogeneous throughout and free from visible cracks, holes, foreign inclusions or other injurious defects. Provide pipe as uniform as commercially practical in color, opacity, density and other physical properties.

C. The Project Manager reserves the right to inspect pipes or witness pipe manufacturing. Inspection shall in no way relieve manufacturer of responsibilities to provide products that comply with applicable standards and these Technical Specifications.

1. Manufacturer's Notification: Should the Project Manager wish to witness manufacture of specific pipes, manufacturer shall provide the Project Manager with minimum three weeks (3 Wks) notice of when and where production of those specific pipes shall take place.

2. Failure to Inspect: Approval of products or tests shall not be implied by the Project Manager's decision not to inspect

manufacturing, testing or finished pipes.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the products specified in this section with documented experience of a minimum five years (5 Yrs) of pipe installations that have been in successful, continuous service for same type of service as the proposed Work.

PART II: PRODUCTS

2.1 GENERAL

A. All polyethylene (PE) tubing shall be high density, high molecular weight plastic tubing meeting.

B. Polyethylene (PE) tubing for water services shall be pressure rated at two hundred pounds per square inch (200 psi) working pressure and must bear the National Sanitation Foundation seal of approval.

C. Pipe manufacturers shall be listed on SPL WW-65.

D. Polyethylene (PE) tubing shall be designated PE3408, denoting Grade 34 with hydrostatic design stress of eight hundred pounds per square inch (800 psi).

2.2 MARKING

A. Mark each standard and random length of pipe in compliance with these Technical Specifications with following information:

1. Nominal tubing size.
2. Standard PE code designation.
3. Standard Dimension Ratio (SDR) and pressure rating.
4. AWWA designation.
5. Manufacturer Name or Trademark and testing agency name or seal.

PART III: EXECUTION

3.1 INSTALLATION

A. Conform to requirements of following Sections:

1. Section 02125 – Excavation and Backfill for Utilities.
2. Section 02400 – Water Lines.
3. Section 02430 – Water and Tap Service Line Installations.
4. Section 02460 – Wet Connections.
5. Section 02455 – Disinfection of Waterline.

B. Install pipe in accordance with the manufacturers recommended installation procedures.

C. Polyethylene (PE) tubing is not approved in applications requiring augering of pipe.

D. Bedding and backfill: Conform to requirements of Section 02125 – Excavation and Backfill for Utilities.

END OF SECTION

SECTION 02235

POLYVINYL CHLORIDE (PVC) PIPE

PART I: GENERAL

1.1 GENERAL REQUIREMENTS

A. Polyvinyl chloride pressure pipe for water distribution, in nominal diameters four inches (4 In) through twenty inches (20 In).

B. Polyvinyl chloride sewer pipe for gravity sewers in nominal diameters four inches (4 In) through forty-eight inches (48 In).

C. Polyvinyl chloride pressure pipe for gravity sewers and force mains in nominal diameters four inches (4 In) through twenty inches (20 In).

1.2 MEASUREMENT AND PAYMENT

A. Unit Prices:

1. No separate payment will be made for PVC pipe under this Section. Include cost in the unit price for work included as specified in the following sections:

   a. Section 02400 – Water Lines.

   b. Section 02500 – Gravity Sanitary Sewers.

   c. Section 02510 – Sanitary Sewer Force Mains.

   d. Section 02600 – Storm Sewers.

2. Refer to Section 01270 – Measurement and Payment for unit price procedures.

B. Stipulated Price (Lump Sum):

1. If Contract is Stipulated Price Contract, payment for work in this Section is included in Total Stipulated Price.

1.3 REFERENCES

A. ANSI – American National Standards Institute.

1. ANSI A21.16 (AWWA C116) – Protective Fusion Bonded Epoxy Coating for the Interior and Exterior Surfaces of Ductile Iron and Grey Iron Fittings for Water Supply Service.

B. ASTM – American Society for Testing and Materials.

1. ASTM D1248 – Standard Specification for Polyethylene Plastics Molding and Extrusion Materials.

2. ASTM D1784 – Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.

3. ASTM D2241 – Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).

4. ASTM D2321 – Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.

5. ASTM D2444 – Standard Test Method for Determination of the Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tup (Falling Weight).

6. ASTM D2680 – Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly (Vinyl Chloride) (PVC) Composite Sewer Piping.

7. ASTM D3034 – Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

8. ASTM D3139 – Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.

9. ASTM D3212 – Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.

10. ASTM F477 – Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

11. ASTM F679 – Standard Specification for Poly (Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.

12. ASTM F794 – Standard Specification for Poly (Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter.

13. ASTM F949 – Standard Specification for Poly (Vinyl Chloride) (PVC) Corrugated Sewer Pipe with Smooth Interior and Fittings.

C. AWWA – American Water Works Association.

1. AWWA C110 – American National Standard for Ductile-Iron and Gray-Iron Fittings, 3 Inches Through 48 Inches for Water.

2. AWWA C111 – American National Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

3. AWWA C900 – Standard for Polyvinyl Chloride (PVC) Pressure Pipe, 4 Inches Through 12 Inches for Water Distribution.

4. AWWA C905 – Standard for Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 In. Through 48 In., for Water Transmission and Distribution.

5 AWWA C909 – Standard for Molecularly-Oriented Polyvinyl Chloride (PVCO) Pressure Pipe, 4 Inches through 12 Inches (100mm through 300 mm), for Water Distribution.

D. CTFS – City of Friendswood Technical Specification.

1. Section 01270 – Measurement and Payment.

2. Section 01330 – Submittal Procedures.

3. Section 02125 – Excavation and Backfill for Utilities.

4. Section 02215 – Ductile Iron Pipe (DIP) and Fittings.

5. Section 02260 – Polyethylene Wrap.

6. Section 02400 – Water Lines.

7. Section 02500 – Gravity Sanitary Sewers.

8. Section 02510 – Sanitary Sewer Force Mains.

9. Section 02600 – Storm Sewers.

E. PPI – Plastic Pipe Institute.

1. PPI TR3 – Policies and Procedures for Developing Recommended Hydrostatic Design Stresses for Thermoplastic Pipe Materials.

F. UNI – Uni-Bell Standard.

1. UNI-B-13 – Recommended Standard Performance Specification for Joint Restraint Devices for Use with Polyvinyl Chloride Pipe.

1.4 SUBMITTALS

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

B. Submit shop drawings showing design of new pipe and fittings indicating alignment and grade, laying dimensions, fabrication, fittings, flanges and special details.

1.5 QUALITY CONTROL

A. Submit manufacturer's certifications that PVC pipe and fittings meet requirements of this Section and AWWA C900, AWWA C909 and AWWA C905 for pressure pipe applications or appropriate ASTM standard specified for gravity sewer pipe.

B. Submit manufacturer's certification that PVC pressure pipe for water lines and force mains has been hydrostatically tested at factory in accordance with AWWA C900, AWWA C909 and AWWA C905 and this Section.

C. When foreign manufactured material is proposed for use, have material tested for conformance to applicable ASTM requirements by certified independent testing laboratory located in United States. Certification from other source is not acceptable. Furnish copies of test reports to the Project Manager for review. Cost of testing paid by the Contractor.

PART II: PRODUCTS

2.1 MATERIAL

A. Use PVC compounds in manufacture of pipe that contain no ingredient

in amount that has been demonstrated to migrate into water in quantities considered to be toxic.

B. Furnish PVC pressure pipe manufactured from Class 12454-A or Class 12454-B virgin PVC compounds as defined in ASTM D1784. Use compounds qualifying for rating of four thousand pounds per square inch (4000 psi) for water at seventy-three and four tenths degrees Fahrenheit (73.4° F) per requirements of PPI TR3. Provide pipe which is homogeneous throughout, free of voids, cracks, inclusions and other defects, uniform as commercially practical in color, density and other physical properties. Deliver pipe with surfaces free from nicks and scratches with joining surfaces of spigots and joints free from gouges and imperfections which could cause leakage.

C. PVC Restrained Pipe: Must be listed on the City's current Product Approval List.

1. Pipe Material:

a. DR 18: For restrained joints where shown on Drawings.

b. DR 14: For alternate to offset pipe sections shown on the Drawings. Do not use PVC for offset sections with depth of cover greater than twenty feet (20 Ft) or less than four feet (4 Ft). Do not use PVC in potentially petroleum contaminated areas.

D. Water Service.

1. Provide self-extinguishing PVC pipe that bears Underwriters' Laboratories mark of approval and is acceptable without penalty to Texas State Fire Insurance Committee for use in fire protection lines.

2. Bear National Sanitation Foundation Seal of Approval (NSF-PW).

E. Gaskets:

1. Gaskets shall meet requirements of ASTM F477. Use elastomeric factory-installed gaskets to make joints flexible and watertight.

2. Flat Face Mating Flange: Full faces one-eighth inch (1/8 In) thick ethylene propylene (EPR) rubber.

3. Raised Face Mating Flange: Flat ring one-eighth inch (1/8 In) ethylene propylene (EDR) rubber, with filler gasket between OD of raised face and flange OD to protect flange from bolting moment.

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

G. Do not use PVC in potentially or known contaminated areas.

H. Do not use PVC in areas exposed to direct sunlight.

2.2 WATER SERVICE PIPE

A. Pipe four inch (4 In) through twelve inch (12 In): AWWA C900, AWWA C909, Class 150, DR 18; AWWA C900, Class 200, DR 14 as alternate to offset pipe sections; nominal twenty foot (20 Ft) lengths; cast-iron equivalent outside diameters.

B. Pipe fourteen inch (14 In) through twenty inch (20 In): AWWA C905; Class 235; DR 18; nominal twenty foot (20 Ft) lengths; cast-iron equivalent outside diameter.

C. Provide Polyvinyl Chloride Pipe from approved manufacturers.

D. Make curves and bends by deflecting joints. Do not exceed maximum deflection recommended by pipe manufacturer. Submit details of other methods of providing curves and bends for review by the Project Manager.

E. Hydrostatic Test: AWWA C900, AWWA C905, AWWA C909, ANSI A21.10 (AWWA C110); at point of manufacture; submit manufacturer's written certification.

2.3 GRAVITY SEWER PIPE

A. PVC gravity sanitary sewer pipe and storm sewer pipe shall be as specified in TABLE 4.1 – PVC PIPE DESIGNATION in the Section.

B. When solid wall PVC pipe eighteen inches (18 In) to twenty-seven inches (27 In) in diameter is required in SDR 26, provide pipe conforming to ASTM F679, except provide wall thickness as required for SDR 26 and pipe strength of one hundred fifteen pounds per square

inch (115 psi).

C. For sewers up to twelve inch (12 In) diameter crossing over water lines or crossing under water lines with less than two feet (2 Ft) separation, provide minimum one hundred fifty pounds per square inch (150 psi) pressure-rated pipe conforming to ASTM D2241 with suitable PVC adapter couplings.

D. Joints: Spigot and integral wall section bell with solid cross section elastomeric or rubber ring gasket conforming to requirements of ASTM D3212 and ASTM F477 or ASTM D3139 and ASTM F477. Gaskets shall be factory-assembled and securely bonded in place to prevent displacement. Manufacturer shall test sample from each batch conforming to requirements ASTM D2444.

E. Fittings: Provide PVC gravity sewer sanitary bends, tee or wye fittings for new sanitary sewer construction. PVC pipe fittings shall be full-bodied, either injection molded or factory fabricated. Saddle-type tee or wye fittings shall not be acceptable.

F. Conditioning: Conditioning of samples prior to and during tests is subject to approval by the Project Manager. When referee tests are required, condition specimens in accordance with Procedure A in ASTM D618 at seventy-three and four-tenths degrees Fahrenheit (73.4° F) plus or minus three and six-tenths degrees Fahrenheit (±3.6° F) and fifty percent (50%) relative humidity plus or minus five percent (5%) relative humidity for not less than forty hours (40 Hrs) prior to test. Conduct tests under same conditions of temperature and humidity unless otherwise specified.

G. Pipe Stiffness: Determine pipe stiffness at five percent (5%) deflection in accordance with Test Method D 2412. Minimum pipe stiffness shall be forty-six pounds per square inch (46 psi). For diameters four inches (4 In) through eighteen inches (18 In), test three (3) specimens, each a minimum of six inches (6 In) in length. For diameters twenty-one inch (21 In) through thirty-six inch (36 In), test three (3) specimens, each a minimum of twelve inch (12 In) in length.

H. Flattening: Flatten three (3) specimens of pipe, prepared in accordance with Paragraph 2.3.F, in suitable press until internal diameter has been reduced to sixty percent (60%) of original inside diameter of pipe. Rate of loading shall be uniform. Test specimens, when examined under normal light and with unaided eye, shall show no evidence of splitting, cracking, breaking or separation of pipe walls or bracing profiles. Perform the flattening test in conjunction with pipe stiffness test.

I. Joint Tightness: Test for joint tightness in accordance with ASTM D3212, except that joint shall remain watertight at minimum deflection of five percent (5%). Manufacturer shall be required to provide independent third (3rd) party certification for joint testing each diameter of storm sewer pipe.

J. Purpose of Tests: Flattening and pipe stiffness tests are intended to be routine quality control tests. Joint tightness test is intended to qualify pipe to specified level of performance.

2.4 SANITARY SEWER FORCE MAIN PIPE

A. Provide approved PVC pressure pipe conforming to requirements for water service pipe and conforming to minimum working pressure rating specified in Section 02510 – Sanitary Sewer Force Mains.

B. Acceptable pipe joints are integral bell-and-spigot, containing a bonded-in elastomeric sealing ring meeting requirements of ASTM F477. In designated areas requiring restrained joint pipe and fittings, use approved joint restraint device conforming to UNI-B-13, for PVC pipe twelve inch (12 In) diameter and less.

C. Fittings: Provide approved ductile iron fittings as per Section 02215 – Ductile Iron Pipe (DIP) and Fittings, Paragraph 2.4, except furnish fittings with one (1) of following approved internal linings:

1. Nominal forty (40) mils [thirty-five (35) mils minimum] virgin polyethylene complying with ASTM D1248, heat fused to interior surface of fitting.

2. Nominal forty (40) mils [thirty-five (35) mils minimum] polyurethane.

3. Nominal forty (40) mils [thirty-five (35) mils minimum] ceramic epoxy.

4. Nominal forty (40) mils [thirty-five (35) mils minimum] fusion bonded epoxy.

D. Exterior Protection: Provide polyethylene wrapping of ductile-iron fittings as required by Section 02260 – Polyethylene Wrap.

E. Hydrostatic Tests: Hydrostatically test pressure rated pipe in accordance with Paragraph 2.2.E.

2.5 BENDS AND FITTINGS FOR PVC PRESSURE PIPE

A. Bends and Fittings: ANSI A 21.10 or ANSI A 21.53, ductile iron; ANSI A 21.11 single rubber gasket push-on type joint; minimum two hundred pounds per square inch (150) psi pressure rating. Approved restrained joints, two hundred pounds per square inch (200 psi) and two hundred fifty pounds per square inch (250 psi), may be provided for up to twelve (12) inches in diameter (water or sanitary).

B. Provide approved restrained joint fittings: Integral restrained joint fittings and pipe shall not require secondary restraint.

PART III: EXECUTION

3.1 PROTECTION

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

3.2 INSTALLATION

A. Conform to requirements of Section 02400 – Water Lines, Section 02500 – Gravity Sanitary Sewers and Section 02510 – Sanitary Sewer Force Mains, as applicable.

B. Install PVC pipe in accordance with Section 02125 – Excavation and Backfill for Utilities, ASTM D2321 for Sewer Pipe and manufacturer's recommendations.

C. Install PVC water service pipe to clear utility lines and have minimum depth of cover below property line grade of street, unless otherwise required by Drawings:

1. Water service pipe twelve (12) inches in diameter and smaller four feet (4 Ft) of cover.

2. Water service pipe sixteen (16) inches in diameter and larger five (5) feet of cover.

D. Avoid imposing strains that shall overstress or buckle pipe when lowering pipe into trench. Do not drop pipe more than two feet (2 Ft).

E. Hand shovel pipe bedding under pipe haunches and along sides of pipe barrel and compact to eliminate voids and ensure side support.

F. Store PVC pipe under cover out of direct sunlight. Protect pipe from excessive heat or harmful chemicals. Prevent damage by crushing or piercing.

G. Allow PVC pipe to cool to ground temperature before backfilling when assembled out of trench to prevent pullout due to thermal contraction.

3.3 PVC RESTRAINED MECHANISM

A. Do not apply lubricant to spline or pipe or coupling spline grooves.

B. Do not use excessive force while inserting the spline through coupling.

C. Insert spline until it is fully seated around circumference of pipe.

D. Field Cutting of Pipe Ends:

1. Perform by workers certified by manufacturer.

2. Use a PVC pipe cutter and provide square ends.

3. Use manufacturer approved power routing and grooving tool to field fabricate required pipe groove.

PART IV: TABLES

4.1 – PVC PIPE DESIGNATION

WALL CONSTRUCTION	MANUFACTURER	ASTM DESIGNATION	SDR (MAX.)/ STIFFNESS (MIN.)	DIAMETER SIZE RANGE
Solid	J-M Pipe	D3034	SDR 26 / PS 115	6” TO 10”
		D3034	SDR 35 / PS 46	12” & 15”
	CertainTeed	F679	SDR 35 / PS 46	18” to 27”
	Diamond	AWWA C900	DR 18 / N/A	4” to 12”
	Uponor ETI	AWWA C909	DR 18 / N/A	4” to 12”
	North American	AWWA C905	DR 18 / N/A	14” to 16”
Truss (Gasketed)	Contech	D2680	N/A / 200 psi	8” to 15”
Profile	Contech A-2000	F949	N/A / 46 psi	12” to 16”
	Contech A-2026	F949	N/A / 115 psi	8” to 10”
	ETI, Ultra-Rib	F794	N/A / 46 psi	8” to 30”
	ETI, Ultra-Corr	F794	N/A / 46 psi	24” to 36”

END OF SECTION

SECTION 02240

REINFORCED CONCRETE BOXES (RCB)

PART I: GENERAL

1.1 GENERAL REQUIREMENTS

A. Precast reinforced concrete box sewers.

1.2 MEASUREMENT AND PAYMENT

A. Unit Prices:

1. No separate payment will be made for precast reinforced concrete box sewer under this Section. Include payment in the unit price for Section 02600 – Storm Sewers.

2. Refer to Section 01270 – Measurement and Payment for unit price procedures.

B. Stipulated Price (Lump Sum):

1. If Contract is Stipulated Price Contract, payment for work in this section is included in Total Stipulated Price.

1.3 REFERENCES

A. ASTM – American Society for Testing and Materials.

1. ASTM C1433 – Standard Specification for Precast Reinforced Concrete Box Sections for Culverts, Storm Drains and Sewers.

B. CFTS – City of Friendswood Technical Specifications.

1. Section 01270 – Measurement and Payment.

2. Section 01330 – Submittal Procedures.

3. Section 02125 – Excavation and Backfill for Utilities.

4. Section 02600 – Storm Sewers.

5. Section 03300 – Structural Concrete.

1.4 SUBMITTALS

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

B. Submit shop drawings and data on box sections, fittings, gaskets and appurtenances for approval. Indicate conformance to reference standards.

1.5 QUALITY ASSURANCE

A. Provide manufacturer's affidavits that pipe was manufactured in compliance with standards referenced in this Section.

PART II: PRODUCTS

2.1 PRECAST REINFORCED CONCRETE BOX SEWERS

A. Conform to ASTM C1433, as indicated on the Drawings.

B. Pipe and boxes shall be machine-made or cast by process which shall provide for uniform placement of concrete in forms and compaction by mechanical devices to produce dense, structurally sound concrete.

2.2 CONCRETE

A. Conform to requirements of Section 03300 – Structural Concrete.

B. Use concrete mixed in central batch plant or other batching facility from which quality and uniformity of concrete can be assured. Transit-mixed concrete is not acceptable.

2.3 SOURCE QUALITY CONTROL

A. The Project Manager shall inspect manufacturer's plant and casting operations as deemed necessary.

PART III: EXECUTION

3.1 BEDDING

A. Bed box sections on foundation of firm and stable material accurately shaped to conform to their bases. Install bedding as specified in Section 02125 – Excavation and Backfill for Utilities. When required by the Drawings, use special bedding material. When single-cell box sections are placed in parallel for multi-cell installation, place in

conformance with details shown on the Drawings.

3.2 PLACEMENT

A. Carefully lower box sections to bottom of trench and lay accurately in line and grade, with spigot or tongue end downstream entering bell or groove end to full depth and in such manner as not to drag foreign material into annular space.

3.3 JOINTING

A. Join box sections together and match so that they shall form continuous smooth and uniform invert.

3.4 BACKFILLING

A. After box has been properly jointed and bedded, commence backfilling.

B. Backfill in accordance with Section 02125 – Excavation and Backfill for Utilities.

END OF SECTION

SECTION 02245

REINFORCED CONCRETE PIPE (RCP)

PART I: GENERAL

1.1 GENERAL REQUIREMENTS

A. Reinforced concrete pipe for sanitary sewers and storm sewers.

1.2 MEASUREMENT AND PAYMENT

A. Unit Prices:

1. No separate payment will be made for reinforced concrete pipe under this Section. Include cost in unit price work as specified in following Sections:

   a. Section 02500 – Gravity Sanitary Sewers.

   b. Section 02600 – Storm Sewers.

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

B. Stipulated Price (Lump Sum):

1. If Contract is Stipulated Price Contract, payment for work in this section is included in Total Stipulated Price.

1.3 REFERENCES

A. ASTM – American Society for Testing and Materials.

1. ASTM C76 – Standard Specification for Reinforced Concrete Culvert, Storm Drain and Sewer Pipe.

2. ASTM C443 – Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe Using Rubber Gaskets.

3. ASTM C497 – Standard Test Method for Concrete Pipe, Manhole Sections or Tile.

4. ASTM C506 – Standard Specification for Reinforced Concrete

Arch Culvert, Storm Drain and Sewer Pipe.

5. ASTM C655 – Standard Specification for Reinforced Concrete D-load Culvert, Storm Drain and Sewer Pipe.

6. ASTM C877 – Standard Specification for External Sealing Bands for Noncircular Concrete Sewer, Storm Drain and Culvert Pipe.

B. CFTS – City of Friendswood Technical Specifications.

1. Section 01270 – Measurement and Payment.

2. Section 01330 – Submittal Procedures.

3. Section 02125 – Excavation and Backfill for Utilities.

4. Section 02500 – Gravity Sanitary Sewers.

5. Section 02600 – Storm Sewers.

6. Section 03105 – Grout.

1.4 SUBMITTALS

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

B. Submit complete product data for pipe, fittings and gaskets for approval. Indicate conformance to appropriate reference standards.

C. Submit manufacturer's certificate that concrete pipes meet applicable standards.

D. For jacking pipe, submit drawings and data describing grouting port design and closure procedures when required by Section 03105 – Grout, including liner repair, as applicable.

1.5 QUALITY ASSURANCE

A. Provide manufacturer's affidavits that pipe was manufactured in compliance with standards referenced in this Section.

PART II: PRODUCTS

2.1 REINFORCED CONCRETE PIPE

A. Conform circular reinforced concrete pipe to requirements of ASTM C76, for Class III wall "B" thickness. Conform to rubber gasket joints for sanitary sewers and storm sewers and tongue and groove for roadside ditch culverts to ASTM C443.

B. Conform reinforced concrete arch pipe to requirements of ASTM C506 for Class A-III. Joints shall conform to ASTM C877.

C. Reinforced concrete elliptical pipe, either vertical or horizontal, shall conform to requirements of ASTM C507 for Class VE-III for vertical or Class HE-III for horizontal. Use rubber gasket joints conforming to ASTM C877.

D. Conform reinforced concrete D-load pipe requirements of ASTM C655.

2.2 GASKETS

A. When no contaminant is identified, furnish rubber gasket conforming to ASTM C443 for circular reinforced concrete pipe and rubber gasket conforming to ASTM C877 for reinforced concrete elliptical pipe.

B. Pipes allowed to be installed in potentially contaminated areas, where free product is found near elevation of proposed sewer, shall have gasket materials for noted contaminant as specified in TABLE 4.1 – GASKET MATERIAL REQUIRED FOR CONTANIMANTS in this Section.

2.3 LINERS FOR SANITARY SEWER PIPE

A. Reinforced concrete pipe for sanitary sewers shall be PVC lined.

B. Reinforced concrete pipes to be installed in potentially contaminated areas shall have liners recommended by manufacturer as resistant to contaminants identified in Phase II Environmental Site Assessment Report.

2.4 SOURCE QUALITY CONTROL

A. The Project Manager shall inspect manufacturer's plant and casting operations as deemed necessary.

PART III: EXECUTION

3.1 BEDDING

A. Bed pipe sections on foundation of firm and stable material accurately shaped to conform to their bases. Install bedding as specified in Section 02125 – Excavation and Backfill for Utilities. When required by the Drawings, use special bedding material. When single-cell pipe sections are placed in parallel for multi-cell installation, place in conformance with details shown on the Drawings.

3.2 PLACEMENT

A. Carefully lower pipe sections to bottom of trench and lay accurately in line and grade, with spigot or tongue end downstream entering bell or groove end to full depth and in such manner as not to drag foreign material into annular space.

3.3 JOINTING

A. Join pipe sections together and match so that they shall form continuous smooth and uniform invert.

3.4 BACKFILLING

A. After pipe has been properly jointed and bedded, commence backfilling.

B. Backfill in accordance with Section 02125 – Excavation and Backfill for Utilities.

PART IV: TABLES

4.1 GASKET MATERIAL REQUIRED FOR CONTANIMANTS

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

END OF SECTION

SECTION 02250

STEEL PIPE AND FITTINGS

PART I: GENERAL

1.1 GENERAL REQUIREMENTS

A. Steel pipe and fittings for water lines for aerial crossings, aboveground piping and encasement sleeves.

B. Specifications identify requirements for small-diameter less than or equal to twenty inches (20 In).

1.2 MEASUREMENT AND PAYMENT

A. Unit Prices:

1. No payment will be made for steel pipe and fittings under this Section. Refer to Section 02400 – Water Lines for measurement and payment.

2. Refer to Section 01270 – Measurement and Payment for unit price procedures.

B. Stipulated Price (Lump Sum):

1. If Contract is Stipulated Price Contract, payment for work in this Section is included in Total Stipulated Price.

1.3 REFERENCES

A. AASHTO – American Association of State Highway and Transportation Officials.

1. AASHTO – Standard Specifications for Highway Bridges.

B. ASME – American Society of Mechanical Engineers.

1. ASME B16.1 – Cast-Iron Pipe Flanges and Flanged Fittings.

C. ASTM – American Society for Testing and Materials.

1. ASTM A36 – Standard Specification for Carbon Structural

Steel.

2. ASTM A53 – Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.

3. ASTM A105 – Standard Specification for Carbon Steel Pipe Forgings for Piping Applications.

4. ASTM A106 – Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.

5. ASTM A135 – Standard Specification for Electric-Resistance-Welded Steel Pipe.

6. ASTM A139 – Standard Specification for Electric-Fusion (ARC) – Welded Steel Pipe (NPS 4 and Over).

7. ASTM A1011 – Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.

8. ASTM D4541 – Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers.

D. AWWA – American Water Works Association.

1. AWWA C200 – Standard for Steel Water Pipe 6 in. and Larger.

2. AWWA C206 – Standard for Field Welding of Steel Water Pipe.

3. AWWA C207 – Standard for Steel Pipe Flanges for Waterworks Service – Sizes 4 in. through 144 in.

4. AWWA C210 – Standard for Liquid Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines.

5. AWWA M11 – Steel Pipe – A Guide for Design and Installation.

E. CFTS – City of Friendswood Technical Specifications.

1. Section 01270 – Measurement and Payment.

2. Section 01330 – Submittal Procedures.

3. Section 02125 – Excavation and Backfill for Utilities.

4. Section 02400 – Water Lines.

F. SSPC – Steel Structure Painting Council.

1. SSPC Good Painting Practice, Volume 1.

2. SSPC SP1 – Surface Preparation Specification No. 1 Solvent Cleaning.

3. SSPC SP5 – Joint Surface Preparation Standard White Blast Cleaning.

4. SSPC SP6 – Surface Preparation Specification No. 6 Commercial Blast Cleaning.

5. SSPC SP10 – Surface Preparation Specification No. 10 Near-White Blast Cleaning.

6. SSPC VIS1 – Visual Standard for Abrasive Blast Cleaned Steel.

1.4 SUBMITTALS

A. Conform to requirements of Section 01330 – Submittal Procedures. For aerial crossings and above ground piping, include lay schedule of new pipe and fittings indicating alignment and grade, laying dimensions, lining and coating systems, proposed welding procedures, fabrication, fitting, flange and special details. Show station numbers for pipe and fittings corresponding to the Drawings.

B. Submit manufacturer's certifications that pipe and fittings are new and unused.

C. Submit manufacturer's certifications that pipe and fittings have been hydrostatically tested at factory in accordance with AWWA C200.

D. Submit manufacturer's affidavits that coatings and linings comply with applicable requirements of this Section and:

1. Polyurethane coatings were applied in strict accordance with manufacturer's recommendation and allowed to cure at temperature five degrees Fahrenheit (5° F) above dew point.

2. Linings were applied and allowed to cure at temperature above thirty-two degrees Fahrenheit (32° F).

E. Submit certification from National Association of Corrosion Engineers (NACE) Certified Coatings Inspector, having Level III certification for coatings and linings, that steel pipe furnished on project was properly inspected and any defective coating detected was properly repaired.

1.5 QUALITY CONTROL

A. Prior to start of work, provide proof of certification of qualification for welders employed for type of work, procedures and positions involved. Provide welder qualifications in accordance with AWWA C206.

B. Shop-applied coatings and linings; provide services of an independent coating and lining inspection service or testing laboratory with qualified coating inspectors. Perform inspection by NACE trained inspectors under supervision of NACE Level III Certified Coatings Inspector verifying compliance with same requirements specified in Paragraph 3.2.

C. Coatings: Measure temperature and dew point of ambient air before applying coatings. Inspect physical dimensions and overall condition of coatings. Inspect for visible surface defects, thickness and adhesion of coating to surface and between layers.

D. Final Inspection:

1. Before shipment, inspect each finished pipe, fitting, special and accessory for markings, metal thickness, coating thickness, lining thickness (if shop applied), joint dimensions and roundness.

2. Inspect for coating placement and defects. Test exterior coating for holidays.

a. Inspect linings for thickness, pitting, scarring and adhesion.

E. Ensure workmen engaged in manufacturing are qualified and experienced in performance of their specific duties.

PART II: PRODUCTS

2.1 STEEL PIPE

A. Manufacture pipe with nominal diameter twenty inches (20 In) and less, but more than two inches (2 In), to conform to ASTM A106 or A 53

Grade B, standard weight.

B. Provide steel pipe and encasement sleeves designed and manufactured in conformance with AWWA C200 and AWWA M11 except as modified herein. Steel to be minimum of A36, ASTM A1011 Grade 36, ASTM A53 Grade B, ASTM A135 Grade B or ASTM A139 Grade B.

C. Minimum Allowable Steel-Wall Thickness shall be as specified in TABLE 4.1 – STEEL WALL THICKNESS FOR CARRIER PIPE in this Section.

1. Review pipe and fitting design for conditions exceeding those specified herein.

2. Provide pipe with wall thickness of no less than listed in TABLE 4.1 – STEEL WALL THICKNESS FOR CARRIER PIPE in this Section.

D. Minimum Diameter for Casing Pipe shall be as specified in TABLE 4.2 – MINIMUM DIAMETER FOR CASING PIPE in this Section.

1. Provide casing pipe with wall thickness of no less than listed in TABLE 4.2 – MINIMUM DIAMETER FOR CASING PIPE in this Section.

2. Casing pipe: AWWA C200 new uncoated welded steel.

3. Verify casing diameter required with dimensions of casing spacer.

E. Provide pipe sections in lengths of not less than sixteen feet (16 Ft) except as required for special sections and not greater than forty feet (40 Ft).

F. Provide short sections of steel pipe not less than four feet (4 Ft) in length unless indicated on the Drawings or specifically permitted by the Project Manager.

G. Fittings: Factory forged for sizes two inches (2 In) through twenty inches (20 In); long radius bends; beveled ends for field butt welding; wall thickness equal to or greater than pipe to which fitting is to be welded unless otherwise shown on the Drawings.

H. Joints:

1. Standard field joint for steel pipe and encasement sleeve: AWWA C206. Single-welded, butt joint.

2. Provide mechanically coupled or flanged joints for valves and fittings, as shown on the Drawings. Flanges: AWWA C207, Class D; same diameter and drilling as Class 125 cast iron flanges ASME B16.1. Maintain electrically isolated flanged joints between steel and cast iron by using epoxy-coated bolts, nuts, washers and insulating type gasket.

3. Elbows to be standard weight seamless elbows per ASTM A106, Grade A or B.

4. Flanges for pipe twenty inches (20 In) in diameter and less, but more than two inches (2 In), shall be ANSI one hundred fifty pound (150 Lb) flat face, slip on or weld neck flanges, meeting ASTM A105 requirements. Where flanges are to join to valves with raised face flanges, use ANSI one hundred fifty pound (150 Lb) raised flange.

5. Provide same coating for exposed portions of nuts and bolts as flanges which they secure.

I. Fabricate flanges with over-size bolt holes, with flanges drilled in pairs, to accommodate insulating sleeves.

2.2 INTERNAL LINING SYSTEMS FOR STEEL PIPE, ALL INSTALLATIONS

A. Supply steel pipe with epoxy lining, capable of conveying water at temperatures not greater than one hundred forty degrees Fahrenheit (140° F). Provide linings conforming to American National Standards Institute/National Sanitation Foundation (ANSI/NFS) Standard 61 and certification to be from organization accredited by ANSI. Unless otherwise noted, coat exposed (wetted) steel parts of flanges, blind flanges, bolts, access manhole covers, etc., with epoxy lining, as specified in TABLE 4.3 EPOXY LINING in this Section.

B. Epoxy Lining AWWA C210, White or approved equal for shop and field joint applied, except as modified in this Section. Provide material from same manufacturer. For Pipe larger than two inches (2 In) in diameter protect interior surface with liquid two-part chemically cured epoxy primer specified for interior surfaces.

1. Total allowable dry film thickness for system:

a. Minimum: Twelve (12) mils.

b. Maximum: Eighteen (18) mils.

c. Minimum field adhesion: Seven hundred pounds per square inch (700 psi).

2. Dry film thicknesses for approved alternate products in accordance with product manufacturer's recommendations.

3. Lining system may consist of three (3) or more coats of same approved alternate epoxy lining without use of separate primer.

2.3 EXTERNAL COATING SYSTEM FOR STEEL PIPE INSTALLED ABOVEGROUND AND IN VAULTS (EXPOSED)

A. Provide three (3) coat epoxy/polyurethane coating system as specified in TABLE 4.4 – THREE PART EPOXY/POLYURETHANE COATINGS in this Section. Provide material from same manufacturer.

B. Total Allowable Dry Film Thickness (DFT) for System:

1. Minimum: Nine and one-half (9.5) mils

2. Maximum: Twelve and one-half (12.5) mils

C. Clean bare pipe free from mud, mill lacquer, oil, grease or other contaminant. Inspect and clean surfaces according to SSPC SP1 to remove oil, grease and loosely adhering deposits prior to blast cleaning. Remove visible oil and grease spots by solvent wiping. Use only approved safety solvents which do not leave residue. Use preheating to remove oil, grease, mill scale, water and ice provided pipe is preheated in uniform manner to avoid distortion.

D. Remove surface imperfections such as slivers, scabs, burrs, weld spatter and gouges, presence of metallic defects may be cause for rejection of pipe.

PART III: EXECUTION

3.1 PIPING INSTALLATION

A. Conform to applicable provisions of Section 02400 – Water Lines, except as modified in this Section.

B. Comply with the following:

1. Bedding and Backfilling: Conform to requirements of Section 02125 – Excavation and Backfill for Utilities.

2. For pipes with coating: Do not roll or drag pipe on ground, move pipe in such a manner as not to damage pipe or coating. Carefully inspect pipe for abrasions and repair damaged coating before pipe is installed.

C. Static Electricity:

1. Properly ground steel pipeline during construction as necessary to prevent build-up of static electricity.

2. Electrically test where required after installation is complete.

D. Do not bury steel pipe, unless it is large diameter water line.

3.2 EXTERNAL COATING SYSTEM FOR STEEL PIPE INSTALLED ABOVE GROUND AND IN VAULTS (EXPOSED) AND EPOXY INTERNAL LINING SYSTEM.

A. Safety: Paints, coatings and linings specified in this Section are hazardous materials. Vapors may be toxic or explosive. Protective equipment, approved by appropriate regulatory agency, is mandatory for personnel involved in painting, coating and lining operations.

B. Workmanship:

1. Application: By qualified and experienced workers who are knowledgeable in surface preparation and application of high-performance industrial coatings.

2. Paint Application Procedures: SSPC Good Painting Practices, Volume 1.

C. Surface Preparation:

1. Prepare surfaces for painting by using abrasive blasting.

2. Schedule cleaning and painting so that detrimental amounts of dust or other contaminants do not fall on wet, newly-painted surfaces. Protect surfaces not intended to be painted from effects of cleaning and painting operations.

3. Prior to blasting, clean surfaces to be coated or lined of grease, oil and dirt by steaming or detergent cleaning in accordance with SSPC SP1.

4. Metal and Weld Preparation: Remove surface defects such as gouges, pits, welding and torch-cut slag, welding flux and spatter by grinding to one-quarter inch (1/4 In) minimum radius.

5. Abrasive Material:

   a. Blast only as much steel as can be coated same day of blasting.

   b. Use sharp, angular, properly graded abrasive capable of producing depth of profile specified herein. Transport abrasive to job site in moisture-proof bags or airtight bulk containers. Copper slag abrasives are not acceptable.

   c. After abrasive blast cleaning, verify surface profile with replica tape such as Tes-Tex Coarse or Extra Coarse Press-O-Film Tape or approved equal. Furnish tapes to the Project Manager.

   d. Do not blast if metal surface may become wet before priming commences or when metal surface is less than five degrees Fahrenheit (5° F) above dew point.

6. Evaluate degree of cleanliness for surface preparation with use of Pictorial Surface Preparation Standards for Painting Steel Surfaces, SSPC Vis1.

7. Remove dust and abrasive residue from freshly blasted surfaces by brushing or blowing with clean, dry air. Test cleanliness by placing three-quarters inch by four inch (3/4 In x 4 In) piece of clear Scotch type tape on blasted surface, then removing and placing tape on three inch by five inch (3 In x 5 In) white index card. Re-clean areas exhibiting dust or residue.

D. Coating and Lining Application:

1. Environmental Conditions: Do not apply coatings or linings when metal temperature is less than fifty (50) degrees F; when ambient temperature is less than five degrees Fahrenheit (5° F) above dew point; when expected weather conditions are such

that ambient temperature will drop below forty degrees Fahrenheit (40° F) within six hours (6 Hrs) after application; or when relative humidity is above eighty-five percent (85%). Measure relative humidity and dew point by use of sling psychrometer in conjunction with U.S. Department of Commerce Weather Bureau Psychrometric Tables. Provide dehumidifiers for field-applied coatings and linings to maintain proper humidity levels.

2. Application Procedures:

   a. Apply in accordance with manufacturer's recommendations and requirements of this Section. Provide finish free of runs, sags, curtains, pinholes, orange peel, fish eyes, excessive over spray or delaminations.

   b. Thin materials only with manufacturers recommended thinners. Thin only with an amount required to adjust viscosity for temperature variations, proper atomization and flow-out. Mix material components using mechanical mixers.

   c. Discard catalyzed materials remaining at end of day.

3. Thoroughly dry pipe before primer is applied. Apply primer immediately after cleaning surface. Apply succeeding coats before contamination of undersurface occurs.

4. Cure a minimum of twenty-four hours (24 Hrs) at seventy-seven degrees Fahrenheit (77° F) before successive coats are applied. During curing process, provide force air ventilation in volume sufficient to maintain solvent vapor levels below published threshold limit value. Apply successive coats within recoat threshold time as recommended by coating or lining manufacturer on printed technical data sheets or through written communications. Brush blast joints of pipe which have been shop primed and are to receive intermediate and finish coats in field prior to application of additional coats. After interior coatings are applied, provide forced air ventilation in sufficient volume and for sufficient length of time to ensure proper curing before filling pipe with water.

E. Testing of Coatings and Linings:

1. Inspect pipe for holidays and damage to coating:

a. If test indicates no holidays and coating is damaged, remove deficient or damaged layers of coating and repair in accordance with coating manufacturer's recommendations.

2. Perform holiday test in accordance with NACE Standard Recommended Practice, RPO 188-90, Discontinuity (Holiday) Testing of Protective Coatings.

3. Begin testing of completed coating after coating has sufficiently cured, usually one day (1 D) to five days (5 D). Consult coating manufacturer for specific curing schedule.

4. Perform adhesion test on pipe in accordance with ASTM D4541.

5. For coating thickness of twenty (20) mils or less, test with wet sponge low-voltage holiday detector. For coating thickness in excess of twenty (20) mils, test with high-voltage holiday detector. Perform electrical holiday test with sixty (60) cycle current audio detector. Select test voltage as specified in TABLE 4.5 – MINIMUM VOLTAGES FOR HIGH VOLTAGE SPARK TESTING in this Section.

3.3 JOINTS AND JOINTING

A. Welded Joints:

1. Conform to requirements of Section 02400 – Water Lines.

2. Field weld to be full penetration butt welded joints for steel pipe and encasement sleeves for entire circumference.

3. The City shall employ an independent certified testing laboratory to perform weld acceptance tests on welded joints. Testing Laboratory shall test by X-ray methods for butt welds, for 100 percent of joint welds. The Project Manager has final decision as to suitability of welds tested.

B. Flanged Joints: Conform to requirements of Section 02400 – Water Lines.

C. Joint Grouting and Testing: Conform to requirements of Section 02400 – Water Lines.

3.4 COATINGS AND LININGS INSPECTION RESPONSIBILITIES

A. Contractor is responsible for quality control of coatings and linings applications and testing and inspection stipulated in this Section. The Project Manager is responsible for quality assurance and reserves the right to inspect or acquire services of an independent third-party inspector who is fully knowledgeable and qualified to inspect surface preparation and application of high-performance coatings at all phases of coatings and linings, work, field- or shop-applied. Contractor is responsible for proper application and performance of coatings and linings whether or not the Project Manager provides such inspection.

PART IV: TABLES

4.1 MINIMUM ALLOWABLE STEEL-WALL THICKNESS

CARRIER PIPE			
Nom. Pipe Size (In.)	Min. Wall		Approx. Wt. Per L.F. Uncoated (Lb.)
	O.D. (In.)	Thick. (In.)	
4	4.50	0.250	11.35
6	6.625	0.280	18.97
8	8.625	0.322	28.55
10	10.75	0.365	40.48
12	12.75	0.375	49.56
16	16.00	0.375	62.58
20	20.00	0.375	78.60

4.2 – MINIMUM DIAMETER FOR CASING PIPE

MINIMUM DIAMETER CASING PIPE (ENCASEMENT SLEEVES)			
Corresp. Casing Pipe Size (In.)	Min. Wall		Approx. Wt. Per L.F. Uncoated (Lb.)
	O.D. (In.)	Thick. (In.)	
8	8.625	0.219	19.64
10	10.75	0.219	24.60
12	12.75	0.219	29.28
16	16.00	0.219	36.86
18	18.00	0.250	47.39
20	20.00	0.250	52.73
24	24.00	0.250	63.41

4.3 EPOXY LINING

Surface Preparation 2.0 to 3.0 mils surface profile	SSPC – 5 (64) White Blast Clean
Prime Coat 4.0 to 6.0 mils DFT	NSF Certified Epoxy – Buff or approved Equal
Intermediate Coat 4.0 to 6.0 mils DFT	NSF Certified Epoxy – Buff or approved Equal
Finish Coat 4.0 to 6.0 mils DFT	NSF Certified Epoxy – White or approved Equal

4.4 – THREE PART EPOXY/POLYURETHANE COATINGS

Surface Preparation 2.0 to 3.0 mils surface profile	SSPC SP10 Near White Blast Clean
Prime Coat 4.0 to 6.0 mils DFT	Inhibitive Epoxy Primer or approved equal
Intermediate Coat 4.0 to 6.0 mils DFT	Chemical Resistant Epoxy or approved equal
Finish Coat 1.5 to 2.5 mils DFT	Polyurethane or approved equal Barr Blue Color as approved by the Project Manager

4.5 – MINIMUM VOLTAGES FOR HIGH VOLTAGE SPARK TESTING

MINIMUM VOLTAGES FOR HIGH VOLTAGE SPARK TESTING	
Total Dry Film Thickness (mils)	Suggested Inspection (V)
20 to 40	3,000
41 to 55	4,000
56 to 80	6,000

END OF SECTION

SECTION 02255

STEEL PIPE AND FITTINGS FOR LARGE DIAMETER WATER LINES

PART I: GENERAL

1.1 GENERAL REQUIREMENTS

A. Large diameter [twenty-four inches (24 In) and greater] steel pipe and fittings for water lines and pumping facilities.

1.2 MEASUREMENT AND PAYMENT

A. Unit Prices:

1. No separate payment will be made for steel pipe and fittings under this Section. Include cost in the unit price for water lines, pumping facilities and encasement sleeves.

2. Refer to Section 01270 – Measurement and Payment for unit price procedures.

B. Stipulated Price (Lump Sum):

1. If Contract is Stipulated Price Contract, payment for work in this Section is included in Total Stipulated Price.

1.3 REFERENCES

A. AASHTO – American Association of State Highway and Transportation Officials.

1. AASHTO – Standard Specifications for Highway Bridges.

B. AREMA – American Railway Engineering and Maintenance-of-way Association.

1. AREMA – Manual for Railway Engineering, Volume II, Chapter 15.

C. ASTM – American Society for Testing and Materials.

1. ASTM A36 – Standard Specification for Structural Steel.

2. ASTM A53 – Standard Specification for Pipe, Steel, Black and

Hot-Dipped, Zinc-Coated Welded and Seamless.

3. ASTM A135 – Standard Specification for Electric-Resistance-Welded Steel Pipe.

4. ASTM A139 – Standard Specification for Electric-Fusion (ARC) – Welded Steel Pipe (NPS 4 and Over).

5. ASTM A570 – Standard Specification for Steel, Sheet and Strip, Carbon, Hot-Rolled, Structural Quality.

6. ASTM C33 – Standard Specification for Concrete Aggregates.

7. ASTM C35 – Standard Specification for Inorganic Aggregates for Use in Gypsum Plaster.

8. ASTM C150 – Standard Specification for Portland Cement.

9. ASTM C494 – Standard Specification for Chemical Admixtures for Concrete.

10. ASTM C595 – Standard Specification for Blended Hydraulic Cements.

11. ASTM C881 – Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.

12. ASTM C1107 – Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).

13. ASTM D512 – Standard Test Methods for Chloride Ion in Water.

14. ASTM D1293 – Standard Test Methods for pH of Water.

15. ASTM D3363 – Standard Test Method for Film Hardness by Pencil Test.

16. ASTM D4541 – Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Tests.

17. ASTM D4752 – Standard Test Method for Measuring MEK Resistance of Ethyl Silicate (Inorganic) Zinc-Rich Primers by Solvent Rub.

D. AWWA – American Water Works Association.

1. AWWA C200 – Steel Water Pipe 6 in. and Larger.
2. AWWA C205 – Cement-Mortar Protective Lining and Coating for Steel Water Pipe.
3. AWWA C206 – Standard for Field Welding of Steel Water Pipe.
4. AWWA C207 – Standard for Steel Pipe Flanges for Waterworks Service – Sizes 4 in. through 144 in.
5. AWWA C208 – Dimensions for Fabricated Steel Water Pipe Fittings; Addendum C 208A.
6. AWWA C209 – Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections and Fittings for Steel Water Pipelines.
7. AWWA C210 – Liquid Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines.
8. AWWA C214 – Tape Coating Systems for the Exterior of Steel Water Pipelines.
9. AWWA C602 – Cement-Mortar Lining of Water Pipelines – 4 In. (100 mm) and Larger – In Place.
10. AWWA M11 – Steel Pipe-A Guide for Design and Installation.

E. CFTS – City of Friendswood Technical Specifications.

1. Section 01270 – Measurement and Payment.
2. Section 01330 – Submittal Procedures.
3. Section 02125 – Excavation and Backfill for Utilities.
4. Section 02250 – Steel Pipe and Fittings.
5. Section 02265 – Polyurethane Coatings on Steel or Ductile Iron Pipe.
6. Section 02400 – Water Lines.

F. SSPC – Steel Structures Painting Council.

1. SSPC Good Painting Practice, Volume 1.

2. SSPC SP1 – Surface Preparation Specification No. 1 Solvent Cleaning.

3. SSPC SP5 – Joint Surface Preparation Standard White Blast Cleaning.

4. SSPC SP6 – Surface Preparation Specification No. 6 Commercial Blast Cleaning.

5. SSPC SP10 – Surface Preparation Specification No. 10 Near-White Blast Cleaning.

6. SSPC VIS1 – Visual Standard for Abrasive Blast Cleaned Steel.

1.4 SUBMITTALS

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

B. Submit shop drawings signed and sealed by a Professional Engineer licensed by the State of Texas showing following:

1. Manufacturer's pipe design calculations.

2. Provide lay schedule of pictorial nature indicating alignment and grade, laying dimensions, welding procedures, fabrication, fitting, flange and special details, with plan view of each pipe segment sketched, detailing pipe invert elevations, horizontal bends, welded joints and other critical features. Indicate station numbers for pipe and fittings corresponding to the Drawings. Do not start production of pipe and fittings prior to review and approval by the Project Manager. Provide final approved lay schedule on CD-ROM in Adobe portable document format (*.PDF).

3. Include hot tapping procedure.

4. Submit certification from manufacturer that design was performed for project in accordance with requirements of this Section. Certification to be signed and sealed by a Professional Engineer licensed by the State of Texas.

C. Submit manufacturer's certifications that pipe and fittings have been hydrostatically tested at factory in accordance with AWWA C200, Section 3.4.

D. Submit certification from NACE Certified Coatings Inspector, under supervision of inspector having Level III certification for coatings and linings, that steel pipe furnished on project was properly inspected and defective coatings detected properly repaired.

E. Submit inspection procedures to be used by manufacturer and for quality control and assurance for materials and welding. Submit at least thirty days (30 D) prior to repair work, procedures that describe in details shop and field work to be preformed. Repair defects such as substandard welds, excessive radial offsets (misalignment), pitting, gouges, cracks, etc.

F. Submit following for nonshrink grout for special applications:

1. Manufacturer's technical literature including the Technical Specifications for mixing, placing and curing grout.

2. Results of tests performed by certified independent testing laboratory showing conformance to ASTM C1107, Nonshrink Grout and requirements of this specification.

3. Certification product is suitable for use in contact with potable water.

G. Submit proof of certification for welders. Indicate certified procedures and position each welder is qualified to perform. Ensure welder and welding operator have been certified within past six months (6 Mos) in accordance with AWWA C206.

H. Within forty-five calendar days (45 cD) after manufacturing of all pipe, submit affidavit of compliance that materials and work furnished comply with applicable requirements of referenced standards and these Technical Specifications. Make available copy of physical and chemical testing reports.

I. Within forty-five days (45 D) of manufacturing of all pipe, submit manufacturer's affidavits that coatings and linings comply with applicable requirements of this Section and:

1. Polyurethane coatings were applied in accordance with manufacturer's recommendation and allowed to cure at temperature five degrees Fahrenheit (5° F) above dew point.

2. Mortar coatings and linings were applied and allowed to cure at temperature above thirty-two degrees Fahrenheit (32° F).

3. Test Results:

   a. Compressive strength [seven day (7 D) and twenty-eight day (28 D)] test results for mortar coating.

   b. Hydrostatic testing, magnetic particle and x-ray weld test reports as required.

J. Prior to start of field-applied cement mortar lining operation, submit comprehensive plan which identifies and describes as minimum:

1. Equipment used for batching, weighing, mixing transporting and placing mortar.

2. Qualifications and specific experience of machine operators.

3. Source and type of cement, pozzolan, sand and admixtures used and certifications from suppliers that materials meet the Technical Specifications.

4. Mix proportions to be used and slump limits (max. and min.).

5. A quality control plan which identifies quality control material tests and documented inspections necessary to ensure compliance with specified requirements.

K. Submit certification showing calibration within last twelve months (12 Mos) for equipment such as scales, measuring devices and calibration tools used in manufacture of pipe. Each device used in manufacture of pipe is required to have tag recording date of last calibration. Devices are subject to inspection by the Project Manager.

1.5 QUALITY CONTROL

A. Manufacturer to provide permanent quality control department and laboratory facility capable of performing inspections and testing as required by the Technical Specifications. Material testing, inspection procedures and manufacturing process are subject to inspection by the Project Manager. Perform manufacturer's tests and inspections required by referenced standards and these Technical Specifications, including the following. Correct nonconforming conditions.

1. Steel Plate and Coils: Review mill certifications for conformance to requirements of the Technical Specifications; perform physical and chemical testing of each heat of steel for conformance to applicable ASTM standards.

2. Pipe:

   a. Inspect thickness, circumference, roundness, strength and size of seam welds (spiral or longitudinal) and squareness of pipe ends to verify compliance with AWWA C200.

   b. Inspect physical dimensions and overall conditions of all joints for compliance with AWWA C200, approved submittals and Technical Specifications.

   c. Hydrostatically test finished pipe section to seventy-five percent (75%) of specified minimum yield strength of steel being used with zero (0) leakage.

   d. For wall thickness greater than one-half inch (1/2 In) perform Charpy V-Notch (CVN) Test in accordance with AWWA C200.

3. Linings:

   a. Inspect unlined pipe for overall condition of inside barrel. Maintain inside barrel free of corrosive products, oil, grease, dirt, chemical and deleterious material.

   b. Inspect lined pipe for physical dimensions and overall condition of lining, visible surface defects, thickness of lining and adhesion to steel surface.

   c. Review certifications by manufacturers of lining components for conformance to AWWA standards and these Technical Specifications.

4. Coatings: Measure temperature and dew point of ambient air before applying coatings. Inspect physical dimensions and overall condition of coatings. Inspect for visible surface defects, thickness and adhesion of coating to surface and between layers.

5. Final Inspection:

   a. Before shipment, inspect finished pipe, fittings, specials and accessories for markings, metal, coating thickness, lining thickness (if shop applied), joint dimensions and roundness.

   b. Inspect for coating placement and defects. Test exterior coating for holidays.

   c. Inspect linings for thickness, pitting, scarring and adhesion.

B. Shop-applied coatings and linings; provide services of independent coating and lining inspection service or testing laboratory with qualified coating inspectors. Perform inspection by National Association of Corrosion Engineers (NACE) trained inspectors under supervision of NACE Level III Certified Coatings Inspector.

C. Ensure workmen engaged in manufacturing are qualified and experienced in performance of their specific duties.

D. Cast four (4) standard test cylinders each day for each fifty cubic yards (50 Cy) of mortar coating or portion thereof for each coating and lining placed in a day. Perform compressive strength test at twenty-eight days (28 D). No cylinder test result shall be less than eighty percent (80%) of specified strength.

E. Dented steel cylinders shall result in rejection of pipe.

F. Make available copy of physical and chemical testing reports for steel cylinders and provide reports at request of the Project Manager.

G. Check physical dimensions of pipe and fittings. Physical dimensions to include at least pipe lengths, pipe I.D., pipe O.D. and bend angles.

1.6 INSPECTION

A. The Project Manager may witness manufacture and fabrication of pipe and appurtenances. Independent testing laboratory under contract to the Project Manager may perform tests at direction of the Project Manager to verify compliance with these Technical Specifications. Provide assistance to accomplish such testing, including equipment and personnel, at no additional cost to the City.

PART II: PRODUCTS

2.1 STEEL PIPE

A. Furnish pipe by same manufacturer.

B. Furnish pipe smaller than twenty-four inch (24 In) in accordance with Section 02250 – Steel Pipe and Fittings.

C. Fabricate and supply miscellaneous steel pipe and fittings with nominal diameter of twenty-four inches (24 In) and larger in accordance with AWWA C200, C207, C208 and AWWA M11 except as modified herein. Steel to be a minimum of ASTM A36, ASTM A570 Grade 36, ASTM A53 Grade B, ASTM A135 Grade B or ASTM A139 Grade B.

D. Provide pipe sections in lengths no greater than forty feet (40 Ft) and no less than ten feet (10 Ft) except as required for special fittings or closure sections.

E. Provide shop-coated and shop-lined steel pipe with minimum of one (1) coat of shop-applied primer approved for use in potable water transmission on all exposed steel surfaces. Primer for tape-coated steel pipe to be used for field-applied coatings shall have no less than five percent (5%) solids. Provide primer compatible with coating system and in accordance with coating manufacturer's recommendations.

F. Provide closure sections and short sections of steel pipe not less than four feet (4 Ft) in length unless indicated on the Drawings or specifically permitted by the Project Manager.

G. Square flanges with pipe with bolt holes straddling both horizontal and vertical axis. Provide one-half inch (1/2 In) gap between pipe ends to be coupled with sleeve coupling unless otherwise indicated on the Drawings.

1. Provide standard ring or hub type flanges, conforming to AWWA C207, Class D.

2. Apply Densco petroleum-based tape or approved equal to exposed portions of nuts and bolts.

H. Pipe Design Conditions:

1. Design: Design pipe and fittings to withstand most critical simultaneous application of external loads and internal

pressures. Base design on minimum of AASHTO HS-20 loading, AREMA E-80 loads and depths of bury as indicated on the Drawings. Design pipes with Marston's earth loads for transition width trench for all heights of cover.

2. Groundwater Level: Design for most critical ground water level condition.

3. Working pressure = One hundred pounds per square inch (100 psi).

4. Hydrostatic field test pressure = One hundred fifty pounds per square inch (150 psi).

5. Maximum pressure due to surge = One hundred fifty pounds per square inch (150 psi).

6. Minimum pressure due to surge = Minus five pounds per square inch (-5 psi).

7. Modulus of elasticity (E) = Thirty million pounds per square inch (30000000 psi).

8. Maximum deflection from specified diameter: Two percent (2%) for mortar coating; three percent (3%) for flexible coatings and three percent (3%) for mortar lining.

9. Design stress due to working pressure to be no greater than fifty percent (50%) of minimum yield and stress not to exceed sixteen thousand five hundred pounds per square inch (16500 psi) for mortar coated pipe.

10. Design stress due to maximum hydraulic surge pressure to be no greater than seventy-five percent (75%) of minimum yield and stress not to exceed twenty-four thousand seven hundred fifty pounds per square inch (24750 psi) for mortar coated pipe.

11. Modulus of soil reaction (EN) < one thousand five hundred pounds per square inch (1500 psi). If EN > one thousand pounds per square inch (1000 psi), do not use silty sand (SM) for embedment.

12. Unit weight of fill (w) > One hundred twenty pounds per cubic foot (120 pcf).

13. Deflection lag factor (D1) = One and two tenths (1.2).

14. Bedding constant (K) = One tenth (0.1).

15. Fully saturated soil conditions: hw = h = depth of cover above top of pipe.

16. Do not allow diameter (D) over thickness (t) ratio to be greater than two hundred thirty (230).

17. Nominal Allowable Steel-wall Thickness for Water Lines: Provide in accordance with following table for HS-20 live loads and depths of cover of up to sixteen feet (16 Ft). Net internal diameter (including inside linings) to be no less than net inside diameter listed. The Contractor to review design for conditions more extreme than those indicated by this specification and design accordingly. If, in opinion of the Project Manager, proposed pipe wall thicknesses appear inadequate for indicated loading conditions, submittal of design calculations shall be required for review. Pipe wall to be not less than that specified in TABLE 4.1 PIPE WALL THICKNESSES in this Section.

I. Fittings for Water Lines: Fabricate in accordance with AWWA M11, Section 13.3-13.7 and AWWA C208.

1. Wall Thickness: Equal to or greater than pipe to which fitting is to be welded.

2. Elbows: two (2) pieces for zero degrees (0°) to twenty-two and one-half degrees (22-1/2°); three (3) pieces for twenty-three degrees (23°) to forty-five degrees (45°); four (4) pieces for forty-six degrees (46°) to sixty seven and one-half degrees (67-1/2°); and five (5) pieces for sixty-eight degrees (68°) to ninety degrees (90°), unless otherwise shown on the Drawings.

3. Outlets: Reinforced in accordance with AWWA M11, Sections 13.3-13.7, AWWA C200 and AWWA C208. Provide interior lining and exterior coating in accordance with paragraphs on coating and lining and matching pipe to access inlets, service outlets, test inlets and air-vacuum valve and other outlets, including riser pipes.

4. Radius: Minimum radius of two and one-half (2-1/2) times pipe diameter.

5. Butt Straps for Closure Piece: Minimum twelve inch (12 In) wide split butt strap; minimum plate thickness equal to thinnest

member being joined; fabricated from material equal in chemical and physical properties to thinnest member being joined. Provide minimum lap of four inches (4 In) between member being joined and edge of butt strap, welded on both inside and outside, unless otherwise approved by the Project Manager. Provide minimum six inch (6 In) welded outlet for inspecting each closure section, unless access manway is within forty feet (40 Ft) of closure section.

6. Joints are to be double-welded and butt or lap joints as shown on the Drawings. Use flanged joints at valves.

7. Provide double-welded lap field joints or full penetration butt-welded joints for tee fitting supported on pier foundation, aboveground piping and field welds for risers including vertical portion of crossover piping.

J. Joints:

1. Standard field joint for steel pipe: AWWA C206. Rubber gasket Carnegie shape joint or rolled-groove rubber gasket and O-ring joint, sixty-six inch (66 In) maximum diameter. Joints may be lap-welded slip type in accordance with AWWA C206, except where flanged joints or butt strap joints are required.

2. Provide double-welded butt joints at aerial crossings and where noted on the Drawings.

3. Pipe Manufacturer: Minimum of five years (5 Yrs) of successful service with proposed field joint or submit results from joint tests determined by the Project Manager. Tests which may be required include tensile strength or yield tests of base material and spiral welded sections (API 5L), flattening tests, chemical analysis, impact and hardness tests. The Project Manager's decision as to acceptability of joint is final.

4. Capable of withstanding jacking forces.

5. Design restrained joints for test pressure or maximum surge pressure as specified, whichever is greater. Only minimum restrained joint lengths for prestressed concrete cylinder pipe are shown on the Drawings.

6. Provide full circumferential welds at joints required to be welded.

7. Use wire and flux from same manufacturer throughout entire project.

8. Rubber Gasketed Bell-and-Spigot Joints.

   a. Bells: Formed by either expansion of pipe end or by segmental expander which stretches steel past its elastic limit or by attaching sized weld-on bell rings. Spigot ends: Sized prior to rolling gasket groove. Joints: Interchangeable and match up during installation, even if used out of sequence. Weld-on bell rings: AWWA M11; AWWA C200; attached with single or double, full thickness fillet welds (double weld in areas of thrust restraint).

   b. Provide bells and spigots with dimensions and tolerances in accordance with AWWA C200, as modified herein. Difference in diameter between I.D. of bell and O.D. of spigot shoulder at point of full engagement with allowable deflection range of zero inch (0.00 In) to four hundredths inch (0.04 In) as measured on circumference with diameter tape. Minimum thickness of completed bell ring is equal to thickness of pipe wall in barrel of pipe between joint ends.

   c. Furnish joint suitable for safe working pressure equal to class of pipe and shall operate satisfactorily with deflection, tangent of which is not to exceed seventy-five hundredths inch per inch diameter (0.75 In/D) where D is outside diameter of pipe in inches or with pull-out of three-quarters inch (3/4 In).

   d. Design clearance between bells and gasketed spigots so, when joint is assembled, it shall be self-centered and gasket shall be restrained or confined to annular space in such manner that movement of pipe or hydrostatic pressure cannot displace it. Compression of gasket when joint is completed shall not be dependent upon water pressure in pipe and shall provide watertight joints under operating conditions when properly installed.

K. Manufacturer must maintain on site or in plant enough fittings as specified in TABLE 4.2 – REQUIRED BENDS STOCK in this Section.

L. Manufacturer must be capable of delivering bends to job site within twelve hours (12 Hrs) of notification. Use fittings at direction of the Project Manager where unforeseen obstacles are encountered during construction. These fittings are in addition to fittings called out on the Drawings and must be available at all times. Use same product throughout entire project.

M. Perform x-ray or ultrasonic testing of manual welds on special pipe and fittings.

N. Hydrostatic Test of Pipe:

1. AWWA C200, Section 3.5.3, at point of manufacture. Hold test for minimum two minutes (2 Min) and conduct thorough inspection of pipe. Repair or reject pipe revealing leaks or cracks.

2. Calibrate pressure gauges within one year (1 Yr) prior to testing as specified in Section 1.4.L.

O. Provide forged steel threaded outlets of approved design where required for use in passing hose or lead wires into pipe. Tap plugs with standard pipe threads and weld to pipe in approved manner and use solid forged steel plugs for closure.

P. Flanges:

1. Fabricate flanges with oversize bolt holes, with flanges drilled in pairs, to accommodate insulating sleeves.

2. Test, coat, line and ship each shop-assembled insulated flange assembly to field as fitting. Use no less than two (2) snug-fitting alignment pins to assist in aligning flanges during assembly. Do not remove pins until bolts have been installed in all remaining holes and have been drawn up tight. After insulating joints have been assembled, subject each assembly (fitting) to shop hydrostatic test pressure of one hundred fifty pounds per square inch (150 psi) and electrically test to ensure that insulated sections are effective. After assembly has been tested, coat insulating joint and adjacent steel pipe as specified for below-ground installation. Line assembly as specified for interior surfaces and in accordance with details shown on the Drawings.

Q. Dished Head Plugs: Design dished head plugs (test plugs) to withstand field hydrostatic test pressure from either side of plug. Design stress

due to hydrostatic pressure to be no greater than fifty percent (50%) of minimum yield. Pipe on opposite side of hydrostatic test may or may not contain water. Manufacturer of the steel pipe to hydrostatically test plug at factory.

R. Make curves and bends by deflecting joints or by using beveled joints or by combination of two (2) methods, unless otherwise indicated on the Drawings or permitted by the Project Manager. Do not exceed deflection angle at joint as recommended by pipe manufacturer. Make penetration of spigot into bell at all points of circumference at least equal to minimum required penetration shown on the Drawings. Beveled pipe sections used in curved alignment to be of standard length except when shorter sections are required to limit radius of curvature, in which case all sections throughout curve are to be of equal length. Do not allow bevel to exceed five degrees (5°).

2.2 INTERNAL LINING SYSTEMS FOR STEEL PIPE, ALL INSTALLATIONS

A. Supply steel pipe with either epoxy lining or cement-mortar lining, capable of conveying water at temperatures not greater than one hundred forty degrees Fahrenheit (140° F). Provide linings conforming to American National Standards Institute/National Sanitation Foundation (ANSI/NFS) Standard 61 and certification to be from organization accredited by ANSI. Unless otherwise noted, coat all exposed (wetted) steel parts of flanges, blind flanges, bolts, access manhole covers, with epoxy lining, as specified.

B. Epoxy Lining:

1. AWWA C210, color White or approved equal for shop and field joint applied, except as modified in this Section. Provide materials from same manufacturer. Protect interior surface with approved liquid two (2) part chemically cured epoxy primer for interior surfaces as specified in TABLE 4.3 – EPOXY PRIMER FOR INTERIOR SURFACES in this Section.

2. Total allowable dry film thickness for system:

   a. Minimum: Twelve (12) mils.

   b. Maximum: Eighteen (18) mils.

3. Provide dry film thicknesses for approved alternate products in accordance with product's manufacturer recommendations.

4. Lining system may consist of three (3) or more coats of same

approved alternate epoxy lining without use of separate primer.

5. Perform adhesion test on pipe forty-eight inches (48 In) in diameter and larger in accordance with ASTM D4541. Minimum field adhesion: seven hundred pounds per square inch (700 psi). Perform test on pipe for project at frequency of one (1) for every one thousand square feet (1000 Sf) of epoxy lining. Perform cure test in accordance with ASTM D4752 (solvent rub test) and ASTM D3363 (pencil hardness) for each section of pipe. Repair tested areas with approved procedures.

C. Shop-applied Cement-mortar Lining:

1. AWWA C205; except as specified herein: one-half inch (1/2 In) minimum thickness for pipe diameters forty-two inches (42 In) and larger; three-eighths (3/8) inch minimum thickness for pipe diameters thirty-six inches (36 In) and smaller. Cut back lining from joint ends no more than two inches (2 In) to facilitate joining and welding of pipe.

2. Apply cement-mortar lining to inside of pipe by centrifugally spinning. For special sections (shape of which precludes application by spinning method) accomplish by mechanical placement or pneumatic placement and finish to produce smooth, dense surface comparable to centrifugally spinning.

3. Use galvanized wire mesh when shop-applied mortar is not applied by machine. Do not extend wire mesh across welded portion of mitered fittings. Crimp mesh to provide integral "chair" so wire does not fully rest against steel cylinder.

4. Make repairs of cement-mortar lining for widths exceeding six inches (6 In) by bonding to steel and adjacent faces of lining with bonding agent conforming to ASTM C881, Type II.

5. Restrict usage of sprinkler heads during moist curing to prevent over spraying onto lining. No alternative curing methods are allowed as described in Section 4.4.7.4 of AWWA C205.

6. Satisfy the Project Manager that above requirements can be accomplished by manufacturer prior to shipment of pipe.

D. Field-applied Cement-mortar Lining (for pipe > forty-eight inches (48 In) in diameter): Provide field-applied internal cement-mortar linings in accordance with AWWA C602, latest edition, except as modified in this Section.

1. Lining: Applied in one (1) course application of cement-mortar by machine that centrifugally places mortar against wall of pipe and mechanically trowel lining to smooth finish.

2. Steel pipe, fittings, receives cement-mortar lining.

3. Cement-mortar for lining.

   a. Cement-mortar: Dense, smooth and of uniform quality and consistency to assure efficient machine operation and uniform cement-mortar lining on pipe wall.

   b. Water-cement ratio: Kept as low as possible; consistent with proper plasticity for application, allowing slight variations dependent upon temperature, length of haul for mortar and moisture condition in pipe.

   c. Mortar: Mixture of one (1) part cement with not less than one (1) or more than one and one-half (1-1/2) parts of dry screened sand, by volume. After determining mixture, control materials to within plus or minus two and one-half percent (2-1/2%) by weight throughout entire work.

   d. Comply with following materials for cement-mortar:

      1) Provide Type II low-alkali Portland cement conforming to ASTM C150 or Type IP (MS) Portland-Pozzolan cement conforming to ASTM C595, unless otherwise specified. Conform to low alkali requirements of Table IA of ASTM C150. Type IP (MS) cement to contain no more than percent (20%) Pozzolan, to be inter-ground with clinker.

      2) Use suitable facilities approved by the Project Manager when available for handling and weighing bulk cement. Otherwise, deliver cement in original unopened sacks that have been filled by manufacturer. Plainly mark sacks with manufacturer's name or brand, cement type lot number and weight. Discard unused cement. Use unopened bags of cement for each new batch.

3) Material storage: Store cement to permit ready access for inspection and sampling. Protect cement and sand against contamination or moisture. Do not use and remove from site cement delivered with evidence of contamination or otherwise unsuitable. Store admixtures in accordance with manufacturer's directions.

4) Use Portland cement of same brand and type unless otherwise approved by the Project Manager.

5) Pozzolanic material: AWWA C602, Paragraph 2.2.

6) Sand: AWWA C205, Section 2.3, except gradation of sand to yield fineness modulus of approximately 1.7; having no material coarser than that passing No. 16 sieve. Submit certification for compliance of sand with these Technical Specifications at least ten calendar days (10 cD) before start of lining placement.

7) Water: Clean; free of deleterious amounts of acids, alkalis or organic materials; total dissolved solids less than one thousand milligrams per liter (1000 mg/l); ASTM D512 chloride ions less than one hundred milligrams per liter (100 mg/l) for slurry and mortar cure; ASTM D1293 pH greater than 6.5.

2.3 EXTERNAL COATING SYSTEM FOR STEEL PIPE INSTALLED ABOVEGROUND AND IN VAULTS (EXPOSED)

A. Provide approved three (3) coat epoxy/polyurethane coating system as specified in TABLE 4.4 – THREE COAT EPOXY/POLYURETHANE COATINGS in this Section. Provide materials from same manufacturer.

B. Total Allowable Dry Film Thickness for System:

1. Minimum: Nine and one-half (9.5) mils.

2. Maximum: Twelve and one-half (12.5) mils.

C. Perform adhesion test on pipe forty-eight inches (48 In) in diameter and larger in accordance with ASTM D4541. Minimum field adhesion:

seven hundred pounds per square inch (700 psi). Perform test on pipe for project at frequency of one (1) for every 1000 square feet of epoxy lining. Perform cure test in accordance with ASTM D4752 (solvent rub test) and ASTM D3363 (pencil hardness) for each section of pipe. Repair tested areas with approved procedures.

2.4 EXTERNAL COATING SYSTEMS FOR BURIED STEEL PIPE

A. Supply pipe with one (1) of the following coatings specified.

1. Tape Coating: Provide approved tape for external tape coating. Apply in accordance with AWWA C214 and requirements of this section; eighty (80) mil.

a. Components: Primer, one (1) twenty (20) mil layer of inner-layer tape for corrosion protection and two (2) thirty (30) mil layers of outer-layer tape for mechanical protection.

b. Where sleeve type or victaulic couplings are required, bond coupling to adjacent pipes with bonding cables as shown on the Drawings.

c. Use approved filler putty type insulating putty to fill in gap and create smooth sloped transition between top of reinforcing plate and pipe, before tape coating is applied.

d. Primer: Compatible with tape coating, supplied by coating-system manufacturer.

e. Provide pipe with shop coatings cut back approximately four inches (4 In) to four and one-half inches (4-1/2%) from joint ends to facilitate joining and welding of pipe. Taper successive tape layers by one inch (1 In) staggers to facilitate field wrapping and welding of joints.

f. Inner and outer tape width: Twelve inches (12 In) or eighteen inches (18 In).

g. Do not expose tape coating to direct sunlight for more than sixty days (60 D).

2. Cement-mortar Coating: AWWA C205; shop-applied, cement-mortar coating except as modified in this Section; one inch (1

In) minimum thickness; cut back coating from joint ends no more than two inches (2 In) to facilitate joining and welding of pipe.

3. Polyurethane Coating: See Section 02265 – Polyurethane Coatings on Steel or Ductile Iron Pipe for requirements for use of polyurethane coating system.

B. Heat Shrink Joint Sleeves for Tape and Polyethane Coating: Aqua-shield or approved equal. For repairs to heat shrink joint sleeves, use Aqua-shield Repair Patch Kit or approved equal.

2.5 GROUT FOR JOINTS AND SPECIAL APPLICATIONS

A. Cement Grout Mixture: One (1) part cement to two (2) parts of fine, sharp clean sand. Mix interior joint mortar with as little water as possible until very stiff but workable. Mix exterior joint mortar with water until it has consistency of thick cream. Mix cement grout to specific gravity of nineteen pounds per gallon (19 Lb/Gal) or greater as measured by grout/slurry balance. Use balance manufactured grout/slurry by Baroid or approved equal. Perform test in presence of and at request of the Project Manager. Add additional cement grout or water to mixed cement grout to bring mix to proper moisture content or specific gravity. Discard cement grout that has been mixed more than twenty minutes (20 Min) and is not at proper specific gravity or moisture content.

1. Portland Cement: ASTM C150, Type II. Provide one (1) type of cement for entire project.

2. Sand:

a. Interior joints: ASTM C35 fine graded plaster sand.

b. Exterior joints: ASTM C33; natural sand with one hundred percent (100%) passing No. 16 sieve.

3. Water: Potable water with total dissolved solids less than one thousand milligrams per liter (1000 mg/l); ASTM D512 chloride ions less than one hundred milligrams per liter (100 mg/l) for slurry and mortar cure; ASTM D1293 pH greater than 6.5. Use potable water with two hundred fifty parts per million (250 ppm) limit on chlorides and sulfates.

B. Provide approved Nonshrink Grout for Special Applications, Patches and Repairs.

1. Conform to requirements of ASTM C1107, Nonshrink Grout.

2. Pre-blended factory-packaged material manufactured under rigid quality control, suitable for use in joints of prestressed concrete cylinder pipe.

3. Contain non-metallic natural aggregate and be nonstaining and noncorrosive.

4. Meeting NSF 61 Standard suitable for use in contact with potable water supply.

5. Exterior: Highly flowable to fill joint wrapper without leaving voids or trapped air. Interior capable of being placed with plastic consistency.

6. Compressive strength: ASTM C1107 two thousand five hundred pounds per square inch (2500 psi) minimum seven day (7 D) unconfined; five thousand pounds per square inch (5000 psi) minimum twenty-eight day (28 D) unconfined.

7. Non-bleeding and non-segregating at fluid consistency.

8. Contain no chlorides or additives which may contribute to corrosion of steel pipe.

9. Free of gas-producing, gas-releasing agents.

10. Resist attack by oil or water.

11. Mix, place and cure in accordance with manufacturer's instructions and recommendations. Upon seventy-two hours (72 Hrs) notice, provide services of qualified representative of nonshrink grout manufacturer to aid in assuring proper use of product under job conditions. Representative to be on site when product is first (1st) used.

12. Mix cement grout to specific gravity of seventeen and seven-tenths pounds per gallon (17.7 Lb/Gal) or greater as measured by grout/slurry balance. Use balance manufactured grout/slurry by Baroid or approved equal. Perform test in presence of and at request of the Project Manager. Add additional cement grout to mixed cement grout or water to bring mix to proper moisture content or specific gravity. Discard cement grout that has been mixed more than twenty minutes (20 Min) and is not at proper

specific gravity or moisture content.

13. Compressive strength: ASTM C1107 two thousand five hundred pounds per square inch (2500 psi) minimum seven day (7 D) unconfined; five thousand pound per square inch (5000 psi) minimum twenty-eight day (28 D) unconfined.

C. Finished surface of lining and interior joint to be comparable to surface rubbed with No. 16 Carborundum stone. Rub joint mortar sufficiently to bring paste to surface, to remove depressions and projections and to produce smooth, dense surface. Add cement to form surface paste as necessary. Leave interior with clean, neat and uniform-appearing finish.

D. Joint Wrapper: Minimum width of nine inches (9 In) for thirty-three inch (33 In) diameter and smaller; minimum width of twelve inches (12 In) for diameters greater than thirty-three inch (33 In) hemmed at edge to allow threading with minimum five-eighths inch (5/8 In) wide steel strap. Provide minimum six inch (6 In) wide Ethafoam strip sized, positioned and sewn such that two (2) circumferential edges of Ethafoam are one and one-half inches (1-1/2 In) from outer edge of wrapper.

2.6 COLD-APPLIED TAPE COATING

A. Shop-applied Tape Wrap Coating

1. Use primer furnished by tape manufacturer.

2. Wrap, specials and fittings that cannot be machine wrapped due to configuration with primer layer and two (2) layers of prefabricated tape each thirty-five (35) mils thick.

3. Overlap machine applied tape with hand applied tape by minimum of two inches (2 In) and bind to it.

4. Apply approved thirty (30) mil filler tape parallel to spiral weld seams if weld height measures greater than or equal to one-eighth inch (1/8 In).

B. Surface Preparation

1. Clean bare pipe from mud, mill lacquer, oil, grease or other contaminants. Inspect and clean surfaces according to SSPC SP1 to remove oil, grease and loosely adhering deposits prior to blast cleaning. Remove visible oil and grease spots by solvent wiping. Use approved safety solvents which do not

leave residue. Preheating to remove oil, grease, mill scale, water and ice may be used provided pipe is preheated in uniform manner to avoid distortion.

2. Remove surface imperfections such as slivers, scabs, burrs, weld spatter and gouges by hand filling or grinding to prevent excessive number of holidays. Presence of metallic defects may be cause for rejection of pipe.

2.7 EXTERNAL TAPE COATING SHOP APPLICATION

A. Separate tape dispensing equipment far enough apart to visually inspect continuous steps.

B. Make cutbacks straight and for total thickness of coating.

C. State of dryness of primer prior to application of weld filler and inner layer of tape to be in accordance with written recommendation of manufacturer.

D. Apply weld filler tape over primer and extend minimum of one inch (1 In) on each side of weld seam. Filler tape may contact rollers as long as release liner is in place and adhesion requirements are met. Remove release liner before applying inner layer tape.

E. Spirally apply inner layer of tape in direction of helix weld. Overlap each spiral of tape one inch (1 In) or greater with next successive spiral of tape applied.

F. Overlap end of new roll on top of previous roll minimum of six inches (6 In).

G. Tape-roll body temperature to be greater than seventy degrees Fahrenheit (70° F); pipe surface temperature to be greater than sixty degrees Fahrenheit (60° F).

H. Spirally apply outer layer tapes in direction of helix weld and use overlap width and application tensions as recommended by manufacturer.

2.8 INSPECTION AND TESTING OF COATINGS

A. Perform electrical inspection on inner layer of tape before intermediate layer of tape is applied.

B. If holidays are detected, repair holidays immediately before applying

outer layer of tape. Clear holiday area of material and reprime if necessary. Recoat area with inner wrap tape. Overlap inner wrap tape onto surrounding inner wrap coating by at least two inches (2 In). Perform electrical retest at repaired area after repairing holiday and before outer wrap is continued.

C. Shrink Wrap: Perform electrical inspection on shrink wrap to check for holidays. Perform peel tests over heat affected zone. Minimum acceptable result: fifteen foot-pounds per inch (15 Ft-Lbs/In).

PART III: EXECUTION

3.1 PIPING INSTALLATION

A. Conform to applicable provisions of Section 02400 – Water Lines, except as modified in this Section.

B. Comply with following:

1. Make available services of manufacturer's representative when deemed necessary by the Project Manager. Representative to advise in aspects of installation, including but not limited to handling and storing, cleaning and inspecting, coating and lining repair and general construction methods as applicable to pipe.

2. Install stulls prior to placement of pipe, bends and fittings to prevent deflection during installation. Provide stulls consisting of timber struts with end blocks shaped to fit curvature of interior surface of pipe or other appropriate configuration and material. Firmly edge and secure stulls to blocks so that they shall remain intact position during handling and installation. Provide stulls adequate to resist loads encountered without structural failure to stull members or damage to pipe. Where applicable, place stulls at such lengths so as to elongate vertical diameter of pipe as required to suit trench conditions encountered.

3. Handling and Storage: Install padded struts or stulls prior to shipping, horizontally and vertically at ten foot (10 Ft) intervals or as proposed by manufacturer and approved by the Project Manager. Spiders: Installed in joint ends of fittings. Stulls to remain in place, horizontally and vertically positioned under following conditions:

a. During storage and shipping.

b. Until welding is complete.

4. Reject and remove immediately from site pipe that arrives at site with defects in lining, including sand pockets, voids and oversanded areas.

5. Store pipe at job site with securely fastened plastic endcaps to maintain moist pipe interior. Promptly replace damaged endcaps to avoid shrinkage or cracking of cement-mortar lining.

6. Immediately replace damaged plastic end caps. Do not leave uncapped for more than four hours (4 Hrs).

7. Bedding and Backfilling:

   a. Conform to requirements of Section 02125 – Excavation and Backfill for Utilities.

   b. Align pipe at proper grade prior to joint connection and do not shift after jointing operation has been completed.

   c. Take necessary precautions during bedding and backfilling operations to prevent deformation or deflection of cylindrical shape of pipe by more than allowable pipe deflection. Do not move trench support system (trench safety system) once bedding material is compacted.

   d. Excavate outside specified trench section for bell holes and for spaces sufficient to permit removal of slings. Provide bell holes at proper locations for unrestricted access to joint. Form bell holes large enough to facilitate joint wrapping and to permit visual examination of process. Enlargement of bell holes as required or directed by the Project Manager. Subsequent backfilling thereof shall not be considered as authorized additional excavation and backfill. Backfill bell holes and spaces to satisfaction of the Project Manager.

   e. Blocking may be removed twenty-four hours (24 Hrs) after placing backfill to top of pavement or natural ground level.

8. Pipe Deflection: After backfill is complete, test pipe for excessive deflection by measuring actual inside vertical diameter. For maximum deflection allowable, see Section 2.1.H.8.

   a. Deflection may be measured by the Project Manager at location along pipe. Arithmetical averages of deflection are not acceptable.

   b. If deflection exceeds that specified, do one (1) of the following:

      1) Remove backfill and side support. Re-round the pipe and properly replace compacted backfill and side support. Review cement mortar lining to assure that no harmful damage has occurred.

      2) Remove entire portion of deflected pipe section and install new pipe as directed by the Project Manager at no additional cost to the City.

9. Move pipe in such manner not to damage pipe or coating. Do not roll pipe nor drag on ground. Inspect and repair coating abrasions before pipe is lowered into trench.

10. Use of dogs, clips, lugs or equivalent devices welded to steel pipe for purpose of forcing it into position shall not be permitted unless approved by the Project Manager. Remove foreign matter and protective material from surfaces that are to be in contact at joints. Leave surfaces of joint areas thoroughly clean for metal-to-metal contact of field joints.

C. Static Electricity:

1. Properly ground steel pipeline during construction as necessary to prevent build-up of static electricity.

2. Electrically test where required after installation of pipeline is complete.

D. Deviation of installed pipe in one pipe section from line and grade shown on approved shop drawing layout shall not exceed two inches (2 In) from grade and three inches (3 In) from line. No deviation from line and grade at contact interfaces are allowed.

E. Use adequate surveying methods, procedures and employ competent

surveying personnel to ensure pipe sections are laid to line and grade and within stipulated tolerances. Measure and record, in form approved by the Project Manager and submit copy of data to the Project Manager at end of that day. Survey data to include unique pipe number, deflection angle at pipe joint and whether beveled ends were used, invert elevation at pipe joint, deviation of joint from project line, deviation of joint from project grade, inside pipe joint lap measured at top, bottom and at springline (each side).

F. Any time that laying of additional pipe is stopped for more than eight hours (8 Hrs); plug ends of installed pipe and take proper precautions against flotation of pipe segments.

3.2 EXTERNAL COATING SYSTEM FOR STEEL PIPE INSTALLED ABOVE GROUND AND IN VAULTS (EXPOSED) AND EPOXY INTERNAL LINING SYSTEM

A. Safety: Paints, coatings and linings specified in this Section are hazardous materials. Vapors may be toxic or explosive. Protective equipment, approved by appropriate regulatory agency, is mandatory for personnel involved in painting, coating and lining operations.

B. Workmanship:

1. Application: By qualified and experienced workers who are knowledgeable in surface preparation and application of high-performance industrial coatings.

2. Paint Application Procedures: SSPC Good Painting Practices, Volume 1.

C. Surface Preparation:

1. Use abrasive blasting to prepare surfaces.

2. Schedule cleaning and painting so that detrimental amounts of dust or other contaminants do not fall on wet, newly-painted surfaces. Protect surfaces not intended to be painted from effects of cleaning and painting operations.

3. Prior to blasting, clean surfaces to be coated or lined of grease, oil and dirt by steaming or detergent cleaning in accordance with SSPC SP1.

4. Metal and Weld Preparation: Remove surface defects such as gouges, pits, welding and torch-cut slag, welding flux and

spatter by grinding to one-quarter inch (1/4 In) minimum radius.

5. Abrasive Material:

   a. Blast only as much steel as can be coated within same day of blasting.

   b. Use sharp, angular, properly graded abrasive capable of producing depth of profile specified herein. Transport abrasive to jobsite in moisture-proof bags or airtight bulk containers. Copper slag abrasives are not acceptable.

   c. After abrasive blast cleaning, verify surface profile with replica tape such as Tes-Tex Coarse or Extra Coarse Press-O-Film Tape or approved equal. Furnish tapes to the Project Manager.

   d. Do not blast if metal surface may become wet before priming commences or when metal surface is less than five degrees Fahrenheit (5° F) above dew point.

6. Evaluate degree of cleanliness for surface preparation with use of SSPC Pictorial Surface Preparation Standards for Painting Steel Surfaces, SSPC Vis1.

7. Remove dust and abrasive residue from freshly blasted surfaces by brushing or blowing with clean, dry air. Test cleanliness by placing three-quarters inch by four inch (3/4 In x 4 In) piece of clear Scotch-type tape on blasted surface, then removing and placing tape on three inch by five inch (3 In x 5In) white index card. Re-clean areas exhibiting dust or residue.

D. Coating and Lining Application:

1. Environmental Conditions: Do not apply when metal temperature is less than fifty degrees Fahrenheit (50° F); when ambient temperature is less than five degrees Fahrenheit (5° F) above dew point; when expected weather conditions are such that ambient temperature shall drop below forty degrees Fahrenheit (40° F) within six hours (6 Hrs) after application; or when relative humidity is above eighty-five percent (85%). Measure relative humidity and dew point by use of sling psychrometer in conjunction with U.S. Department of Commerce Weather Bureau Psychometric Tables. Provide dehumidifiers for field-applied coatings and linings to maintain

proper humidity levels.

2. Application Procedures:

   a. Apply in accordance with manufacturer's recommendations and requirements of this Section. Provide finish free of runs, sags, curtains, pinholes, orange peel, fish eyes, excessive over spray or delaminations.

   b. Thin materials only with manufacturers recommended thinners. Thin only amount required to adjust viscosity for temperature variations, proper atomization and flow-out. Mix material components using mechanical mixers.

   c. Discard catalyzed materials remaining at end of day.

3. Thoroughly dry pipe before primer is applied. Apply primer immediately after cleaning surface. Apply succeeding coats before contamination of undersurface occurs.

4. Cure minimum of twenty-four hours (24 Hrs) at seventy-seven degrees Fahrenheit (77° F) before successive coats are applied. During curing process, provide force air ventilation in volume sufficient to maintain solvent vapor levels below published threshold limit value. Apply successive coats within recoat threshold time as recommended by coating or lining manufacturer on printed technical data sheets or through written communications. Brush blast joints of pipe which have been shop primed and are to receive intermediate and finish coats in field prior to application of additional coats. After interior coats are applied, provide forced-air ventilation in sufficient volume and for sufficient length of time to ensure proper curing before filling pipe with water.

3.3 EXTERNAL COATING SYSTEM FOR BURIED STEEL PIPE

A. Tape Coating System:

1. Joint Protection

   a. Coating field joints, tie-ins and other field-welded joints: Provide application of approved insulating putty at bell step-offs and two (2) wraps of Field Joint Tape Primer: Furnished by tape manufacturer.

b. At the Contractor's option, apply approved special heat resistant tape system prior to internal welding of pipe. Coat entire pipe with shop-applied tape. Coat bell end with shop-applied heat-resistant tape. In field, fill joint step off area with insulating putty. Field apply two (2) layers of field joint tape over joint followed by high shear strength outerwrap. Follow manufacturer's recommendation for field-applied tape coating.

c. At the Contractor's option, provide field-applied shrink-wrap coating system for coating field joints, tie-ins and other field welded joints. Apply heat-shrink sleeves prior to internal welding of pipe using approved procedure compatible with coating system. Install heat-shrink joint sleeves in accordance with manufacturer's recommendations. Provide shrink-wrap systems consisting of primer, tape coating and polyurethane coating and high-strength application of Aqua-shield Wrap for pipeline. Provide services of technical representative of manufacturer available on site at beginning of pipelaying operations. Representative to advise the Contractor and the Project Manager regarding installation, repairs and general construction methods.

2. Field Application: AWWA C209 around joint cutbacks except as modified:

a. Field-welded joints: Clean shop-primed ends of weld splatter, damaged primer and rust to achieve required surface preparation prior to field repair of coatings.

b. Extend joint cleaning four inches (4 In) onto existing coating. Completely remove damaged and loose end-coatings.

c. Prior to placing pipe in trench, remove shop-applied primer by abrasive blasting, solvent or other method as approved by the Project Manager. Avoid damage to adjacent existing coatings.

d. Clean surfaces to achieve surface preparation at least equivalent to SSPC SP6 in accordance with AWWA C209. Provide solvent that is environmentally safe and compatible with coating system primer.

e. Apply insulating putty onto bell step-off as shown on the Drawings. Remove release liner during application.

f. Apply primer immediately prior to application of first layer of tape to achieve maximum bond. Apply tape while primer is still "tacky" with three inch (3 In) minimum overlap over shop-applied coating.

3. Joint Tape

a. Extend inner wrap minimum of two inches (2 In) onto existing coating on each side of joint. Extend outer wrap minimum of four inches (4 In) onto existing coating each side of joint. Stagger end laps minimum of six inches (6 In). Overlap adjacent tape wraps at least one inch (1 In) and overlap seam of outer wrap. Do not allow to be coincident with overlap seam of inner wrap. Wash with Xylol area that shall be overlapped.

b. Apply approved joint wrap tape to uncontaminated primer at proper roll body temperature. If necessary, store joint wrap material in heated box up to point of application.

c. Apply joint wrap material to pipe in either spiral or cigarette fashion dependent upon specification. Begin wrapping process two inches (2 In) to four inches (4 In) onto mill-applied pipe wrap and proceed wrinkle-free up over bell and across joint to spigot side pipe wrap.

d. Apply joint wrap under machine tension of five pounds (5 Lbs) to ten pounds (10 Lbs) per inch width. Joint wrap width should narrow (neck down) as material is applied tightly around pipe.

e. Apply first one-third (1/3) and last one-third (1/3) turn of joint material around pipe with less tension to prevent wrap crawlback. Overlap of joint wrap material and system's total thickness as specified in this Section.

f. End joint wrap process such that its final edge is directed downwards when pipe is placed in ditch to prevent backfill from pulling exposed joint wrap edge.

4. Do not expose tape coatings or heat-shrinkable joint sleeves to harmful ultraviolet light for more than ninety days (90 D). Discard (remove) and replace outer layer of tape coating when exposure exceeds ninety days (90 D). In case of factory-applied coatings, remove pipe from site for removal and reapplication of outer layer of tape coatings.

5. At option of the Project Manager, coating system and application may be tested and inspected at plant site in accordance with AWWA C214.

B. Test for holidays:

1. Inspect pipe for holidays and damage to coating.

a. If test indicates no holidays and outer wrap is torn, remove damaged layers of outer wrap by carefully cutting with sharp razor-type knife. Wash with Xylol area to be patched and at least four inches (4 In) of undamaged tape where hand-applied tape wrap shall overlap. AWWA C209 cold-applied tape compatible with tapewrapping system applied for each layer of outer-wrap tape that has been removed.

b. If test indicates holiday, remove outer layers and expose inner wrap. Prime exposed area and overlaps with light coat of primer. Firmly press into place patch of two (2) thirty-five (35) mil inner wrap tape extending four inches (4 In) from affected area in all directions. Second patch to overlap first patch by two inches (2 In). Perform holiday test of patch to verify satisfactory installation. Wash exposed outer wrap tape with Xylol and prime.

c. For severe outer wrap tape tears or damage and holiday is not detected, remove outer wrap to boundaries of damaged area, taking care not to damage inner wrap coating. Before replacing outer wrap, apply holiday detector to exposed area to determine that no damage has been made to primary coating. After verification that no holidays exist in underlying tape, clean damaged area and use patch of thirty-five (35) mil outer wrap tape. Apply as specified herein for repair of areas where bare pipe is exposed.

2. Do not allow bubbles in tape coating system regardless of

holiday test results, cut out bubbles and patch as described above as directed by the Project Manager.

3. Perform test procedure in accordance with NACE Standard RP-02-74. Perform electrical holiday test with sixty (60) cycle current audio detector. Use test voltage as specified in TABLE 4.5 TEST VOLTAGES in this Section.

C. Remove areas having physical damage and recoat. After repairing area, apply holiday detector as stated above to verify area is adequately repaired.

D. Cement mortar coating. AWWA C205; one inch (1 In) minimum thickness; Cut back from joint ends no more than two inches (2 In) to facilitate joining and welding of pipe.

3.4 JOINTS AND JOINTING

A. Rubber Gasketed Bell-and-Spigot Joints.

1. Use O-ring gasket with sufficient volume to approximately fill area of groove and gasket material in accordance with AWWA C200. Check each splice in gasket by stretching gasket to at least twice original length of gasket. Visually check stretched splice by rotating three hundred sixty degrees (360°). Reject splices showing visible separation or cracks.

2. Equalize rubber gasket cross section after rubber gasket is placed in spigot groove of pipe by inserting tool or bar such as large screwdriver under rubber gasket and moving it around periphery of pipe spigot. Lubricate gaskets with nontoxic water-soluble lubricant before pipe units are joined. Fit pipes together in manner to avoid twisting or otherwise displacing or damaging rubber gasket. Check gaskets after pipe sections are joined with feeler gauge to ensure that no displacement of gasket has occurred at point around circumference after joining. If displacement has occurred, remove pipe section and remake joint as if for new pipe. Remove old gasket and replace before remaking joint.

B. Welded Joints:

1. Conform to requirements of Section 02400 – Water Lines.

2. Field weld to be double-welded lap field joints or full penetration butt welded joints for steel pipe and encasement sleeves for

entire circumference.

3. Employ independent certified testing laboratory, approved by the Project Manager, to perform weld acceptance tests on welded joints. Include cost of such testing in contract the unit price bid for water line. Furnish copies of all test reports to the Project Manager for review. Test by magnetic particle test method for lap welds and fillet welds or by X-ray methods for butt welds, for one hundred percent (100%) of all joint welds. The Project Manager has final decision as to suitability of welds tested.

C. Flanged Joints: Conform to requirements of Section 02400 – Water Lines.

D. Joint Grouting and Testing: Conform to requirements of Section 02400 – Water Lines.

E. Do not allow steel plugs for threaded outlets to project beyond inner surface of pipe shell and seal weld by at least two (2) passes. Apply weld around outside of plug after it has been inserted in final position. Coat outlets and plugs inside and outside as required at field joints on pipe.

3.5 FIELD-APPLIED CEMENT-MORTAR LINING

A. Entrances Into Pipeline:

1. Establish means to permit entry and exit of labor, materials and equipment necessary for progress of work, as approved by the Project Manager.

2. Provide dikes and channeling for diversion of flood and drainage waters away from these openings in pipeline. Use temporary airtight covers over openings to provide proper curing conditions in completed sections of lined pipe. Where operation of equipment requires that end of pipe be left open, install temporary bulkhead inside pipe to eliminate direct draft through pipe over completed sections.

3. Brace closure sections of pipeline left out to facilitate field lining above ground to conform as nearly as possible to shape of pipe in ground and then place cement-mortar lining by machine or hand trowel to same thickness as in adjoining machine-lined sections. Bulkhead sections immediately after being lined to maintain proper curing conditions for period of not less than

forty-eight hours (48 Hrs) before sections are installed in pipeline. Install these sections of steel pipe.

4. Coat exterior surface of buttstraps and uncoated exterior surface area of steel pipe within excavations in accordance with the Technical Specifications. Place cement-mortar lining inside areas of joints in accordance with the Technical Specifications.

B. Mixing of Cement-mortar: Mix ingredients for cement-mortar for not less than one and one-half minutes (1-1/2 Min) and not more than six minutes (6 Min); use mortar promptly after mixing for lining pipe. Do not use mortar that has attained its initial for lining. Do not re-temper mortar. Add water to mix last.

C. Placing Cement-mortar Lining:

1. Complete joint work, backfill and welding before cement-mortar lining begins. After cement-mortar lining has cured hydrostatic testing of pipe can begin.

2. Provide provisions necessary for the Project Manager to conduct inspections of work in safe and thorough manner during and after initial application of mortar and after necessary repairs made. Include, as minimum, space on application machine and adequate lighting to inspect gross surface areas

3. Comply with ASTM C494 and with manufacturer's recommendations when using chemical admixtures, bonding agents, accelerators and other additives.

4. Remove dirt, debris, oil, grease and loose mill scale and rust from interior surfaces of pipe and scrape or brush surface with stiff bristle brush and/or water blast as may be necessary and approved by the Project Manager, to ensure clean surfaces for successful application of cement-mortar lining. Interior surfaces to be approved by the Project Manager prior to placing lining.

5. Provide cement-mortar lining uniform in thickness along entire length of pipe. Provide cement-mortar no less than one-half inch (1/2 In) over all surfaces with tolerance of plus one-eighth inch (+1/8 In) and no allowance for minus tolerance.

6. Mechanically control travel of machine and rates of discharge of mortar to produce uniform thickness of lining without segregation around perimeter and along length of pipe.

7. Check finished surface by placing twelve inch (12 In) straightedge parallel to axis of pipe along surface of straight section of lining. At no point shall space between lined surface and straightedge be greater than one-sixteenth inch (1/16 In).

8. Provide smooth finished surface, within tolerances specified. Repair or replace surface irregularities including corrugations, ripples or pits in any direction, to satisfaction of the Project Manager. Remove defective lining material, including, sand pockets, voids, oversanded areas, blisters, delaminations or unbounded areas, cracked areas, irregular surfaces and unsatisfactory thin spots. Remove to pipe wall and area repaired to full thickness of mortar lining.

9. Repair cracks one-sixteenth inch (1/16 In) and larger to satisfaction of the Project Manager.

10. Place cement-mortar lining by machine having following features:

    a. An applicator head which can be centered within pipe and which shall centrifugally project mortar against wall of pipe at high velocity producing dense, uniformly distributed mortar on wall of pipe.

    b. Equipped with mechanically driven, rotating steel trowels that immediately follow applicator, providing smooth, hard surface without spiral shoulders. Compensate for torque so that machine shall sit true in pipe and trowel faces shall not vary in angle with mortar face during complete three hundred sixty degree (360°) cycle. Clean trowels at frequent intervals to prevent accumulated mortar from obtaining initial set resulting in sanded or unglazed finish. Continuously operate trowels during application of cement-mortar and forward progress of lining machine.

    c. Design applicator so that nothing shall come in contact with troweled surface until it has attained final set and so that forward progress of machine and mechanical placing of mortar can be controlled to assure uniform thickness of lining.

11. Cement-mortar Lining: Adhere to steel at all points; provide consistent thickness except that lining of bell end of pipe where

lining is to be thicker in order to fill depression and make smooth surface.

12. Immediately prior to application of cement-mortar lining, sweep and clean off slime, dirt, loose rust, loose mill scale and other foreign materials. Free interior surface of pipe after cleaning of accumulated water on pipe wall or at joints.

13. After receiving its finish troweling, do not roughen lining by rebound material or by mortar direct from machine.

14. Temporarily close outlets in pipeline with easily removable stoppers to prevent spun mortar from being thrown into such openings. After lining is applied, remove stoppers from outlets and repair lining damaged by removal of stoppers. Point outlet openings up to provide smooth flow.

D. Hand Finishing:

1. Repair defective areas in machine-applied lining and unlined joints by hand patching to yield lining equal to that required for machine-applied troweled lining.

2. Provide nonshrink grout for patching or lining joints as specified in this Section.

3. Clean defective areas of loose foreign material and moisten with water just prior to application of hand-applied mortar.

4. Use steel finishing trowels for hand application of cement-mortar.

5. Complete hand finishing required in given pipe section not later than day following machine application of mortar lining to that particular pipe section, whether normal working day or otherwise. Slow down or stop machine application of mortar lining to allow time for hand patching.

E. Curing of Lining: Begin curing operations immediately after completing any portion of mortar lining. Close pipe by airtight bulkheads and maintain moist atmosphere in completed section of pipe to keep lining damp and to prevent evaporation of entrained water from mortar lining. Humidify air introduced into pipe for ventilating or curing purposes and maintain moist atmosphere inside pipe until the Project Manager accepts the Work.

3.6 INSPECTION (EXCEPT MORTAR COATED PIPE)

A. Include cost of inspection described in Paragraph 3.7, Inspection, in contract the unit price for water line. Furnish copies of certified inspection reports to the Project Manager for review.

B. Holiday Test and Adhesion Test: Provide services of independent coating and lining inspection service or testing laboratory with qualified coating inspectors. Provide inspections by NACE trained inspectors under supervision of NACE Certified Coatings Inspector having Level III Certification.

3.7 COATINGS AND LININGS INSPECTION RESPONSIBILITIES

A. The Contractor is responsible for quality control of coatings and linings applications and testing and inspection stipulated in this Section. The Project Manager is responsible for quality assurance and reserves right to inspect or acquire services of independent third-party inspector who is fully knowledgeable and qualified to inspect surface preparation and application of highperformance coatings at phases of coatings and linings, field or shop applied. The Contractor is responsible for proper application and performance of coatings and linings whether or not the Project Manager provides such inspection.

B. Cement Mortar Lining and Joint Finish: Finished surface of lining and joint to be comparable to surface rubbed with No. 16 Carborundum stone. Rub joint mortar sufficiently to bring paste to surface, to remove depressions and projections and to produce smooth, dense surface. Add cement to form surface paste as necessary. Leave interior with clean, neat and uniform-appearing finish.

3.8 FIELD REPAIR PROCEDURES AND SPECIAL FITTINGS APPLICATION FOR CEMENT MORTAR LINING

A. Areas less than or equal to six inches (6 In) in diameter: Patch honeycomb and minor defects in concrete surfaces with nonshrink grout. Repair defects by cutting out unsatisfactory material and replacing with nonshrink grout, securely bonded to existing concrete. Finish to make junctures between patches and existing concrete as inconspicuous as possible. After each patch has stiffened sufficiently to allow for greatest portion of shrinkage, strike off grout flush with surrounding surface.

B. Areas greater than six inches (6 In) in diameter:

1. Remove defective lining down to bare steel by chipping, making

sure care is taken to prevent further lining damage. Ends of lining where defective lining is removed are to be left square and uniform not feathered.

2. Clean bare steel with wire brush to remove loose or other foreign matter.

3. Remove existing wire reinforcement and replace. Overlap new reinforcement to existing reinforcement by one-half inch (1/2 In). Secure reinforcement, against wall of pipe, at frequent intervals, by tack welding to pipe.

4. Prepare cement mortar mixture. Mixture to compose of Portland Type II cement, sand and water. Proportions of sand to cement not to exceed three (3) parts sand to one (1) part cement, by weight. Use only enough water to obtain proper placement characteristics. Set up time before mixture is to be discarded is to be no longer than one-half hour (1/2 Hr). Nonshrink grout may also be used. Do not use combination of cement mortar and nonshrink grout within same repair.

5. Apply WELD-CRETE or approved equal, concrete bonding agent to bare steel and interface of existing lining. After bonding agent is applied to steel and lining new mix must be applied within ten minutes (10 Min).

6. Apply cement mortar to repair area one-half inch (1/2 In) thick then hand trowel to achieve smooth dense finish, making sure wire is not left exposed. To ensure proper thickness while placing new mortar, check thickness with one-half inch (1/2 In) long wire gauge.

7. Curing: Place plastic sheeting over repair area, use tape to adhere plastic to area surrounding repair area. Let cure for four days (4 D) then remove plastic sheeting.

PART IV: TABLES

4.1 PIPE WALL THICKNESSES

Net Inside Diameter (Inches)	Minimum Wall Thickness (Inches)	
	Flexible Coating	Mortar Coating
24	0.149	0.136
30	0.149	0.136
36	0.178	0.163
42	0.207	0.189
48	0.235	0.215
54	0.271	0.250
60	0.301	0.268
66	0.333	0.295
72	0.362	0.320
78	0.393	0.359
84	0.423	0.395
90	0.454	0.430
96	0.484	0.464

4.2 – REQUIRED BENDS STOCK

Line Diameter	Required Bends*
20 and 24 inches	Four 45 degree bends per 5,000 LF of water line
>24 inches	Four 22.5 degree bends per 10,000 LF of water line

* Based on total length of contract [minimum of four (4)]). Any combination of bends may be substituted at manufacturer's option [i.e. two (2) – twenty-two and one half degree (22-1/2°) bends are equivalent to one (1) – forty-five degree (45°) bend] and shall be counted as one (1) fitting.

4.3 – EPOXY PRIMER FOR INTERIOR SURFACES

Surface Preparation	**SSPC SP5 White Blast Clean 2.0 to 3.0 mils surface profile**
Prime Coat 4.0 to 6.0 mils DFT	NSF Certified Epoxy – Buff or approved equal
Intermediate Coat 4.0 to 6.0 mils DFT	NSF Certified Epoxy – Buff or approved equal
Finish Coat 4.0 to 6.0 mils DFT	NSF Certified Epoxy – White or approved equal

4.4 – THREE COAT EPOXY/POLYURETHANE COATINGS

Surface Preparation	**SSPC SP10 Near White Blast Clean 2.0 to 3.0 mils surface profile**
Prime Coat 4.0 to 6.0 mils DFT	Inhibitive Epoxy Primer of approved equal
Intermediate Coat 4.0 to 6.0 mils DFT	Chemical Resistant Epoxy or approved equal
Finish Coat 1.5 to 2.5 mils DFT	Polyurethane or approved equal

4.5 TEST VOLTAGES

Total Coating Thickness (Mils)	**Test Voltage (Volts)**
20	6,000
30/35	7,500
50	9,000
70	11,500
80	12,000

END OF SECTION

SECTION 02260

POLYETHYLENE WRAP

PART I: GENERAL

1.1 GENERAL REQUIREMENTS

A. Polyethylene wrap to be used in open-cut construction for cast iron and ductile iron pipe when cathodic protection system is not required by the Drawings.

1.2 MEASUREMENT AND PAYMENT

A. Unit Prices:

1. No separate payment will be made for polyethylene wrap. Include cost of polyethylene wrap in the unit price for pipes and fittings to be wrapped.

2. Refer to Section 01270 – Measurement and Payment for unit price procedures.

B. Stipulated Price (Lump Sum):

1. If Contract is Stipulated Price Contract, payment for work in this Section is included in Total Stipulated Price.

1.3 REFERENCE

A. ASTM – American Society for Testing and Materials.

1. ASTM D1248 – Standard Specification for Polyethylene Plastics Molding and Extrusion Materials For a Wire and Cable.

B. AWWA – American Water Works Association.

1. AWWA C105 – Standard for Polyethylene Encasement for Ductile-Iron Pipe System.

C. CFTS – City of Friendswood Technical Specifications.

1. Section 01270 – Measurement and Payment.

2. Section 01330 – Submittal Procedures.

1.4 SUBMITTALS

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

B. Submit product data for proposed film and tape for approval.

1.5 QUALITY ASSURANCE

A. Provide manufacturer's affidavits that material was manufactured in compliance with Technical Standards referenced in this Section.

PART II: PRODUCTS

2.1 MATERIALS

A. Polyethylene Film: Tubular or sheet form without tears, breaks, holidays or defects; conforming with requirements of AWWA C105, two and one-half percent (2-1/2%) to three (3%) percent carbon black content, either low- or high-density:

1. Low-density polyethylene film: Low-density polyethylene film shall be manufactured of virgin polyethylene material conforming to following requirements of ASTM D1248.

a. Raw material.

1) Type : I.

2) Class: C (black).

3) Grade: E-5.

4) Flow rate (formerly melt index): Four tenths gallons per ten minutes (0.4 Gal/10 Min), maximum.

5) Dielectric strength: Volume resistivity, 10_{15} ohm-cm, minimum.

b. Physical properties.

1) Tensile strength: One thousand pounds per square inch (1200 psi), minimum.

2) Elongation: Three hundred percent (300%),

minimum.

3) Dielectric strength: Eight hundred volts per mil (800 V/mil) thickness, minimum.

c. Thickness: Low-density polyethylene film shall have normal thickness of eight thousandths inch (0.008 In). Minus tolerance on thickness is ten percent (-10%) of nominal thickness.

2. High-density, cross-laminated polyethylene film: High-density, cross laminated polyethylene film shall be manufactured of virgin polyethylene material conforming to following requirements of ASTM D1248.

a. Raw material.

1) Type: III.

2) Class: C (black).

3) Grade: P33.

4) Flow rate (formerly melt index): Four tenths Gallon per ten minutes (0.4 Gal/10 Min) to five tenths gallon per ten minutes (0.5 Gal/10 Min), maximum.

5) Dielectric strength: Volume resistivity, 10_{15} ohm-cm, minimum.

b. Physical properties:

1) Tensile strength: Five thousand pounds per square agent (5000 psi), minimum.

2) Elongation: One hundred percent (100%), minimum.

3) Dielectric strength: Eight hundred volts per mil (800 V/mil) thickness, minimum.

c. Thickness: Film shall have nominal thickness of four thousandths inch (0.004 In). Minus tolerance of thickness is ten percent (-10%) of nominal thickness.

B. Polyethylene Tape: Provide three inch (3 In) wide, plastic-backed, adhesive tape; Paleocene No. 900, Scotchwrap No. 50 or approved equal.

PART III: EXECUTION

3.1 PREPARATION

A. Remove lumps of clay, mud and cinders from pipe surface prior to installation of polyethylene encasement. Prevent soil or embedment material from becoming trapped between pipe and polyethylene.

B. Fit polyethylene film to contour of pipe to affect snug, but not tight fit; encase with minimum space between polyethylene and pipe. Allow sufficient slack in contouring to prevent stretching polyethylene where it bridges irregular surfaces, such as bell-spigot interfaces, bolted joints or fittings and to prevent damage to polyethylene due to backfilling operations. Secure overlaps and ends with adhesive tape to hold polyethylene encasement in place until backfilling operations are complete.

C. For installations below water table or in areas subject to tidal actions, seal both ends of polyethylene tube with adhesive tape at joint overlap.

3.2 INSTALLATION

A. Tubular Type (Method A):

1. Cut polyethylene tube to length approximately two feet (2 Ft) longer than pipe section. Slip tube around pipe, centering tube to provide one foot (1 Ft) overlap on each adjacent pipe section and bunching it accordion-fashion lengthwise until it clears pipe ends.

2. Lower pipe into trench and make up pipe joint with preceding section of pipe. Make shallow bell hole at joints to facilitate installation of polyethylene tube.

3. After assembling pipe joint, make overlap of polyethylene tube. Pull bunched polyethylene from preceding length of pipe, slip it over end of adjoining length of pipe and secure in place, then slip end of polyethylene from adjoining pipe section over end of first wrap until it overlaps joint at end of preceding length of pipe. Secure overlap in place. Take up slack width at top of pipe to make a snug, but not tight, fit along barrel of pipe, securing fold at quarter points.

4. Repair cuts, tears, punctures or other damage to polyethylene. Proceed with installation of next section of pipe in same manner.

B. Tubular Type (Method B):

1. Cut polyethylene tube to length approximately one foot (1 Ft) shorter than pipe section. Slip tube around pipe, centering it to provide six inches (6 In) of bare pipe at each end. Take up slack width at top of pipe to make snug, but not tight, fit along barrel of pipe, securing fold at quarter points; secure ends.

2. Before making up joint, slip three foot (3 Ft) length of polyethylene tube over end of preceding pipe section, bunching in accordion-fashion lengthwise. After completing joint, pull three foot (3 Ft) length of polyethylene over joint, overlapping polyethylene previously placed on each adjacent section of pipe by at least one foot (1 Ft); make each end snug and secure.

3. Repair cuts, tears, punctures or other damage to polyethylene. Proceed with installation of next section of pipe in same manner.

C. Sheet Type:

1. Cut polyethylene sheet to length approximately two feet (2 Ft) longer than pipe section. Center length to provide one foot (1 Ft) overlap on each adjacent pipe section, bunching sheet until it clears pipe ends. Wrap polyethylene around pipe so that sheet circumferentially overlaps top quadrant of pipe. Secure cut edge of polyethylene sheet at intervals of approximately three feet (3 Ft).

2. Lower wrapped pipe into trench and make up pipe joint with preceding section of pipe. Make shallow bell hole at joints to facilitate installation of polyethylene. After completing joint, make overlap and secure ends.

3. Repair cuts, tears, punctures or other damage to polyethylene. Proceed with installation of next section of pipe in same manner.

D. Pipe-shaped Appurtenances: Cover bends, reducers, offsets and other pipe-shaped appurtenances with polyethylene in same manner as pipe.

E. Odd-shaped Appurtenances: When it is not practical to wrap valves, tees, crosses and other odd-shaped pieces in tube, wrap with flat sheet or split length of polyethylene tube by passing sheet around appurtenance and encasing it. Make seams by bringing edges together, folding over twice and taping down. Tape polyethylene securely in place at valve stem and other penetrations.

F. Openings in Encasement: Create openings for branches, service taps, blow-offs, air valves and similar appurtenances by making X-shaped cut in polyethylene and temporarily folding back film. After appurtenance is installed, tape slack securely to appurtenance and repair cut, as well as other damaged area in polyethylene, with tape. Service taps may also be made directly through polyethylene, with resulting damaged areas being repaired as specified.

G. Junctions between Wrapped and Unwrapped Pipe: Where polyethylene-wrapped pipe joins adjacent pipe that is not wrapped, extend polyethylene wrap to cover adjacent pipe for distance of at least three feet (3 Ft). Secure end with circumferential turns of tape. Wrap service lines of dissimilar metals with polyethylene or suitable dielectric tape for minimum clear distance of three feet (3 Ft) away from cast or ductile iron pipe.

3.3 REPAIRS

A. Repair cuts, tears, punctures or damage to polyethylene with adhesive tape or with short length of polyethylene sheet or cut open tube, wrapped around pipe to cover damaged area and secured in place.

END OF SECTION

SECTION 02265

POLYURETHANE COATINGS ON STEEL OR DUCTILE IRON PIPE

PART I: GENERAL

1.1 GENERAL REQUIREMENTS

A. Two (2) component polyurethane coating system for use as external coating for steel or ductile iron pipe.

1.2 MEASUREMENT AND PAYMENT

A. Unit Prices:

1. No separate payment will be made for work performed under this Section. Include cost of polyurethane coatings in contract unit prices for steel pipe or ductile iron pipe.

2. Refer to Section 01270 – Measurement and Payment for unit price procedures.

B. Stipulated Price (Lump Sum):

1. If Contract is Stipulated Price Contract, payment for work in this Section is included in Total Stipulated Price.

1.3 REFERENCES

A. ASTM – American Society for Testing and Materials.

1. ASTM D522 – Standard Test Method for Mandrel Bend Test of Attached Organic Coatings.

B. AWWA – American Water Works Association.

1. AWWA C210 – Standard for Liquid Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines.

C. CFTS – City of Friendswood Technical Specifications.

1. Section 01270 - Measurement and Payment.

2. Section 01330 - Submittal Procedures.

3. Section 02215 – Ductile Iron Pipe (DIP) and Fittings.

4. Section 02250 – Steel Pipe and Fittings.

D. SSPC – Steel Structures Painting Council.

1. SSPC PA2 – Measurement of Dry Paint Thickness with Magnetic Gauges.

2. SSPC PA Guide 3 – A Guide to Safety in Paint Application.

3. SSPC PS Guide 17.00 – Guide for Selecting Urethane Painting Systems.

4. SSPC PS10 – Near-White Blast Cleaning.

1.4 SAFETY

A. Secure, from manufacturer, Material Safety Data Sheet (MSDS) for polyurethane coatings and repair materials listed in this Section.

B. Safety requirements stated in this specification and in related sections apply in addition to applicable federal, state and local rules and regulations. Comply with instructions of coating manufacturer and requirements of insurance underwriters.

C. Follow handling and application practices of SSPC PA Guide 3; SSPC PS Guide 17.00; Coating Manufacturer's Material Safety Data Sheet.

1.5 SUBMITTALS

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

B. Submit coating manufacturer's catalog sheets and technical information for approval, prior to delivery of pipe.

C. Obtain from coating manufacturer and submit coating "affidavit of compliance" to requirements of this Section stating that coatings were applied in factory and in accordance with manufacturer's minimum requirements.

1.6 DELIVERY, STORAGE and HANDLING

A. Use standard containers to prevent gelling, thickening deleteriously or forming of gas in closed containers within period of one year (1 Yr) from date of manufacture.

B. Label each container of separately packaged component clearly and durably to indicate date of manufacture, manufacturer's batch number, quantity, color, component identification and designated name or formula specification, number of coatings together with special instructions. Do not use coating components older than one year (1 Yr).

C. Deliver coating materials to pipe manufacturer in sealed containers showing designated name, batch number, color, date of manufacture and name of coating manufacturer.

D. Store material onsite in enclosures, out of direct sunlight in a warm, ventilated and dry area.

E. Prevent puncture, inappropriate opening or other action which may lead to product contamination.

1.7 QUALITY ASSURANCE

A. Provide manufacturer's affidavits that pipe was manufactured in compliance with standards referenced in this Section.

PART II: PRODUCTS

2.1 COATING MATERIAL

A. CORROPIPE II PW – TOUCHUP (two-component) or approved equal; mix in accordance with coating manufacturer's recommendations.

1. For areas less than or equal to six inches (6 In) in diameter, brush apply.

2. For areas greater than six inches (6 In) in diameter, spray apply.

B. Coating System: Use Type V system which is two (2) package polyisocyanate, polyol-cured urethane coating, mixed in one to one (1:1) ratio at time of application. Components shall be balanced viscosities in their liquid state and not require agitation during use.

C. Exterior Coating Material: CORROPIPE II-TX and Joint Coating Material CORROPIPE II-PW, manufactured by Madison Chemical Industries, Inc.

D. Internal Coating Material: Joint Coating Material CORROPIPE II-PW,

manufactured by Madison Chemical Industries, Inc

E. Cured Coating Properties:

1. Conversion to Solids by Volume: Ninety-seven percent (97%) plus or minus three percent (±3%).

2. Temperature Resistance: Minus forty degrees Fahrenheit (-40° F) and plus one hundred degrees Fahrenheit (130° F).

3. Minimum Adhesion: Five hundred pounds per square inch (500 psi), when applied without primer to ductile iron pipe which has been blasted to comply with SSPC SP10.

4. Cure Time: For handling in one minute (1 Min) at one hundred twenty degrees Fahrenheit (120° F) and full cure within seven days (7 D) at seventy degrees Fahrenheit (70° F).

5. Maximum Specific Gravities: Polyisocyanate resin, 1.20. Polyol resin, 1.15.

6. Minimum Impact Resistance: eighty inch-pounds (80 in-lb) using one inch (1 In) diameter steel ball where coating is applied at thirty (30) mils to ductile iron pipe surface which has been blasted to SSPC No. 10 finish.

7. Minimum Tensile Strength: Two thousand pounds per square inch (2000 psi).

8. Hardness: Fifty-five (55) plus or minus five (±5) Shore D at seventy degrees Fahrenheit (70° F).

9. Flexibility Resistance: ASTM D522 using one inch (1 In) mandrel. Allow coating to cure for seven days (7 D). Perform testing on test coupons held for fifteen minutes (15 Min) at temperature extremes specified in this Paragraph.

2.2 REPAIR AND TOUCHUP MATERIAL

A. CORROPIPE II PW [Two (2) component, brush applied or approved equal]. Mix in accordance with coating manufacturer's recommendations.

PART III: EXECUTION

3.1 SURFACE PREPARATION

A. Remove deposits of oil, grease or other organic contaminates before blast cleaning by using solvent wash as specified in SSPC PA Guide 3. Clean and dry surfaces making them completely dry, free of moisture, dust, grit, oil, grease or other deleterious substances prior to application of coating.

B. Exterior and Interior Surfaces: SSPC SP10, near-white metal blast cleaning. Blast with clean, hard, sharp cutting abrasives with no steel or cast iron shot in mix.

C. Ductile Iron Pipe: Prior to start of production blasting, prepare specimens for white metal blast and near-white metal blast using equipment and abrasives proposed for work. During preparation of specimens, Change blasting intensity and abrasive as necessary to provide degree of cleaning required by SSPC SP10, except that color of blasted substrate is not expected to match color of blasted steel. After examination and concurrence by the Project Manager, production blasting may begin. Monitor and control production blasting so that production pipe surfaces match surface of approved blasting specimens.

3.2 THICKNESS

A. External Coatings: Minimum DFT of twenty-five (25) mils (0.025 inch).

B. Internal Coatings: Minimum DFT of thirty-five (35) mils.

C. Thickness Determinations: Use Type 1 magnetic thickness gauge as described in SSPC PA2 specification. Individual readings below ninety percent (90%) of specified minimum are not acceptable. Average individual spot readings [consisting of three (3) point measurements within three inches (3 In) of each other] less than ninety-five percent (95 %) of minimum are not acceptable. Average of all spot readings less than minimum thickness specified are not acceptable.

3.3 FACTORY APPLICATION OF POLYURETHANE COATING

A. Equipment: Two-component, one to one (1:1) mix ratio, heated airless spray unit.

B. Temperature: Minimum five degrees Fahrenheit (5° F) above dew point temperature. Temperature of surface shall not be less than sixty

degrees Fahrenheit (60° F) during application.

C. Humidity: Heating of pipe surfaces may be required to meet requirements of Paragraph 2.1E, Cured Coating Properties, when relative humidity exceeds eighty percent (80%).

D. Do not thin or mix resins; use as received. Store resins at temperature above fifty-five degrees Fahrenheit (55° F) at all times.

E. Application: Conform to coating manufacturer's recommendations. Apply directly to substrate to achieve specified thickness. Multiple-pass, one (1) coat application process is permitted provided maximum allowable recoat time specified by coating manufacturer is not exceeded.

F. Recoat only when coating has cured less than maximum time specified by coating manufacturer. When coating has cured for more than recoat time, brush-blast or thoroughly sand coating surface. Blow-off cleaning using clean, dry, high pressure compressed air.

G. Cure at ambient temperature above zero degrees Fahrenheit (0° F). Do not handle pipe until coating has been allowed to cure as specified in TABLE 4.1 – MINIMUM CURE TIME in this Section.

3.4 JOINTS

A. Apply coating to unlined pipe surfaces including inside of bell socket and outside of spigot.

B. Coating thickness on sealing areas of spigot end of pipe exterior: Minimum eight (8) mils (0.008 inch), maximum of ten (10) mils (0.010 inch). Maximum ten (10) mils may be exceeded in spigot end provided maximum spigot diameter as specified by pipe manufacturer is not exceeded.

3.5 INSPECTION

A. The Project Manager may inspect coatings at coating applicator's facilities.

B. Secure approval of surface preparation by coating manufacturer's representative prior to coating application.

C. Holiday Inspection: Conform to AWWA C210, Section 5.3.3.1. Follow coating manufacturer's recommendation. Conduct inspection any time after coating has reached initial cure. Repair in accordance with

Paragraph 3.7, Repair and Field Touchup.

3.6 PIPE INSTALLATION

A. When required by the Project Manager, provide services of manufacturer's representative for period of not less than two weeks (2 Wks) at beginning of actual pipe laying operations to advise the Contractor regarding installation, including, but not limited to, handling and storing, cleaning and inspecting, coatings repairs and general construction methods as to how they may affect pipe coatings.

B. Use nylon straps, padded lifts and padded storage skids. Field cuts shall be kept to minimum. Repair damage to coating due to handling or construction practices. See Section 02215 – Ductile Iron Pipe (DIP) and Fittings and Section 02250 – Steel Pipe and Fittings for additional requirements.

C. Just before each section of pipe is to be placed into trench, conduct visual and holiday inspection. Repair defects in coating system before pipe is installed.

3.7 REPAIR AND FIELD TOUCHUP

A. Apply repair and touchup materials to holidays and other deficient coating in conformance with factory application of polyurethane coating requirements specified in this Section, excluding equipment requirements.

B. Repair Procedure – Holidays:

1. Remove traces of oil, grease, dust, dirt and other deleterious materials.

2. Roughen area to be patched by sanding with rough grade forty (40) grit sandpaper.

3. Apply one (1) coat of repair material described above. Work repair material into scratched surface by brushing.

C. Repair Procedure – Field Cuts or Large Damage:

1. Remove burrs from field cut ends or handling damage and smooth out edge of polyurethane coating.

2. Remove traces of oil, grease, dust, dirt and other deleterious materials

3. Roughen area to be patched with rough grade forty (40) grit sandpaper. Feather edges and include overlap of one inch (1 In) to two inches (2 In) of roughened polyurethane in area to be patched.

4. Apply thick coat of repair material described above. Work repair material into scratched surface by brushing. Feather edges of repair material into prepared surface. Cover at least one inch (1 In) of roughened area surrounding damage or adjacent to field cut.

D. Repair Procedure – Thermite Brazed Connection Bonds:

1. Remove polyurethane coating with power wire brush from area on metal surface which is to receive thermite brazed connection.

2. Grind metal surface to shiny metal with power grinder and coarse grit grinding wheel.

3. Apply thermite-brazed connection using equipment, charge and procedure recommended by manufacturer of thermite equipment.

4. After welded surface has cooled to temperature below one hundred thirty degrees Fahrenheit (130° F), apply protective coating repair material to weld, exposed pipe surface and damaged areas of polyurethane coating.

5. Do not cover or backfill freshly repaired areas of coating at thermite-brazed connection until repair material has completely cured. Allow material to cure in conformance with manufacturer's recommendations.

PART VI: TABLES

4.1 – MINIMUM CURE TIME

Ambient Temperature	**Minimum Full Cure Time**
Over 70 degrees F	7 days
50 to 70 degrees F	9 days
0 to 50 degrees F	12 Days

END OF SECTION

SECTION 02270

AUGERING WATER PIPE AND CONDUIT

PART I: GENERAL

1.1 GENERAL REQUIRMENTS

A. Installing water line service pipe by methods of augering or casing by jacking and boring.

B. Installing Telecommunication Conduit along or under Public Ways

1.2 MEASUREMENT AND PAYMENT

A. Unit Prices:

1 No separate payment will be made for augering pipe for water lines under this Section. Include payment in the unit price for Section 02400 – Water Lines.

2. When open-cut construction is requested by the Contractor for his convenience in areas designated for augering and when approved in advance by the Project Manager, such areas shall be paid for at the unit price for Section 02400 – Water Lines.

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

B. Stipulated Price (Lump Sum):

1. If Contract is Stipulated Price Contract, payment for work in this Section is included in Total Stipulated Price.

1.3 DEFINITIONS

A. Auger Method: Installation of steel casing by excavating soil at advancing end of casing and transporting spoil through casing by otherwise uncased auger, while advancing casing by jacking at same rate as auger excavation progresses.

B. Slurry Auger Method: Installation of casing or pipe by first drilling small diameter pilot hole from pit to pit, followed by removing excess soil and installing pipe or conduit by pull-back or jacking method.

1.4 REFERENCE STANDARDS

A. ASTM – American Society for Testing and Materials.

1. ASTM D638 – Standard Test Method for Tensile Properties of Plastics.

2. ASTM D648 – Standard Test Method for Deflection Temperature of Plastics under Flexural Load in the Edgewise Position.

3. ASTM D695 – Standard Test Method for Compressive Properties of Rigid Plastics.

4. ASTM D790 – Standard Test Method for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

B. CFTS – City of Friendswood Technical Specifications.

1. Section 01270 – Measurement and Payment.

2. Section 01330 – Submittal Procedures.

3. Section 01555 – Traffic Control and Regulation.

4. Section 01580 – Waste Material Disposal.

` 5. Section 01585 – Control of Ground and Surface Water.

6. Section 02100 – Clearing and Grubbing.

7. Section 02125 – Excavation and Backfill for Utilities.

8. Section 02250 – Steel Pipe and Fittings.

9. Section 02280 – Trench Safety Systems.

10. Section 02400 – Water Lines.

11. Section 03105 – Grout.

1.5 REGULATORY REQUIREMENTS

A. Conform to Texas Department of Transportation (TxDOT) for

installations under state highways. The City shall obtain required permits for State Highway crossings on behalf of the contractor.

B. Installations Under Railroads:

1. The City shall obtain required permits for Railroad crossings, from affected railroad companies, on behalf of the Contractor.

2. Comply with requirements of right-of-entry for crossing Railroad Company's easement or right-of-way from railroad companies affected. Comply with railroad permit requirements.

3. Use dry auger method only.

4. Damages due to delays caused by railroad requesting work to be done at hours which shall not inconvenience railroad shall be at no additional cost to the City.

5. Maintain a minimum of thirty-five foot (35 Ft) clearance from centerline of tracks, to the closest edge of the bore pit, but in any case outside of the right-of-way unless otherwise permitted by the railroad.

6. At no time shall any equipment, excavations or materials be closer than thirty-five feet (35 Ft) from the centerline of tracks.

1.6 SUBMITTALS

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

B. For installation by augering, submit for review:

1. Description of mechanized excavating equipment.

2. Method of controlling line and grade.

3. Grouting techniques to be used for filling annular void between water line pipe and casing, and void between water line pipe or casing and ground, including equipment, pumping and injection procedures, pressure grout types, and mixes.

4. Locations and dimensions of pits.

5. Pit design and construction drawings.

6. Identification of casings required and paid under Contract and

casings installed at the Contractor's option.

7. Design of casings.

8. Copy of railroad company permits and right-of-entry.

C. Prepare auger pit and casing design submittals that are site specific. Have auger pit and casing design submittals signed and sealed by a Professional Engineer licensed by State of Texas.

D. Include in construction phase submittals:

1. Daily logs of augering and boring operations

2. Settlement monitoring data to meet requirements of paragraph 3.11, Settlement Monitoring.

3. Submit daily logs and settlement monitoring data within five days (5 D) after day of observation

1.7 CRITERIA FOR CASING INSTALLATION LOADS

A. The Contractor shall be responsible for selection of casing, pipe and pipe joints to carry anticipated thrust of jacks or loads.

PART II: PRODUCTS

2.1 MATERIALS

A. Piping and Fittings: As required by the Technical Specifications or the Drawings.

B. Casings: Where shown on the Drawings, in accordance with Section 02250 – Steel Pipe and Fittings.

C. Casing Spacers: Where casings are shown on the Drawings, use casing spacer width eight inches (8 In) for pipe sizes four inches (4 In) to twelve inches (12 In); twelve inches (12 In) for pipe sizes fourteen inches (14 In) and larger. Wood skids or concrete "donuts" are not acceptable.

1. For welded steel pipe twelve inches (12 In) and smaller, use Pipeline Seal & Insulator Model PE or approved equal.

2. For other pipe materials, use Pipeline Seal & Insulator Model

C8G-2 or approved equal for pipe sizes up to twelve inches (12 In).

3. For all pipe sizes above twelve inches (12 In), use Pipeline Seal & Insulator Model C12G-2 or approved equal.

4. Obtain approval for equal product in writing from the Project Manager prior to bid.

5. Use ISO-9002 registered casing spacer manufacturer or supplier. Submit copy of current certificate with submittal package.

D. Casing End Seals: Provide Pipeline Seal and Insulator Model C or approved equal.

E. Casing Spacers (For Pipes Diameters sixteen inches (16 In) or Greater): Bolt-on style with shell made of two (2) sections of fourteen (14) gauge carbon steel, hot rolled, cleaned and lined with PVC liner, ninety thousandths inch (0.090 In) thick with Durometer A 85-90 overlapping edges to secure liner to spacer; deep embossed flanges for added strength; coated prior to installation of liner and runner with fusion-bonded PVC powder of fourteen (14) mils to twenty (20) mils thickness; electroplated studs, nuts and washers.

1. Runners [For Pipe Diameters sixteen inches (16 In) or Greater]: Supported by ten (10) gauge carbon steel MIG risers welded to shell. Total length of weld beads shall be at least fifty percent (50%) of the length of the runner. Fill bolt holes with caulk or approved equal to provide a water-tight seal. Minimum requirements: Glass reinforced plastic conforming to the following tests:

   a. Tensile Strength: ASTM D638; Seventeen thousand six hundred pounds per square inch (17600 psi).

   b. Flexural Strength: ASTM D790; Twenty-Five thousand three hundred pounds per square inch (25300 psi).

   c. Compression Strength: ASTM D695; Eighteen thousand pounds per square inch (18000 psi).

   d. Deflection Temperature at two hundred sixty-four pounds per square inch (264 psi): ASTM D648; Four hundred five degrees Fahrenheit (405° F).

e. Polyethylene runners are not acceptable.

PART III: EXECUTION

3.1 LIMITS ON AUGER LENGTH WITHOUT CASING

A. Do not exceed one hundred feet (100 Ft) for length of auger hole without receiving pit.

B. Do not exceed seventy-five feet (75 Ft) for length of auger hole for PVC pipe twelve inches (12 In) and less in diameter without receiving pit.

C. Do not exceed forty feet (40 Ft) for length of auger hole for PVC pipe fourteen inches (14 In) to twenty-four inches (24 In) in diameter without receiving pit.

D. Specifications in this paragraph that are in conflict with permit requirements, the permit requirements shall supersede all Technical Specifications. As such this may require substitution of other materials.

3.2 PREPARATION

A. Conform to applicable provisions of Section 02100 – Clearing and Grubbing.

B. Utility Relocations: Relocate utility lines clear of pit and zone of potential significant settlement or other ground disturbance.

C. Install casings as required by the Drawings, in accordance with this Section.

D. Install temporary solid plug at open end of water line to prevent contamination.

3.3 TRAFFIC CONTROL

A. Conform to applicable provisions of Section 01555 – Traffic Control and Regulation.

B. Secure right-of-entry for crossing Railroad Company's easement or right-of-way.

C. During construction operations, furnish and maintain barricades and lights to safeguard traffic and pedestrians, until such time as backfill has been completed and removed from site. Provide additional barricades

and lights as directed by the Project Manager.

3.4 LOCATION AND SIZE OF AUGER PITS

A. Show location of auger pits on auger pit construction drawings. Locate auger pits for slurry boring so that distance between pits is no greater than eighty feet (80 Ft); and for dry augering not more than one hundred twenty feet (120 Ft) apart, except where larger distances are required by railroad permits or railroad rights-of-way.

B. Locate auger pits and associated work areas to avoid blocking driveways and cross streets and to minimize disruption to business and commercial interests. Avoid auger pit locations near areas identified as potentially contaminated.

C. Pit Size: Size pits to provide adequate room to meet operational requirements for auger construction as well as structures indicated on the Drawings. Provide minimum six inch (6 In) space between pipe and walls of auger pit. Maximum allowable width of pit shall be five feet (5 Ft). Width of pit at surface shall not be less than at bottom. Maximum allowable length of pit shall be no more than five feet (5 Ft) longer than one (1) full section of pipe and shall not exceed twenty-five feet (25 Ft).

D. Excavate bore pits to finished grade at least six inches (6 In) lower than grade indicated by stakes.

E. Auger pits that are excavated and backfilled as part of open-cut water line construction shall be in accordance with Section 02125 – Excavation and Backfill for Utilities.

F. Provide and properly maintain safety protection against traffic and accidental or unauthorized entry. Provisions to include concrete traffic barriers or other suitable barriers around periphery of pit as appropriate. Fully cover and secure pits where no construction activity is in progress.

G. Install sheeting, lining, shoring and bracing required for protection of workmen and public in accordance with Section 02280 – Trench Safety Systems.

H. Provide full cover or other security fencing for each access pit in which there is no construction activity or which is unattended by the Contractor's personnel.

I. Provide groundwater control and drainage from pits while work is in progress and until pit is properly backfilled. Conform to requirements of Section 01585 – Control of Ground and Surface Water.

3.5 AUGERING (BORING)

A. Auger from approved pit locations. Excavate for pits and install shoring as outlined above under Paragraph 3.4, Pits. Auger mechanically with use of pilot hole entire length of crossing and check for line and grade. Diameter of auger hole not to exceed pipe bell diameter plus two inches (2 In). Place excavated material outside working pit and dispose of as specified. Use water or other fluids in connection with boring operation only to lubricate cuttings; jetting is not permitted.

B. In unconsolidated soil formations, gel-forming colloidal drilling fluid may be used. Fluid is to consist of at least ten percent (10%) of high-grade processed bentonite and shall consolidate cuttings of bit, seal walls of hole and shall furnish lubrication for subsequent removal of cuttings and installation of pipe.

C. Depending on character of soil encountered during augering operation, conduct operations without interruption, insofar as practical, to prevent hole from collapsing or pipe from seizing up in hole before installation is complete.

D. Allowable variation from line and grade shall be as specified under Paragraph 3.9, Jacking.

E. Remove and replace pipe damaged in augering operations.

3.6 DRY AUGERING OF CASING

A. Provide jacks, mounted on frame or against backstop, of capacity suitable for forcing excavating auger and casing through soil conditions to be encountered. Operate jacks so that even pressure is applied to casing.

B. Provide steerable front section of casing to allow vertical grade adjustments. Provide water level or other means to allow monitoring of grade elevation of auger casing.

C. Bentonite slurry may be used to lubricate casing during installation. Use of water to facilitate removal of spoil is permitted; however, water jetting for excavation of soil is not allowed when jacking casing.

D. Tolerances from lines and grades shown on the Drawings for water line pipe installed in casing are plus or minus six inches (±6 In) in horizontal alignment, and plus or minus one and one-half inches (±1-1/2 In) in elevation.

3.7 SLURRY BORING OF CASING OR PIPE

A. Drill small diameter pilot hole and check for line and grade at receiving end. Re-drill pilot hole when bored pipe does not meet specified tolerances.

B. Using pilot hole as guide bore larger diameter hole of sufficient size for pipe or casing installation. Water jetting is not permitted.

C. Bentonite slurry may be used to maintain stable hole and furnish lubrication for pipe or casing installation.

D. Tolerances from lines and grades shown on the Drawings for installed water line pipe are plus or minus six inches (±6 In) in horizontal alignment and plus or minus one and one-half inches (±1-1/2 In) in elevation.

E. Completely fill annular space between water line pipe and surrounding soil or casing as specified in Paragraph 3.8, Filling Annular Space.

F. Do not discharge auguring liquid into operating storm sewer system. If water only, pump to adjacent ground area where sediment shall be filtered from the liquid by ground. If auguring liquid is Bentonite slurry, pump to tank or container, and dispose of off-site.

3.8 FILLING ANNULAR SPACE

A. For installation of water line, block void space around pipe in augered hole with approximately twelve inches (12 In) of packed clay or approved equal material to prevent bedding or backfill from entering void around pipe in augered hole when compacted. For pipe diameters four inches (4 In) through eight inches (8 In) use minimum one-half cubic foot (1/2 Cf) clay; for pipe diameters twelve inches (12 In) through sixteen inches (16 In) use minimum three-quarters cubic foot (3/4 Cf) clay.

3.9 JACKING

A. Comply with Section 02280 – Trench Safety for all pits, end trenches and other excavations relating to work required by the Technical Specifications. Dewater as required to provide safe working conditions.

B. Wherever end trenches are cut into sides of embankment or beyond it, sheath securely and brace such work to prevent earth caving.

C. Make up only one (1) joint at time in pit or trench prior to jacking.

D. Do not interfere with operation of railroad, street, highway or other facility, nor weaken or damage embankment or structure.

E. Use heavy-duty jacks sized for forcing casing through embankment. Use appropriate jacking head, usually of timber and bracing between jacks and jacking head and jacking frame or backstop. Apply jacking pressure uniformly around ring of casing. Set casing to be jacked on guides, properly braced together, to support section of casing and to direct it in proper line and grade. Place jacking assembly in line with direction and grade of casing. Excavate embankment material just ahead of casing and remove material through casing. Force casing through embankment with jacks into excavated auger hole.

F. Conform excavation for underside of casing to contour and grade of casing, for at least one-third (1/3) of circumference of casing. Provide clearance of not more than two inches (2 In) for upper half of casing. Taper off upper clearance to zero (0) at point where excavation conforms to contour of casing.

G. Excavation may extend beyond end of casing depending on character of material, but shall not exceed two feet (2 Ft). Decrease advance excavation at direction of the Project Manager, when character of material being excavated makes it desirable to keep advance excavation closer to end of casing.

H. Jack casing from low or downstream end. Lateral or vertical variation in final position of casing from line and grade as shown on the Drawings shall be permitted only to extent of one inch (1 In) in ten feet (10 Ft), provided such variation is regular and only in one (1) direction and that final grade of flow line is in direction indicated on the Drawings.

I. Use cutting edge of steel plate around head end of casing extending short distance beyond end of casing with inside angles or lugs to keep cutting edge from slipping back onto casing.

J. Once jacking of casing is begun, carry on without interruption, insofar as practicable, to prevent casing from becoming firmly set in embankment.

K. Remove and replace casing damaged in jacking operations.

L. Backfill pits or trenches excavated to facilitate jacking operations immediately after completion of jacking of casing.

M. Grout annular space between casing and excavated hole when loss of embankment occurs or when clearance of two inches (2 In) is exceeded. Grout as specified in Section 03105 – Grout.

3.10 SPACER INSTALLATION

A. There shall be no inadvertent metallic contact between casing and carrier pipe. Place spacers to ensure that carrier pipe is adequately supported throughout length, particularly at ends, to offset settling and possible electrical shorting unless otherwise approved by the Project Manager. Place end spacer within six inches (6 In) of end of casing pipe, regardless of size of casing and carrier pipe or type of spacer used. Spacing between spacers depends largely on load bearing capabilities of pipe coating and flexibility of pipe.

B. Grade bottom of trench adjacent to each end of casing to provide firm, uniform and continuous support for carrier pipe. When trench requires some backfill to establish final trench bottom grade, place backfill material in six inch (6 In) lifts and compact to density of undisturbed soil.

C. Install casing spacers in accordance with manufacturer's instructions. Take special care to ensure that sub-components are correctly assembled and evenly tightened and that no damage occurs during tightening of insulators or carrier pipe insertion.

D. Seal annulus between carrier pipe and casing with casing end seals at each end of casing.

E. Insulator Spacing:

1. Spacing shall be as shown on Drawing with maximum distance between spacers to be ten feet (10 Ft) for pipe sizes four inches (4 In) to fourteen inches (14 In) and eight feet (8 Ft) for pipe sizes sixteen inches (16 In) to thirty inches (30 In).

2. For ductile iron pipe or bell-and-spigot pipe, install spacers within one foot on each side of bell or flange and one (1) in center of joint when eighteen foot (18 Ft) to twenty foot (20 Ft) long joints are used.

3. If casing or carrier pipe is angled, bent or dented, reduce spacing as directed by the Project Manager. Provide casing with smooth, continuous interior surface.

3.11 SETTLEMENT MONITORING

A. Monitor ground surface elevation along length of augering operation. Locate and record settlement monitoring points with respect to construction baseline and elevations. Record elevations to accuracy of one hundredth feet (0.01 Ft) for each monitoring point location. Establish monitoring points at locations and by methods that protect them from damage by construction operations, tampering, or other external influences. As minimum, locate survey points as follows:

1. For road crossings: Centerline and each shoulder.

2. Railroads: Track subbase at centerline of each track.

3. Utilities and Pipelines: Directly above and ten feet (10 Ft) before and after utility or pipeline intersection.

4. Long bores under improved areas such as pavements: Ground surface elevations must be recorded on centerline ahead of augering operations at locations not to exceed fifty feet (50 Ft) apart (including points located for roads, railroads, utilities, and pipelines), or at least three (3) locations per augering drive.

B. Reading Frequency and Reporting. Take settlement survey readings:

1. Prior to auger excavation reaching point.

2. After auger reaches monitoring point in plan.

3. After grouting of ground supporting pipe or casing is complete.

C. Immediately report to the Project Manager movement, cracking, or settlement which is detected.

D. Following substantial completion but prior to final completion, make final survey of monitoring points.

3.12 DISPOSAL OF EXCESS MATERIAL

A. Remove and dispose of spoil from job site in accordance with Section 01580 – Waste Material Disposal.

END OF SECTION

SECTION 02275

PIPE AND CASING AUGERING FOR SANITARY SEWERS

PART I: GENERAL

1.1 GENERAL REQUIREMENTS

A. Installation of casing for sewer line pipe by dry augering or slurry boring methods, together with installation of sewer line pipe in casing.

B. Installation of sewer line pipe by slurry boring methods. Construction casing may be used at the Contractor's option.

1.2 MEASUREMENT AND PAYMENT

A. Unit Prices:

1. Casing, including sewer line pipe, installed by augering methods in mid-run of open cut segments where shown on the Drawings, shall be measured and paid by linear foot from end to end of casing. Casing may be installed, at the Contractor's option, at locations other than shown on the Drawings, at no additional cost to the City.

2. Sewer line pipe installed by augering method in mid-run of open-cut segments where shown on the Drawings, shall be measured and paid by linear foot from end to end of augered section.

3. Pipe or casing segments installed by augering methods in locations other than mid-run of open cut segments and shown on the Drawings, shall be measured and paid by linear foot along centerline of completed sewer line from centerline to centerline of manholes to ends of stubs or termination of pipe, and to inside face of lift stations and other structures.

4. Payment shall include and be full compensation for labor, equipment, materials and supervision for excavation and construction of sewer line, complete in place including disposal of excess materials, shoring, dewatering, utility adjustments, grouting, backfill, clean-up, and other related work necessary for construction as indicated on the Drawings and specified in this Section.

5. Cost for pits and other excavations are included in the unit price for pipe with or without casing.

6. Trench safety systems for pits are paid as specified in Section 02280 – Trench Safety Systems.

7. Refer to Section 01270 – Measurement and Payment for unit price procedures.

B. Stipulated Price (Lump Sum):

1. If Contract is Stipulated Price Contract, payment for work in this Section is included in Total Stipulated Price.

1.3 DEFINITIONS

A. Augering means either “dry augering” or “slurry augering”.

B. Dry augering is jacking casing while excavating soil at heading and transporting spoil back through casing by otherwise uncased auger.

C. Slurry Auger Method: Installation of casing or pipe by first drilling small diameter pilot hole from shaft to shaft, followed by removing excess soil and installing pipe or conduit by pull back or jacking method.

1.4 REFERENCE STANDARDS

A. AREMA – American Railway Engineering and Maintenance-of-Way Association.

1. American Railway Engineering and Maintenance-of-Way Association (AREMA) Manual for Railway Engineering.

B. AASHTO – American Association of State Highway and Transportation Officials.

C. CFTS – City of Friendswood Technical Specifications.

1. Section 01270 – Measurement and Payment.

2. Section 01330 – Submittal Procedures.

3. Section 01555 – Traffic Control and Regulation.

4. Section 01580 – Waste Material Disposal.

5. Section 01585 – Control of Ground and Surface Water.

6. Section 02100 – Clearing and Grubbing

7. Section 02250 – Steel Pipe and Fittings.

8. Section 02280 – Trench Safety Systems.

9. Section 02500 – Gravity Sanitary Sewers.

10. Section 02525 – Acceptance Testing of Gravity Sanitary Sewer.

11. Section 03105 – Grout.

1.5 REGULATORY REQUIREMENTS

A. Conform to Texas State Department of Transportation (TxDOT) for installations under state highways. The City shall obtain required permits for State Highway crossings on behalf of the Contractor.

B. Installations under Railroads:

1. The City shall obtain required permits for Railroad crossings, from affected railroad companies, on behalf of the Contractor.

2. Comply with requirements of right-of-entry for crossing Railroad Company's easement or right-of-way from railroad companies affected. Comply with railroad permit requirements.

3. Use dry auger method only.

4. Damages due to delays caused by railroad requesting work to be done at hours which shall not inconvenience railroad shall be at no additional cost to the City.

5. Maintain a minimum of thirty-five foot (35 Ft) clearance from centerline of tracks, to the closest edge of the bore pit, but in any case outside of the right-of-way unless otherwise permitted by the railroad.

6. At no time shall any equipment, excavations or materials be closer than thirty-five feet (35 Ft) from the centerline of tracks.

1.6 SUBMITTAL

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

B. For installation by augering, submit for review:

1. Description of mechanized excavating equipment.

2. Method of controlling line and grade.

3. Grouting techniques to be used for filling annular void between sewer line pipe and casing, and void between sewer line pipe or casing and ground, including equipment, pumping and injection procedures, pressure grout types, and mixes.

4. Locations and dimensions of pits.

5. Pit design and construction drawings.

6. Identification of casings required and paid under Contract and casings installed at the Contractor's option.

7. Design of casings.

8. Copy of railroad company permits and right-of-entry.

C. Prepare auger pit and casing design submittals that are site specific. Have auger pit and casing design submittals signed and sealed by a Professional Engineer licensed by the State of Texas.

D. Include in construction phase submittals:

1. Daily logs of augering and boring operations.

2. Settlement monitoring data to meet requirements of paragraph 3.8, Settlement Monitoring.

3. Submit daily logs and settlement monitoring data within five (5) days after day of observation.

1.7 CRITERIA FOR DETERMINING CASING INSTALLATION LOADS

A. Select and design casing pipe and pipe joints to carry thrust of jacks or loads due to pulling mechanism in combination with overburden, earth and hydrostatic loads. Select casings for dry augering to withstand action of auger without damage.

B. Use Professional Engineer licensed by the State of Texas to determine design stresses, design deflections and factors of safety for design of casing. Present such determination as part of design submittal. Apply the following maximum casing pipe stresses and deflections to casings shown on the Drawings:

1. Design stress in pipe wall: Fifty percent (50%) of minimum yield point of steel or eighteen thousand pounds per square inch (18000 psi), whichever is less, when subjected to applicable loading conditions.

2. Wall thickness: Maximum allowable deflection which does not exceed three percent (3%) of nominal casing diameter.

C. Use Cooper E-80 locomotive loading distributions as criteria for railroad crossings in accordance with AREMA specifications for culverts. In design, account for additive loadings due to multiple tracks.

D. Use H-20 vehicle loading distributions as criteria for truck loading in accordance with AASHTO.

E. When not specifically indicated on the Drawings, select casing diameter to permit practical installation (including skids when applicable) and grouting.

PART II: PRODUCTS

2.1 MATERIALS

A. Provide casing pipe which is straight, circular in section, uncoated, welded steel pipe, in accordance with Section 02250 – Steel Pipe and Fittings.

B. Provide sewer line pipe in accordance with Section 02500 – Gravity Sanitary Sewers. Do not use high density polyethylene pipe for augering.

C. Provide restrained-joint sewer line pipe when installing sewer line pipe in slurry bored holes by pullback method.

D. Supply grout as specified in Section 03105 – Grout.

PART III: EXECUTION

3.1 PREPARATION

A. Conform to applicable provisions of Section 02100 - Clearing and Grubbing.

B. Utility Relocations: Relocate utility lines clear of pit and zone of potential significant settlement or other ground disturbance.

C. Install casings as required by the Drawings, in accordance with this Section.

D. Install temporary solid plug at open end of water line to prevent contamination.

3.2 TRAFFIC CONTROL

A. Conform to applicable provisions of Section 01555 - Traffic Control and Regulation.

B. Secure right-of-entry for crossing Railroad Company's easement or right-of-way.

C. During construction operations, furnish and maintain barricades and lights to safeguard traffic and pedestrians, until such time as backfill has been completed and removed from site. Provide additional barricades and lights as directed by the Project Manager.

3.3 LOCATION AND SIZE OF AUGER PITS

A. Show location of auger pits on auger pit construction drawings. Locate auger pits for slurry boring so that distance between pits is no greater than eighty feet (80 Ft); and for dry augering not more than one hundred twenty feet (120 Ft) apart, except where larger distances are required by railroad permits or railroad rights-of-way.

B. Locate auger pits and associated work areas to avoid blocking driveways and cross streets and to minimize disruption to business and commercial interests. Avoid auger pit locations near areas identified as potentially contaminated.

C. Pit Size: Size pits to provide adequate room to meet operational requirements for auger construction as well as structures indicated on the Drawings. Provide minimum six inch (6 In) space between pipe and

walls of auger pit. Maximum allowable width of pit shall be five feet (5 Ft). Width of pit at surface shall not be less than at bottom. Maximum allowable length of pit shall be no more than five feet (5 Ft) longer than one (1) full section of pipe and shall not exceed twenty-five feet (25 Ft).

D. Excavate bore pits to finished grade at least six inches (6 In) lower than grade indicated by stakes.

E. Auger pits that are excavated and backfilled as part of open-cut water line construction shall be in accordance with Section 02125 - Excavation and Backfill for Utilities.

F. Provide and properly maintain safety protection against traffic and accidental or unauthorized entry. Provisions to include concrete traffic barriers or other suitable barriers around periphery of pit as appropriate. Fully cover and secure pits where no construction activity is in progress.

G. Install sheeting, lining, shoring and bracing required for protection of workmen and public in accordance with Section 02280 - Trench Safety Systems.

H. Provide full cover or other security fencing for each access pit in which there is no construction activity or which is unattended by the Contractor's personnel.

I. Provide groundwater control and drainage from pits while work is in progress and until pit is properly backfilled. Conform to requirements of Section 01585 - Control of Ground and Surface Water.

3.4 DRY AUGERING OF CASING

A. Provide jacks, mounted on frame or against backstop, of capacity suitable for forcing excavating auger and casing through soil conditions to be encountered. Operate jacks so that even pressure is applied to casing.

B. Provide steerable front section of casing to allow vertical grade adjustments. Provide water level or other means to allow monitoring of grade elevation of auger casing.

C. Bentonite slurry may be used to lubricate casing during installation. Use of water to facilitate removal of spoil is permitted; however, water jetting for excavation of soil is not allowed when jacking casing.

D. Tolerances from lines and grades shown on the Drawings for gravity sewer line pipe installed in casing are plus or minus six inches (±6 In) in

horizontal alignment, and plus or minus one and one-half inches (±1-1/2 In) in elevation.

3.5 SLURRY BORING OF CASING OR PIPE

A. Drill small diameter pilot hole and check for line and grade at receiving end. Redrill pilot hole when bored pipe does not meet specified tolerances.

B. Using pilot hole as guide bore larger diameter hole of sufficient size for pipe or casing installation. Water jetting is not permitted.

C. Bentonite slurry may be used to maintain stable hole and furnish lubrication for pipe or casing installation.

D. Tolerances from lines and grades shown on the Drawings for installed sewer line pipe are plus or minus six inches (±6 In) in horizontal alignment and plus or minus one and one-half inches (±1-1/2 In) in elevation.

E. Completely fill annular space between sewer line pipe and surrounding soil or casing with grout, without displacing pipe during grouting operation.

F. Do not discharge auguring liquid into operating storm sewer system. If water only, pump to adjacent ground area where sediment shall be filtered from the liquid by ground. If auguring liquid is Bentonite slurry, pump to tank or container, and dispose of off-site.

3.6 FILLING ANNULAR SPACE

A. Grout annular void between sewer line pipe and casing from end to end of casing. Block and brace sewer line pipe to prevent movement during grout placement and to maintain specified line and grade. Grout as specified in Section 03105 – Grout.

3.7 SPACER INSTALLATION

A. There shall be no inadvertent metallic contact between casing and carrier pipe. Place spacers to ensure that carrier pipe is adequately supported throughout length, particularly at ends, to offset settling and possible electrical shorting unless otherwise approved by the Project Manager. Place end spacer within six inches (6 In) of end of casing pipe, regardless of size of casing and carrier pipe or type of spacer used. Spacing between spacers depends largely on load bearing capabilities of pipe coating and flexibility of pipe.

B. Grade bottom of trench adjacent to each end of casing to provide firm, uniform and continuous support for carrier pipe. When trench requires some backfill to establish final trench bottom grade, place backfill material in six inch (6 In) lifts and compact to density of undisturbed soil.

C. Install casing spacers in accordance with manufacturer's instructions. Take special care to ensure that sub-components are correctly assembled and evenly tightened and that no damage occurs during tightening of insulators or carrier pipe insertion.

D. Seal annulus between carrier pipe and casing with casing end seals at each end of casing.

E. Insulator Spacing:

1. Spacing shall be as shown on Drawing with maximum distance between spacers to be ten feet (10 Ft) for pipe sizes four inches (4 In) to fourteen inches (14 In) and eight feet (8 In) for pipe sizes sixteen inches (16 In) to thirty inches (30 In).

2. For ductile iron pipe or bell-and-spigot pipe, install spacers within one foot on each side of bell or flange and one (1) in center of joint when eighteen feet (18 Ft) to twenty foot (20 Ft) long joints are used.

3. If casing or carrier pipe is angled, bent or dented, reduce spacing as directed by the Project Manager. Provide casing with smooth, continuous interior surface.

3.8 SETTLEMENT MONITORING

A. Monitor ground surface elevation along length of augering operation. Locate and record settlement monitoring points with respect to construction baseline and elevations. Record elevations to accuracy of 0.01 feet for each monitoring point location. Establish monitoring points at locations and by methods that protect them from damage by construction operations, tampering, or other external influences. As minimum, locate survey points as follows:

1. For road crossings: Centerline and each shoulder.

2. Railroads: Track subbase at centerline of each track.

3. Utilities and Pipelines: Directly above and ten feet (10 Ft) before and after utility or pipeline intersection.

4. Long bores under improved areas such as pavements: Ground surface elevations must be recorded on centerline ahead of augering operations at locations not to exceed fifty feet (50 Ft) apart (including points located for roads, railroads, utilities, and pipelines), or at least three (3) locations per augering drive.

B. Reading Frequency and Reporting. Take settlement survey readings:

1. Prior to auger excavation reaching point.

2. After auger reaches monitoring point in plan.

3. After grouting of ground supporting pipe or casing is complete.

C. Immediately report to the Project Manager movement, cracking, or settlement which is detected.

D. Following substantial completion but prior to final completion, make final survey of monitoring points.

3.9 DISPOSAL OF EXCESS MATERIAL

A. Remove and dispose of spoil from job site in accordance with Section 01580 – Waste Material Disposal.

3.10 LEAKAGE TESTING

A. Test sanitary sewers for leakage by low pressure air methods in accordance with Section 02525 – Acceptance Testing of Gravity Sanitary Sewer.

END OF SECTION

SECTION 02280

TRENCH SAFETY SYSTEMS

PART I: GENERAL

1.1 GENERAL REQUIREMENTS

A. Trench safety system for the construction of trench excavations.

B. Trench safety system for structural excavations which fall under provisions of State and Federal trench safety laws.

1.2 MEASUREMENT AND PAYMENT

A. UNIT PRICES:

1. Measurement for trench safety systems used on trench excavations is on a linear foot basis measured along the centerline of the trench, including manholes and other line structures.

2. No payment will be made for trench safety systems for structural excavations under this section. Include payment for trench safety system in applicable structure installation sections.

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

B. Stipulated Price (Lump Sum):

1. If Contract is Stipulated Price Contract, payment for work in this Section is included in Total Stipulated Price.

1.3 DEFINITIONS

A. A trench shall be defined as a narrow excavation (in relation to its depth) made below the surface of the ground at a minimum of five feet (5 Ft) in depth. In general, the depth is greater than the width, but the width of a trench (measured at the bottom) is not greater than fifteen feet (15 Ft).

B. The trench safety system requirements shall apply to larger open excavations if the erection of structures or other installations limits the

space between the excavation slope and these installations to dimensions equivalent of a trench as defined.

C. Trench Safety Systems include, but are not limited to, sloping, sheeting, trench boxes or trench shields, sheet piling, cribbing, bracing, shoring, dewatering or diversion of water to provide adequate drainage.

1.4 SUBMITTALS

A. Submittals shall conform to requirements of Section 01330 - Submittal Procedures.

B. Submit a safety program specifically for the construction of trench excavation. Design the trench safety program to be in accordance with OSHA 29CFR standards governing the presence and activities of individuals working in and around trench excavations.

C. Construction and shop drawings containing deviations from OSHA standards or special designs shall be sealed by a Professional Engineer licensed by the State of Texas retained and paid by the Contractor.

D. Review of the Contractor's safety program by the Project Manager shall only be in regard to compliance with this specification and shall not constitute approval by the Project Manager nor relieve the Contractor of obligations under State and Federal trench safety laws.

1.5 REGULATORY REQUIREMENTS

A. Install and maintain trench safety systems in accordance with the detail the Specifications set out in the provision of Excavations, Trenching, and Shoring, Federal Occupation Safety and Health Administration (OSHA) Standards, 29CFR, Part 1926, Subpart P, as amended, including Final Rule, published in the Federal Register Vol. 54, No. 209 on Tuesday, October 31, 1989. The sections that are incorporated into these specifications by reference include Sections 1926-650 through 1926-652.

B. A reproduction of the OSHA standards included in "Subpart P - Excavations" from the Federal Register Vol. 54, No. 209 is available upon request to the Contractors bidding on City projects. The City assumes no responsibility for the accuracy of the reproduction. The Contractor is responsible for obtaining a copy of this section of the Federal Register.

C. Legislation that has been enacted by the Texas Legislature with regard to Trench Safety Systems, is hereby incorporated, by reference, into

these specifications. Refer to Texas Health and Safety Code Ann., §756.022 (Vernon 1991).

D. Reference materials, if developed for a specific project, shall be issued with the Bid Documents, including the following:

1. Section 00200 - Geotechnical Information: information obtained for use in design of the trench safety system.

1.6 INDEMNIFICATION

A. The Contractor shall indemnify and hold harmless the City, its employees and agents, from any and all damages, costs (including, without limitation, legal fees, court costs, and the cost of investigation), judgments or claims by anyone for injury or death of persons resulting from the collapse or failure of trenches constructed under this Contract.

B. The Contractor acknowledges and agrees that this indemnity provision provides indemnity for the City in case the City is negligent either by act or omission in providing for trench safety, including, but not limited to safety program and design reviews, inspections, failures to issue stop work orders, and the hiring of the Contractor.

1.7 REFERENCED STANDARDS

A. CFCO – City of Friendswood Code of Ordinances.

1. Ordinance 70-114 – Trench Excavation Safety Compliance.

2. Ordinance 70-147 – Violation of Conditions; Revocation; Repair by the City.

3. Ordinance 70-148 – Surety Bond Required.

B. CFTS – City of Friendswood Technical Specifications.

1. Section 00200 – Geotechnical Information.

2. Section 01270 – Measurement and Payment.

3. Section 01330 – Submittal Procedures.

C. OSHA – Occupational Safety and Health Administration.

1. OSHA Standards, 29CFR, Part 1926, Subpart P.

2. Federal Register Vol. 54, No. 209.

D. Texas Health and Safety Code Ann., §756.022 (Vernon 1991).

PART II: PRODUCTS – Not Used

PART III: EXECUTION

3.1 INSTALLATION

A. Install and maintain trench safety systems in accordance with provisions of OSHA 29CFR.

B. Install specially designed trench safety systems in accordance with the Contractor's trench excavation safety program for the locations and conditions identified in the program.

C. A competent person, as identified in the Contractor's Trench Safety Program, shall verify that trench boxes and other premanufactured systems are certified for the actual installation conditions.

3.2 INSPECTION

A. The Contractor, or the Contractor's independently retained consultant, shall make daily inspections of the trench safety systems to ensure that the installed systems and operations meet OSHA 29CFR and other personnel protection regulations requirements.

B. If evidence of possible cave-ins or slides is apparent, the Contractor shall immediately stop work in the trench and move personnel to safe locations until the necessary precautions have been taken by the Contractor to safeguard personnel entering the trench.

C. Maintain a permanent record of daily inspections.

3.3 FIELD QUALITY CONTROL

A. The Contractor shall verify specific applicability of the selected or specially designed trench safety systems to each field condition encountered on the project.

B. The Project Manager, under written or oral authority of the Director or Deputy Director of Community Development shall stop work on portions of the Work where conditions, equipment or personnel put other personnel, the general public or adjacent property in danger of injury or damage. Work shall not resume until conditions have been remedied

and verified by the Project Manager.

END OF SECTION

SECTION 02285

CATHODIC PROTECTION

PART I: GENERAL

1.1 GENERAL REQUIREMENTS

A. Cathodic protection for metallic water mains, fittings and appurtenances.

B. Trenching, drilling, and other excavation.

C. Installation of anodes, cables, junction boxes and test stations.

D. Backfill and compaction of backfill.

E. Protective coating or wrap for metallic pipe, fittings, restraining devices, and appurtenances.

F. Dust alleviation and control.

G. Cleanup and restoration of surface in improved areas.

H. Supplying all labor, materials, equipment and apparatus not specifically mentioned herein or noted on the Drawings, but which are incidental and necessary to complete the Work specified.

I. All electrical equipment and materials and the design, construction and installation thereof shall comply with all applicable provisions of the National Electrical Code (NEC) and applicable local codes and regulations.

1.2 MEASUREMENT AND PAYMENT

A. UNIT PRICES:

1. Measurement for cathodic protection used is on a linear foot basis measured along the centerline of the pipe.

2. Refer to Section 01270 – Measurement and payment for unit price procedures.

B. Stipulated Price (Lump Sum):

1. If Contract is Stipulated Price Contract, payment for work in this

Section is included in Total Stipulated Price.

1.3 REFERENCES

A. AASSHTO – American Association of State Highway and Transportation Officials.

1. H20 – Specification for Highway Bridges.

B. ASTM – American Society for Testing and Materials.

1. B3 – Standard Specification for Soft or Annealed Copper Wire.

2. B8 – Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.

3. B418 – Standard Specification for Cast and Wrought Galvanic Zinc Anodes.

4. C94 – Standard Specification for Ready-Mixed Concrete.

5. D1248 – Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable.

6. D2220 – Standard Specification for Polyvinyl Chloride (PVC) Insulation for Cable and Wire.

C. AWWA – American Water Works Association.

1. C213 – Fusion Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.

2. C550 – Protective Epoxy Interior Coatings for Valves and Hydrants.

D. CFTS – City of Friendswood Technical Specifications.

1. Section 01270 – Measurement and payment for unit price procedures.

2. Section 01330 – Submittal procedures.

3. Section 02125 – Excavation and Backfill for Utilities.

E. IEEE – Institute of Electrical and Electronic Engineers.

F. IPCEA – Insulated Power Cable Engineers Association.

G. NACE – National Association of Corrosion Engineers.

1. RP0169 – Recommended Practice, Control of External Corrosion on Underground or Submerged Metallic Piping Systems.

2. RP0286 – Electrical Insulation of Cathodically Protected Pipelines.

3. RP0375 – Wax Coating Systems for Underground Piping Systems.

4. TM0497 – Measurement Techniques Related to Criteria for Cathodic Protection on Underground or Submerged Metallic Piping System.

H. NEMA – National Electrical Manufacturers Association.

I. OSHA – Occupational Safety and Health Administration.

1.4 SUBMITTALS

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

B. Submit shop drawings and certification signed and sealed by a Professional Engineer registered in the State of Texas.

C. A complete list of cathodic protection equipment and material, including name and manufacturer, catalog number, size, finish and any other pertinent data necessary for proper identification and to establish conformance with these Technical Specifications.

D. The submitted data shall be marked with a clear indication of the Contractor's choice of the specific item or items, or class of items proposed, in order to establish written record of the Contractor's intent. A list of items indicating "as specified" shall not suffice.

1.5 QUALITY ASSURANCE

A. Cathodic protection components shall be new, of the highest quality, and standard products from a manufacturer regularly engaged in the production of such material or equipment. Bring all cathodic protection materials to the job site in original sealed containers. Cathodic protection components shall be subject to testing to ensure proper installation and operation. The Contractor shall correct all deficiencies and perform any required re-testing.

B. Brands or trade names are mentioned in these Technical Specifications to set standards of quality; use no substitute materials unless approved by the Project Manager in writing. Approval of substitute materials does not relieve the Contractor of responsibility for providing a workable and functioning system as designed.

PART II: PRODUCTS

2.1 ZINC GALVANIC ANODES

A. Galvanic anodes shall be zinc anodes having a Type II chemical composition conforming to the requirements of ASTM B418. Bare anode weight shall be as indicated on the Project Detail Sheets.

B. Anodes shall be cast with a galvanized steel core strap. One (1) end of the anode shall be recessed to provide access to the rod for connection of the lead wire. The lead wire shall be silver brazed to the rod, making a mechanically secure connection. The connection shall be insulated to a six hundred volt (600 V) rating by filling the recess with asphalt. The asphalt material shall be extended over the lead wire insulation by not less than one-half inch (1/2 In). The Contractor shall repair all damaged lead wire insulation as directed.

C. The entire soldered connection and core shall be sealed with epoxy. The zinc anode shall be prepackaged in a cloth bag containing a low resistivity backfill consisting of seventy-five percent (75%) hydrated gypsum, twenty percent (20%) bentonite and five percent (5%) sodium sulfate.

2.2 WIRE

A. Wires utilized for test stations shall be solid single conductor copper wire Type THHN insulation, No.10 AWG, as shown.

B. Wires for joint bonds shall be stranded single conductor copper wire Type HMW/PE insulation No. 8 AWG. Two (2) joint bonds shall be used for each joint.

C. All wire test leads and anode leads shall extend a minimum of eighteen inches (18 In) above grade after connection to the test station panel board.

2.3 PANEL BOARDS

A. Test station panel boards shall be made of four inch by four inch by one-fourth inch (4 In x 4 In x 1/4 In) fabric reinforced Micarta. Double-nutted nickel plated brass studs shall be installed on the panel boards

as shown on the Drawings. Tinned copper ring terminals shall be soldered to the ends of all wires terminated in the test station.

2.4 SHUNTS

A. Shunts for all sacrificial anode test stations shall be one hundredth ohm (0.01 Ω), six ampere (6 A) capacity, manganin wire type.

2.5 EXOTHERMIC WELD EQUIPMENT

A. Cable connections to pipe and fittings shall be made with exothermic weld kits specifically designed by the manufacturer for welding the types of materials and shapes indicated by each installation unless otherwise specified on the Drawings. Connections to ductile iron and cast iron pipe or fittings shall use the weld metal and mold for exothermic connections to cast iron pipe. The mold and weld metal shall be supplied by the same manufacturer. Weld metal shall be Type XF manufactured by Erico, Inc. or approved equal.

B. Exothermic weld equipment shall be as manufactured by "Cadweld" Erico Products, "Thermoweld" Continental Industries, Inc., or approved equal.

C. All welds shall be made utilizing copper wire sleeves and individual components shall not be interchanged between different manufacturers.

2.6 BITUMASTIC COATING

A. Bitumastic Coating shall be TC Mastic, as manufactured by Tapecoat Company; Bitumastic 50, as manufactured by Koppers Company, Inc., or an approved equal.

2.7 INSULATING FLANGE

A. Insulating flange gaskets shall be Neoprene-faced phenolic, suitable for the Work as indicated on the details shown on the Drawings. Sleeves shall be full length and of a material indicated by the manufacturer as suitable for domestic water. Flange bolts, nuts and washers shall be stainless steel and shall fit within the bolt facing of the flange.

B. Contractor shall provide two (2) sets of insulating washers which are one-eighth inch (1/8 In) thick laminated phenolic. Insulating washers shall fit within the bolt facing the flange over the outside diameter of the sleeve.

C. Insulating sleeves shall be spiral wound Mylar, one-thirty-second inch (1/32 In) thick.

D. Underground dielectric insulating flanges shall be covered with petrolatum wax tape.

2.8 PETROLATUM WAX TAPE SYSTEM (FOR ISOLATED FITTINGS AND ALL RESTRAINING DEVICES)

A. Petrolatum wax tape system for coating buried insulating flanges shall be Trenton Primer and #1 Wax-tape, as manufactured by Trenton Corp., or Denso Paste and Densyl Tape by Denso North America, Inc., or approved equivalent.

B. Petroleum Tape System Primer: Saturated petroleum hydrocarbon, non-drying, non-hardening.

C. Mastic: Saturated petroleum hydrocarbon, non-hardening, self-supporting compound.

D. Tape: Non-woven synthetic fabric, fully impregnated and coated with neutral petroleum-based compound.

E. Overwrap: Plasticized PVC tape with natural and synthetic rubber adhesive.

2.9 TEST STATION BOX

A. The traffic valve box for test stations shall be an H10 rated, G5 Utility Box as manufactured by Christy Concrete Products, Inc., or approved equal.

B. The traffic box covers for insulating test stations shall be cast iron with the legend "ANODE" as indicated on the Drawings.

2.10 COATING AND LINING

A. All cast-iron and steel valves, burys, spool pieces, flanged adapters, reducers, tees, crosses and other buried, ferrous metallic fittings, shall require a fusion epoxy coating and lining prepared from a one hundred percent (100%) dry epoxy resin applied by either the fluidizing bed method or electrostatically, in accordance with AWWA C213 for fittings and with AWWA C550 for valves. The minimum coating thickness shall be eight (8) mils and the maximum coating thickness shall be twenty-four (24) mils.

B. For valves, lining materials shall not be applied to valve stems, valve discs or parallel disc seats. Lining materials shall not be built up in thickness so as to interfere with joint assembly or with operation of the

valve being epoxy lined, and in any case, should not be greater than twelve (12) mils.

C. Inspection shall be carried out to determine the dry film thickness of the coating and or lining of each fitting. Any fitting not meeting this specification shall be replaced.

D. Holidays in the protective coating shall be repaired in the field as directed.

PART III: EXECUTION

3.1 EXCAVATION AND BACKFILL

A. Refer to Section 02125 – Excavation and Backfill for Utilities.

3.2 FOREIGN STRUCTURE INTERFERENCE

A. Prevent electrical contact between the metallic pipe and/or fittings being cathodically protected and other existing buried metal structures at the time of the installation of the cathodic protection system. Where necessary, or required by the Project Manager, the Contractor shall install appropriately sized micarta sheeting, one-fourth inch (1/4 In) in thickness between the two (2) metallic surfaces.

3.3 INSULATED FLANGED JOINTS

A. Insulating components of each insulation flange kit shall be cleaned of all dirt, grease, oil, and other foreign materials immediately prior to assembly. Bolt holes in mating flanges shall be properly aligned at the time bolts and insulating sleeves are inserted to prevent damage to the insulation. After flange bolts have been tightened, each insulating washer shall be inspected and replaced by the Contractor if cracked or other damaged.

B. Install insulated flanged joints at flanges connecting above-ground installations, and at other locations shown on the Drawings.

3.4 JOINT BONDING

A. For metallic pipe, joint bond all non-welded rubber gasket joints, mechanical joints, and fusion epoxy coated flanged joints as indicated on the details shown on the Drawings to provide electrical continuity between all metallic sections of the facility to be protected.

B. All buried fusion-bonded epoxy coated pipe fittings shall be bonded for continuity. Joint bonds, for fusion-bonded epoxy coated pipe fittings

shall be installed with a wire loop extended above the bonded joint. The overall length of the conductor shall permit sufficient flexibility of each fitting across the joint without transferring any tensile stress to the bond cable. Cable to fitting connections shall be in conformance with these specifications. Coat all exposed surfaces of each fitting with liquid epoxy patch kit, as supplied by the pipe coating manufacturer.

3.5 EXOTHERMIC WELDS

A. Exothermic weld connections shall be installed in the manner and at the locations shown on the Drawings. Coating materials shall be removed from the surface over an area just sufficient to make the connection. The steel surface shall be cleaned to white metal by grinding or filing prior to welding the conductor. Resin impregnated grinding wheels shall not be allowed.

B. No connections to the structures or piping shall be buried until the Project Manager has inspected the connections and given permission to backfill. Connections made in violation of this provision shall be rejected.

C. Exothermic welds shall be tested by the Contractor for adherence to the pipe and for electrical continuity between the pipe and wires.

D. A twenty-two ounce (22 Oz) hammer shall be used for testing adherence by striking a blow to the weld. Take care to avoid hitting the wires.

E. After welding, coat all bonds with Bitumastic coating as directed. Protect all exposed wires and welds with Royston Handy Cap, or equal.

3.6 WIRES

A. Wires buried in the ground shall be laid straight, without kinks, and provide a minimum cover of twenty-four inches (24 In). Keep the bottom of the finished trench free from stones, roots or other materials that might injure the insulation of the conductors.

B. Each cable run shall be continuous in length and free of joints or splices, unless otherwise specified or shown on the Drawings. Care shall be used during installation to avoid punctures, cuts and similar damage to the insulation. Any damage to insulation shall require replacement of the entire cable length by Contractor. Copper ring terminals shall be crimped and soldered to the ends of the test leads, drain wires and anode leads terminated in the test station.

C. At least eighteen inches (18 In) of slack shall be left for each conductor

at each test station housing. Slack shall be that amount of wire which, when the cover is removed and the wire extended, protrudes beyond the opening of the box or enclosure. No wire bend shall have a radius of less than eight (8) times the diameter of that wire. Copper terminal rings sized for wire and stud shall be used to make all wire connections to terminal studs.

3.7 GALVANIC ZINC ANODES

A. Excavate a hole to a minimum of three inches (3 In) larger than the packaged sacrificial anode diameter, and to a depth one foot (1 Ft) below the fittings to be protected. Excavate the lead wire trench to the depth indicated on the details shown on the Drawings, and backfill in conformance with these Technical Specifications.

B. Exercise care to preclude damaging the cloth bag and lead wire insulation on the sacrificial anode. Do not lift or support anode by the lead wire. Plastic or paper bags shall be removed from the anode before lowering into the hole.

3.8 PETROLATUM WAX TAPE

A. Install per manufacturer's instructions.

B. Wire brush dirt and loose rust from substrate, apply primer by brush and work in to obtain a full film cover on substrate.

C. Install mastic to contour all sharp edges and irregular profiles.

D. Spirally apply tape with minimum fifty-five percent (55%) overlay smooth tape to exclude voids and seal overlaps.

3.9 ANODE TEST STATION

A. Anode test stations shall be installed at the locations shown or called for on the Drawings. Two (2) test leads shall be connected at the nearest pipe joint to the test station.

B. All connections of test lead wires to metal surfaces at the point of connection shall be cleaned by grinding or filing prior to welding the conductor. Cover finished connections with bitumastic.

C. Anode test station boxes shall be installed using a concrete collar satisfactory to prevent settlement. Set this concrete collar level and flush with the top of curb or finish grade.

D. No more than one (1) test station is allowed in each test station box.

3.10 SYSTEM TESTING

A. System testing shall be performed by the Project Manager, a Professional Engineer Licensed by the State of Texas or a qualified testing firm.

B. After installation of the sacrificial anode system, testing shall be conducted to verify proper operation of the cathodic protection system. This testing shall include, and not be limited to the following: bond continuity tests, sacrificial anode current output, pipe-to-soil potentials and other tests deemed necessary to verify proper operation of the systems.

C. Upon completion of testing, a detailed written report shall be submitted to the Contractor describing any deficiencies detected. All such deficiencies shall be corrected by the Contractor at no cost to the City.

D. Upon completion of any corrections or repairs, the system shall be re-tested.

END OF SECTION