SECTION 02400
WATER LINES

PART I: GENERAL

1.1 GENERAL REQUIREMENTS

A. Installation of water lines.

B. Technical Specifications identify requirements for both small diameter water lines and large diameter water lines. When Technical Specifications for large diameter water lines differ from those for small diameter water lines, large diameter Technical Specifications shall govern for large diameter pipe.

1.2 MEASUREMENT AND PAYMENT

A. Unit Prices:

1. Payment for water lines installed by open-cut, augered with or without casing, aerial crossing and pipe offset section or within limits of Potentially Petroleum Contaminated Area (PPCA) is on linear foot basis for each size of pipe installed. Separate pay items are used for each type of installation.
   a. Mains: Measure along axis of pipe and include fittings and valves.
   b. Branch Pipe: Measure from axis of water line to end of branch.
2. Payment for interconnection is on lump sum basis for each interconnection identified on the Drawings. Payment shall include tapping sleeve and valves piping, connections and other related work necessary for construction as shown on the Drawings or specified herein.
3. Payment for removal of existing internal elliptical or dished head plug is on unit price basis for each internal elliptical or dished head plug removed. Payment shall include deletion of plug, drainage or dewatering of water lines, repair of damaged linings, rechlorination and items incidental to operation.
4. Payment for plug and clamp is on a unit price basis for each size of pipe.
5. Payment for drainline connection with service manhole is on unit price basis for each drainline shown on drawings. Payment includes valve, access manhole and connection.
6. Payment for cylindrical corrosion barriers is on a unit price basis for each pipe fitting installed with one or more barriers.
7. When directed by the Project Manager to install extra fittings as required to avoid unforeseen obstacles, payment shall be based on the following:

a. Each extra fitting requested by the Project Manager and

delivered to jobsite shall be paid according to unit price bid for "Extra Fittings in Place."

b. Payment shall include and be full compensation for items necessary for installation and operation of water line.

8. 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 A21.11/AWWA C111 – Standard for Rubber-Gasket Joints for Ductile – Iron Pressure Pipe and Fittings.
2. ANSI/NSF Standard 61 – Drinking Water System -Health Components.

B. ASTM – American Society for Testing and Materials.

1. ASTM A36 – Standard Specification for Carbon Structural Steel.
2. ASTM A126 – Standard Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
3. ASTM A536 – Standard Specification for Ductile Iron Castings.
4. ASTM B21 – Standard Specification for Naval Brass Rod, Bar and Shapes.
5. ASTM B98 – Standard Specification for Copper-Silicon Alloy Rod, Bar and Shapes.
6. ASTM B301 – Standard Specification for Free-Cutting Copper Rod and Bar.
7. ASTM B584 – Standard Specification for Copper Alloy Sand Casting for General Application.
8. ASTM E165 – Standard Test Method for Liquid Penetrant Examination.
9. ASTM E709 – Standard Guide for Magnetic Particle Examination.
10. ASTM F1674 – Standard Test Method for Joint Restraint Products for Use with PVC Pipe.

C. 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 Inches through 144 Inches.
3. AWWA C508 – Standard for Swing-Check Valves for Waterworks Service, 2 IN. through 24 IN. NPS.

D. CFTS – City of Friendswood Technical Specifications.

1.4 SUBMITTALS

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

B. Conform to submittal requirements of applicable Section for type of pipe used.
C. Photographs: Submit photographs conforming to requirements of Section 01320 – Construction Photographs prior to commencement of construction.
D. Submit One Call notification transmittal number(s) prior to beginning excavation.
E. Submit, a minimum of fifteen days (15 D) before beginning pipe laying operations, layout drawing(s) identifying proposed sections for hydrostatic testing (not to exceed four thousand linear feet (4000 LF) per section), disinfecting, and site restoration for entire project for review and approval.

PART II: PRODUCTS

2.1 PIPE MATERIALS

A. Install pipe materials which conform to following:
1. Section 02215 – Ductile Iron Pipe (DIP) and Fittings.
2. Section 02250 – Steel Pipe and Fittings. Water line piping within plant site and aerial crossings to be welded joint steel pipe with flange or approved restraint joint connections, unless otherwise shown on the Drawings.
3. Section 02235 – Polyvinyl Chloride Pipe (PVC).
4. Section 02225 – Prestressed Concrete Cylinder Pipe (PCCP).
5. Section 02255 – Steel Pipe and Fittings for Large Diameter Water Lines.
6. Section 02200 – Bar Wrapped Steel Cylinder Pipe.

B. Conform to American National Standards Institute/National Sanitation Foundation (ANSI/NSF) Standard 61 and have certified by an organization accredited by ANSI.
C. Type of pipe materials used is Contractor's option unless specifically identified on the Drawings.
D. Provide minimum of three-eighths inch (3/8 In) inside joint recess between ends of pipe in straight pipe sections.

2.2 WELDED JOINT PROTECTION FITTING FOR SMALL DIAMETER STEEL PIPE

A. Cylindrical Corrosion Barrier: Provide approved cylindrical corrosion barrier.
B. O-rings: Conform to National Sanitary Foundation requirements.

2.3 RESTRAINED JOINTS

A. Ductile Iron Pipe (DIP): See Section 02215 – Ductile Iron Pipe (DIP) and Fittings.
B. PVC Pipe: See Section 02235 – Polyvinyl Chloride Pipe (PVC). Perform hydrostatic testing in accordance with ASTM F1674.

C. Prestressed Concrete Cylinder Pipe (PCCP), Bar-Wrapped Pipe and Steel Pipe: Welded joints (see Paragraph 3.6 D).
D. Restrained Joints where required on DIP and PVC pipe:
   1. Restraint devices: Manufacture of high strength ductile iron, ASTM A536 up to twenty-four inches (24 In) and ASTM A36 for sizes greater than thirty inches (30 In). Working pressure rating twice that of design test pressure.
   2. Bolts and connecting hardware: High strength low alloy material in accordance with ANSI A21.11/AWWA C111.

2.4 COUPLINGS AND APPURTENANCES FOR LARGE DIAMETER WATERLINE
A. Flexible (Dresser-type) Couplings.
   1. Install where shown on the Drawings or where allowed by the Project Manager for the Contractor's convenience. Use galvanized flexible couplings when installed on galvanized pipe which is cement lined or when underground. Provide gaskets manufactured from Neoprene or Buna-N.
   2. For steel pipe; provide approved sleeve-type flexible couplings. Thickness of middle ring equal to or greater than thickness of pipe wall.
   3. Provide approved flanged adapter couplings for steel pipe.
   4. Use Type 316 stainless steel bolts, nuts and washers where flexible couplings are installed underground. Coat entire coupling with twenty (20) mil of approved coal tar coating.
B. Flap Valves: Provide approved flap valves on discharge of manhole drainline as shown on the Drawings.
   1. Body and Flap: ASTM A126-B cast iron.
   2. Seats: ASTM B21-CA482 or ASTM B301-CA145 bronze.
   3. Resilient Seat: AWWA C508.
   4. Hinge Arms: ASTM B584-CA865 high tensile bronze.
   5. Hinge pins: ASTM B98-CA655 silicon bronze.

PART III: EXECUTION

3.1 PREPARATION
A. Conform to applicable installation Technical Specifications for types of pipe used.
B. Employ workmen who are skilled and experienced in laying pipe of type and joint configuration being furnished. Provide watertight pipe and pipe joints.
C. Lay pipe to lines and grades shown on the Drawings.

D. Confirm that nine feet (9 Ft) minimum separation from gravity sanitary sewers and manholes or separation of four feet (4 Ft) minimum from force mains as specified in this Section in all directions unless a special design is provided on the Drawings.
E. Where above clearances cannot be attained and a special design has not been provided on the Drawings, obtain direction from the Project Manager before proceeding with construction.
F. Inform the Project Manager if unmetered sprinkler or fire line connections exist which are not shown on the Drawings. Make transfer to new lines only after approval by the Project Manager.
G. For projects involving multiple subdivisions or locations, limit water line installation to maximum of two (2) project site locations. Maximizing two (2) pipe installation crews shall be permitted, unless otherwise approved by the Project Manager.
H. The City of Friendswood Public Works Department shall handle, at no cost to the Contractor, operations involving opening and closing valves for wet connections and for chlorination. The Contractor is responsible for handling necessary installations and removal of chlorination and testing taps and risers.
I. If asbestos-cement (A.C.) pipe is encountered, follow safety practices outlined in American Water Works Association's publication, "Work Practices for A/C Pipe". Strictly adhere to "recommended practices" contained in this publication and make them "mandatory practices" for this Project.
J. For pipe diameters thirty-six inches (36 In) and greater, clearly mark each section of pipe and fitting with unique designation on inside of pipe along with pressure class. Locate unique identifying mark minimum of five feet (5 Ft) away from either end of each section of pipe. Provide one (1) unique identifying mark in middle of each fitting. Place markings at consistent locations. Use permanent black paint and minimum letter height of four inches (4 In) to mark designations.
K. The Contractor is responsible for assuring chosen manufacturer fulfills requirements for extra fittings and, therefore, is responsible for costs due to downtime if requirements are not met by the manufacturer.
L. Do not remove plugs or clamps during months of peak water demands; June, July and August, unless otherwise approved by the Project Manager.

3.2 HANDLING, CLEANING AND INSPECTION

A. Handling:
1. Place pipe along project site where storm water or other water shall not enter or pass through pipe.
2. Load, transport, unload and otherwise handle pipe and fittings to prevent damage of any kind. Handle and transport pipe with equipment designed, constructed and arranged to prevent damage to pipe, lining and coating. Do not permit bare chains,

hooks, metal bars or narrow skids or cradles to come in contact with coatings. Where required, provide pipe fittings with sufficient interior strutting or cross bracing to prevent deflection under their own weight.

3. Hoist pipe from trench side into trench by means of sling of smooth steel cable, canvas, leather, nylon or similar material.
4. For large diameter water lines, handle pipe only by means of sling of canvas, leather, nylon or similar material. Sling shall be minimum thirty-six inches (36 In) in width. Do not tear or wrinkle tape layers.
5. Use precautions to prevent injury to pipe, protective linings and coatings.
    a. Package stacked pipe on timbers. Place protective pads under banding straps at time of packaging.
    b. Pad fork trucks with carpet or other suitable material. Use nylon straps around pipe for lift when relocating pipe with crane or backhoe.
    c. Do not lift pipe using hooks at each end of pipe.
    d. Do not place debris, tools, clothing or other materials in pipe.
    e. Do not drop pipe into trench deeper than two feet (2 Ft). Any pipe that has been dropped shall be marked with an "X" and shall not be used.
6. Repair damage to pipe or protective lining and coating before final acceptance.
7. For cement mortar line and coated steel pipe and PCCP, permit no visible cracks longer than six inches (6 In), measured within fifteen degrees (15°) of line parallel to pipe longitudinal axis of finished pipe, except:
    a. In surface laitance of centrifugally cast concrete.
    b. In sections of pipe with steel reinforcing collars or wrappers.
    c. Within twelve inches (12 In) of pipe ends.
8. Reject pipe with visible cracks (not meeting exceptions) and remove from project site.

B. Cleaning: Thoroughly clean and dry interior of pipe and fittings of foreign matter before installation and keep interior clean until the Work has been accepted. Keep joint contact surfaces clean until jointing is completed. Do not place debris, tools, clothing or other materials in pipe. After pipe laying and joining operations are completed, clean inside of pipe and remove any debris.

C. Inspection: Before installation, inspect each pipe and fitting for defects. Reject defective, damaged or unsound pipe and fittings and remove them from site.

3.3 EARTHWORK

A. Conform to applicable provisions of Section 02125 – Excavation and Backfilling for Utilities and Section 02270 – Augering for Water Pipe and Conduit.

B. Bedding: Use bedding materials in conformance with Section 02140 – Utility Backfill Materials.

C. Backfill: Use bank run sand or earth or native soil as specified in Section 02140 – Utility Backfill Materials. Backfill excavated areas in same day excavated. When not possible, cover excavated areas using steel plates on paved areas and other protective measures elsewhere.

D. Place material in uniform layers of prescribed maximum loose thickness and wet or dry material to approximately optimum moisture content. Compact to prescribed density. Water tamping or jetting is not allowed.

E. Pipe Embedment: Including six (6) inch pipe bedding and backfill to twelve inches (12 In) above top of pipe.

3.4 PIPE CUTTING

A. Cut pipe twelve inches (12 In) and smaller with standard wheel pipe cutters. Cut pipe larger than twelve inches (12 In) in manner approved by the Project Manager. Make cuts smooth and at right angles to axis of pipe. Bevel plain end with heavy file or grinder to remove sharp edges.

3.5 PIPING INSTALLATION

A. General Requirements:

1. Lay pipe in subgrade free of water.
2. Make adjustments of pipe to line and grade by scraping away subgrade or filling in with granular material.
3. Properly form bedding to fully support bell without wedging or blocking up bell.
4. Open Cut Construction: Keep pipe trenches free of water which might impair pipe laying operations. Grade pipe to provide uniform support along bottom of pipe. Excavate for bell holes after bottom has been graded and in advance of placing pipe. Lay not more than nominal city block length of not more than three hundred feet (300 Ft) of pipe in trench ahead of backfilling operations. Cover or backfill laid pipe if pipe laying operations are interrupted and during non-working hours. Place backfill carefully and simultaneously on each side of pipe to avoid lateral displacement of pipe and damage to joints. If adjustment of pipe is required after it has been laid, remove and re-lay as new pipe.

B. Install pipe continuously and uninterrupted along each street on which the Work is to be performed. Obtain approval of the Project Manager prior to skipping any portion of the Work.

C. Protection of Pipeline: Securely place stoppers or bulkheads in openings and in end of line when construction is stopped temporarily and at end of each day's work.

D. Perform Critical Location as shown on the Drawings. Refer to Section 02125 – Excavation and Backfill for Utilities for additional requirements at critical locations.

E. Laying Large Diameter Water Line:
   1. Lay not more than fifty feet (50 Ft) of pipe in trench ahead of backfilling operations.
   2. Dig trench to proper width as shown on the Drawings. When trench width below top of pipe becomes four feet (4 Ft) wider than specified, install higher class of pipe or improved bedding, as determined by the Project Manager. No additional payment shall be made for higher class of pipe or improved bedding.
   3. Use adequate surveying methods and equipment; employ personnel competent in use of this equipment. Horizontal and vertical deviations from alignment as indicated on the Drawings shall not exceed one-tenth foot (0.10 Ft). Measure and record "as-built" horizontal alignment and vertical grade at maximum of every one hundred feet (100 Ft) on record drawings.
   4. Prevent damage to coating when placing backfill. Use backfill material free of large rocks or stones or other material which could damage coatings.
   5. Before assembling couplings, lightly coat pipe ends and outside of gaskets with cup grease or liquid vegetable soap to facilitate installation.
   6. Prior to proceeding with critical tie-ins submit sequence of work based on findings from "critical location" effort.

F. Perform following additional procedures when working on plant sites.
   1. Seventy-two hours (72 Hrs) prior to each plant shut down or connection, schedule coordination meeting with the Project Manager and Water Production personnel. At this meeting, present proposed sequencing of the Work and verification of readiness to complete the Work as required and within time permitted. Do not proceed with the Work until the Project Manager agrees key personnel, equipment and materials are on hand to complete the Work.
   2. Prior to fully excavating around existing piping, excavate as minimal as possible to confirm type and condition of existing joints. Verify size, type and condition of pipe prior to ordering materials or fully mobilizing for the Work.
   3. Do not proceed with connections to existing piping and identified critical stages of work unless approved by the Project Manager and the City's Utilities Superintendent is present to observe.
   4. Coordinate with the City's Utilities Superintendent to obtain reduction in operating pressures prior to performing connections to existing piping.
   5. Make connections to existing piping only when two (2) valves are closed off between connection and source of water pressure. Do

not make connection relying solely on one (1) valve being closed, unless otherwise approved by the Project Manager.

6. Perform critical stages of the Work identified on the Drawings at night or during low water demand months as specified in Section 01110 – Summary of Work.
7. Excavation equipment used on plant sites to have smooth bucket; no teeth or side cutters.
8. Submit to the Project Manager One Call Notification transmittal number prior to beginning excavation.
9. Before each "dig" with mechanical excavator, probe ground to determine potential obstructions. Repeat procedure until existing pipe is located or excavation reaches desired elevation. Perform excavations within one foot (1 Ft) of existing piping by hand methods.
10. Provide adequate notice to pipe manufacture's representative when connecting or modifying existing Prestressed Concrete Cylinder Pipe (PCCP).
11. Provide field surveyed (horizontal and vertical elevations) "as-builts" of new construction and existing underground utilities encountered. Submit in accordance with Section 01330 – Submittal Procedures.
12. Prior to performing plant work to be done on weekend, provide list of sites and contact person with phone numbers to the Project Manager by noon on each Thursday of week when such work is contemplated. Contact person must be accessible during weekend, have local Metro Area phone number and be authorized to make emergency decisions.
13. No night work or plant shut down shall be scheduled to begin two (2) working days before or after designated City holidays.

G. For tie-ins to existing water lines, provide necessary material on hand to facilitate connection prior to shutting down existing water line. Provide the City a minimum of seventy-two hours (72 Hrs) notice prior to shutting down existing water line.

1. Any work that has not been scheduled seventy-two hours (72 Hrs) before work is to commence, with the exception of emergency operations, shall not be allowed to start.

3.6 JOINTS AND JOINTING

A. Rubber Gasketed Bell-and-Spigot Joints for Prestressed Concrete Cylinder Pipe (PCCP), Bar Wrapped Pipe PVC, Steel and DIP:

1. After rubber gasket is placed in spigot groove of pipe, equalize rubber gasket cross section by inserting tool or bar recommended by manufacturer under rubber gasket and moving it around periphery of pipe spigot.
2. Lubricate gaskets with nontoxic water-soluble lubricant before pipe units are joined.

3. Fit pipe units together in manner to avoid twisting or otherwise displacing or damaging rubber gasket.
4. After pipe sections are joined, check gaskets to ensure that no displacement of gasket has occurred. If displacement has occurred, remove pipe section and remake joint as for new pipe. Remove old gasket, inspect for damage and replace if necessary before remaking joint.
5. Where preventing movement of sixteen inch (16 In) diameter or greater pipe is necessary due to thrust, use restrained joints as shown on the Drawings.
    a. Include buoyancy conditions for soil unit weight when computing thrust restraint calculations.
    b. Do not include passive resistance of soil in thrust restraint calculations.
6. Except for PVC pipe, provide means to prevent full engagement of spigot into bell as shown on the Drawings. Means may consist of wedges or other types of stops as approved by the Project Manager.

B. Flanged Joints where required on Prestressed Concrete Cylinder Pipe (PCCP), Bar Wrapped Pipe, Ductile Iron Pipe (DIP) or Steel Pipe:
1. AWWA C207. Prior to installation of bolts, accurately center and align flanged joints to prevent mechanical prestressing of flanges, pipe and equipment. Align bolt holes to straddle vertical, horizontal or north-south center line. Do not exceed three sixty-fourths inch per foot (3/64 In/Ft) inclination of flange face from true alignment.
2. Use full-face gaskets for flanged joints. Provide one-eighth inch (1/8 In) thick cloth inserted rubber gasket material. Cut gaskets at factory to proper dimensions.
3. Use galvanized or black nuts and bolts to match flange material. Use cadmium plated steel nuts and bolts underground. Tighten bolts progressively to prevent unbalanced stress. Maintain at all times approximately same distance between two (2) flanges at points around flanges. Tighten bolts alternately one hundred eighty degrees (180°) apart until all are evenly tight. Draw bolts tight to ensure proper seating of gaskets. Provide Densco petroleum based tape or approved equal for all exposed portions of nuts, bolts and pipe.
4. Full length bolt isolating sleeves and washers shall be used with flanged connections.
5. For in-line flange joints thirty inches (30 In) in diameter and greater and at butterfly valve flanges, provide Pyrox G-10 with nitrite seal, conforming to ANSI A 21.11 mechanical joint gaskets. For in-line flange joints sized between twelve inches (12 In) in diameter and greater and twenty-four inches (24 In) in diameter and smaller, provide Phenolic PSI with nitrite seal

gasket conforming to ANSI A 21.11 mechanical joint gaskets.

C. Welded Joints (Prestressed Concrete Cylinder Pipe (PCCP), Bar Wrapped Pipe, Steel Pipe):
   1. Prior to starting work, provide certification of qualification for welders employed on project for type of work procedures and positions involved.
   2. Joints: AWWA C206. Full-fillet, single lap-welded slip-type either inside or outside or double butt-welded type; use automatic or hand welders; completely penetrate deposited metal with base metal; use filler metal compatible with base metal; keep inside of fittings and joints free from globules of weld metal which would restrict flow or become loose. Do not use mitered joints. For interior welded joints, complete backfilling before welding. For exterior field-welded joints, provide adequate working room under and beside pipe. Use exterior welds for thirty inch (30 In) and smaller.
   3. Furnish welded joints with trimmed spigots and interior welds for thirty-six inch (36 In) and larger pipe.
   4. Bell-and-spigot, lap-welded slip joints: Deflection may be taken at joint by pulling joint up to three-quarters inch (3/4 In) as long as one and one-half inch (1-1/2 In) minimum lap is maintained. Spigot end may be miter cut to take deflections up to five degrees (5°) as long as joint tolerances are maintained. Miter end cuts of both ends of butt-welded joints may be used for joint deflections of up to five degrees (5°).
   5. Align piping and equipment so that no part is offset more than one-eighth inch (1/8 In). Set fittings and joints square and true and preserve alignment during welding operation. For butt welded joints, align abutting ends to minimize offset between surfaces. For pipe of same nominal wall thickness, do not exceed one-sixteenth inch (1/16 In) offset. Use line-up clamps for this purpose; however, take care to avoid damage to linings and coatings.
   6. Protect coal-tar-epoxy lining during welding by draping an eighteen inch (18 In) wide strip of heat resistant material over top half of pipe on each side of lining holdback to avoid damage to lining by hot splatter. Protect tape coating similarly if external welding is required.
   7. Welding rods: Compatible with metal to be welded to obtain strongest bond, E-70XX.
   8. Deposit metal in successive layers to provide at least two (2) passes or beads for automatic welding and three (3) passes or beads for manual welding in completed weld.
   9. Deposit no more than one-quarter inch (1/4 In) of metal on each pass. Thoroughly clean each individual pass with wire brush or hammer to remove dirt, slag or flux.

10. Do not weld under weather condition that would impair strength of weld, such as wet surface, rain or snow, dust or high winds, unless work is properly protected.
11. Make tack weld of same material and by same procedure as completed weld. Otherwise, remove tack welds during welding operation.
12. Remove dirt, scale and other foreign matter from inside piping before tying in sections, fittings or valves.
13. Welded Joints for Large Diameter Water Lines:
    a. Furnish pipe with trimmed spigots and interior welds for thirty-six inch (36 In) and larger pipe.
    b. Use exterior welds for thirty inch (30 In) and smaller.
    c. Only one (1) end may be miter cut. Miter end cuts of both ends of butt-welded joints may be used for joint deflections of up to two and one-half degrees (2-1/2°).
    d. For large diameter water lines, employ an independent certified testing laboratory, approved by the Project Manager, to perform weld acceptance tests on welded joints. Include cost of such testing and associated work to accommodate testing in contract unit price bid for water line. Furnish copies of test reports to the Project Manager for review. The Project Manager has the final decision as to suitability of welds tested.
        1) Weld acceptance criteria:
            a) Conduct in accordance with ASTM E165-Standard Test Method for Liquid Penetrant Examination and ASTM E709 Standard Guide for Magnetic Particle Examination. Use X-ray methods for butt welds, for one hundred percent (100%) of joint welds.
            b) Examine welded surfaces for the following defects:
                i) Cracking.
                ii) Lack of fusion/penetration.
                iii) Slag which exceeds one-third (1/3) of (t) where (t) equals material thickness.
                iv) Porosity/Relevant rounded indications greater than three-sixteenths inch (3/16 In); rounded indication is one (1) of circular or elliptical shape with length equal to or less than three (3) times its width.
                v) Relevant linear indications in which length of linear indication exceeds three (3) times its width.

vi) Four (4) or more relevant one-sixteenth inch (1/16 In) rounded indications in line separated by one-sixteenth inch (1/16 In) or less edge to edge.

14. After pipe is joined and prior to start of welding procedure, make spigot and bell essentially concentric by jacking, shimming or tacking to obtain clearance tolerance around periphery of joint except for deflected joints.
15. Furnish each welder employed steel stencil for marking welds, so work of each welder can be identified. Mark pipe with assigned stencil adjacent to weld. When welder leaves job, stencil must be voided and not duplicated. Welder making defective welds must discontinue work and leave project site. Welder may return to project site only after recertification.
16. Provide cylindrical corrosion barriers for epoxy lined steel pipe twenty-four inch (24 In) diameter and smaller, unless minimum wall thickness is one-half inch (1/2 In) or greater.
    a. In addition to welding requirements contained here in Paragraph 3.6, conform to protection fitting manufacturer's installation recommendations.
    b. Provide services of technical representative of manufacturer available on site at beginning of pipe laying operations. Representative to train welders and advise regarding installation and general construction methods. Welders must have twelve months (12 Mos) prior experience installing protection fittings.
    c. All steel pipe is to have cutback three-quarters inch (3/4 In) to not greater than one inch (1 In) of internal diameter coating from weld bevel.
    d. Furnish steel fittings with cylindrical corrosion barriers with shop welded extensions to end of fittings. Extension length to measure no less than diameter of pipe. Shop apply lining in accordance with AWWA C210 or AWWA C213.
    e. All steel pipe receiving field adjustments are to be cold cut using standard practices and equipment. No cutting using torch is to be allowed.

D. Harnessed Joints (Prestressed Concrete Cylinder Pipe (PCCP), Bar Wrapped Pipe):
    1. Use of snap-ring type restrained joints on pipe is limited to twenty inch (20 In) through forty-eight inch (48 In) diameters.
    2. Position snap-ring joint bolt on top [twelve (12) o'clock position]. Provide minimum one-half inch (1/2 In) joint recess. Use joint "diapers" minimum of twelve inches (12 In) wide.
    3. For field adjustments with deflections beyond manufacturer's

recommendations:

a. Field trim spigot.
b. Do not engage ring.

4. Harnessed joints shall not be permitted in areas defined on the Drawings as potentially petroleum contaminated material, in tunnels or at bend greater than five degrees (5°).
5. Install harness type joints including snap rings at straight sections of pipe.

E. Restrained Joints

1. For existing water lines and water lines less than sixteen inches (16 In) in diameter, restrain pipe joints with concrete thrust blocks.
2. Thrust restraint lengths shown on the Drawings are minimum anticipated lengths. These lengths are based on deflections indicated and on use of Prestressed Concrete Cylinder Pipe (PCCP) for large diameter lines and ductile Iron Pipe (DIP) for small diameter lines. Adjustments in deflections or use of other pipe material may result in reduction or increase of thrust lengths. Perform calculations by pipe manufacturer to verify proposed thrust restraint lengths. Submit calculations for all pipe materials sealed by a Professional Engineer licensed by the State of Texas for review by the Project Manager. Make adjustments in thrust restraint lengths at no additional cost to the City.
3. Passive resistance of soil shall not be permitted in calculation of thrust restraint.
4. For sixteen inch (16 In) lines and larger use minimum sixteen foot (16 Ft) length of pipe in and out of joints made up of beveled pipe where restraint joint lengths are not identified on the Drawings. Otherwise, provide restraint joints for a minimum length of sixteen feet (16 Ft) on each side of beveled joints.
5. Restraint Devices:
   a. Prestressed Concrete Cylinder Pipe (PCCP), bar wrapped pipe and steel pipe, that has either welded or flanged fittings or valves, shall not need to be further restrained.
   b. Mega-lug fittings are the acceptable and preferred method of restraint for all other piping with the exception of those listed in paragraph 3.7.E.5.d of this Section.
   c. Use of Ellison clamps and all-threaded rod is allowed with the approval of the Project Manager. Ellison clamps, all-threaded rod and other hardware shall be 316 stainless steel. Ellison clamp shall be a minimum of two feet (2 Ft) from edge of fitting.
   d. All offsets, even if Mega-lugs are used on the fittings, shall have Ellison clamps on the end and/or sides of the

offset and shall have stainless steel all-threaded rod connections in between fittings to prevent movement.

5. Installation:
   a. Install restrained joints mechanism in accordance with manufacturer's recommendations.
   b. Examine and clean mechanism; remove dirt, debris and other foreign material.
   c. Apply gasket and joint NSF 61 FDA food grade approved lubricant.
   d. Verify gasket is evenly seated.
   e. Do not over stab pipe into mechanism.
6. Prevent any lateral movement of thrust restraints throughout pressure testing and operation.
7. Place Class C, two thousand five hundred pounds per square inch (2500 psi) concrete conforming to Section 03300 – Structural Concrete, for blocking at each change in direction of existing water lines, to brace pipe against undisturbed trench walls. Finish placement of concrete blocking, made from Type I cement, four days (4 D) prior to hydrostatic testing of pipeline. Test may be made two days (2 D) after completion of blocking if Type II cement is used.

F. Joint Grout (Prestressed Concrete Cylinder Pipe (PCCP), Bar Wrapped Pipe, Steel Pipe):
1. Mix cement grout mixture by machine except when less than one-half cubic yard (1/2 Cy) is required. When less than one-half cubic yard (1/2 Cy) is required, grout may be hand mixed. Mix grout only in quantities for immediate use. Place grout within twenty minutes (20 Min) after mixing. Discard grout that has set. Retempering of grout by any means is not permitted.
2. Prepare grout in small batches to prevent stiffening before it is used. Do not use grout which has become so stiff that proper placement cannot be assured without retempering. Use grout for filling grooves of such consistency that it shall adhere to ends of pipe.
3. Surface Preparation: Remove defective concrete, laitance, dirt, oil, grease and other foreign material from concrete surfaces with wire brush or hammer to sound, clean surface. Remove rust and foreign materials from metal surfaces in contact with grout.
4. Follow established procedures for hot and cold weather concrete placement.
5. Complete joint grout operations and backfilling of pipe trenches as closely as practical to pipe laying operations. Allow grouted exterior joints to cure at least one hour (1 Hr) before compacting backfill.
6. Grouting exterior joint space: Hold wrapper in place on both sides of joint with minimum five-eighths inch (5/8 In) wide steel

straps or bands. Place no additional bedding or backfill material on either side of pipe until after grout band is filled and grout has mechanically stiffened. Pull ends of wrapper together at top of pipe to form access hole. Pour grout down one side of pipe until it rises on other side. Rod or puddle grout to ensure complete filling of joint recess. Agitate for fifteen minutes (15 Min) to allow excess water to seep through joint band. When necessary, add more grout to fill joint completely. Protect gap at top of joint band from backfill by allowing grout to stiffen or by covering with structurally protective material. Do not remove band from joint. Proceed with placement of additional bedding and backfill material.

7. Interior Joints for Pipe twenty-four inches (24 In) and smaller: Circumferentially butter bell with grout prior to insertion of spigot, strike off flush surplus grout inside pipe by pulling filled burlap bag or inflated ball through pipe with rope. After joint is engaged, finish off joint grout smooth and clean. Use swab approved by the Project Manager for twenty inch (20 In) pipe and smaller.
8. Protect exposed interior surfaces of steel joint bands by metallizing, by other approved coatings or by pointing with grout. Joint pointing may be omitted on potable water pipelines if joint bands are protected by zinc metallizing or other approved protective coatings.
9. Remove and replace improperly cured or otherwise defective grout.
10. Strike off grout on interior joints and make smooth with inside diameter of pipe.
11. When installed in tunnel or encasement pipe and clearance within casing does not permit outside grout to be placed in normal manner, apply approved flexible sealer, such as Flex Protex or equal, to outside joint prior to joint engagement. Clean and prime surfaces receiving sealer in accordance with manufacturer's recommendations. Apply sufficient quantities of sealer to assure complete protection of steel in joint area. Fill interior of joint with grout in normal manner after joint closure.
12. Interior Joints for Water Lines thirty inches (30 In) and larger: Clean joint space, wet joint surfaces, fill with stiff grout and trowel smooth and flush with inside surfaces of pipe using steel trowel so that surface is smooth. Accomplish grouting at end of each work day. Obtain written acceptance from the Project Manager of inside joints before proceeding with next day's pipe laying operation. During inspection, insure no delamination of joint mortar has occurred by striking joint mortar lining with rubber mallet. Remove and replace delaminated mortar lining.
13. Work which requires heavy equipment to be over water line must be completed before mortar is applied to interior joints.

G. Large Diameter Water Main Joint Testing: In addition to testing individual joints with feeler gauge approximately one-half inch (1/2 In) wide and fifteen thousandths inch (0.015 In) thick, use other joint testing procedure approved or recommended by pipe manufacturer which shall help ensure watertight installation prior to backfilling. Perform tests at no additional cost to the City.

H. Make curves and bends by deflecting joints or other method as recommended by manufacturer and approved by the Project Manager. Submit details of other methods of providing curves and bends which exceed manufacturer's recommended deflection prior to installation.
   1. Deflection of pipe joints shall not exceed maximum deflection recommended by pipe manufacturer, unless otherwise indicated on the Drawings.
   2. If deflection exceeds that specified but is less than five percent (5%), repair entire deflected pipe section such that maximum deflection allowed is not exceeded.
   3. If deflection is equal to or exceeds five percent (5%) from that specified, remove entire portion of deflected pipe section and install new pipe.
   4. Replace, repair or reapply coatings and linings as required.
   5. Assessment of deflection may be measured by the Project Manager at location along pipe. Arithmetical averages of deflection or similar average measurement methods shall not be deemed as meeting the intent of this standard.
   6. When rubber gasketed pipe is laid on curve, join pipe in straight alignment and then deflect to curved alignment.

I. Closures Sections and Approved Field Modifications to Steel, Prestressed Concrete Cylinder Pipe (PCCP), Bar Wrapped Pipe and Fittings:
   1. Apply welded-wire fabric reinforcement to interior and exterior of exposed interior and exterior surfaces greater than six inches (6 In) in diameter. Welded-wire fabric: minimum W1; maximum spacing two inches by four inches (2 In x 4 In); three-eighths inch (3/8 In) from surface of steel plate or middle third (3rd) of lining or coating thickness for mortar thickness less than three-quarters inch (3/4 In).
   2. Fill exposed interior and exterior surfaces with nonshrink grout.
   3. For pipe diameters thirty-six inches (36 In) and greater, perform field welds on interior and exterior of pipe.
   4. For large diameter water lines, provide minimum overlap of four inches (4 In) of butt strap over adjacent piece on butt-strap closures.

3.7 CATHODIC PROTECTION APPURTENANCES

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

B. Where identified on the Drawings, modify pipe for cathodic protection as

detailed on the Drawings and specified. Unless otherwise noted, provide insulation kits including test stations at connections to existing water system or at locations to isolate one (1) type of cathodic system from another type, between water line, access manhole piping and other major openings in water line or as shown on the Drawings.

C. Bond joints for pipe installed in tunnel or open cut, except where insulating flanges are provided. Weld strap or clip between bell and spigot of each joint or as shown on the Drawings. No additional bonding required where joints are welded for thrust restraint. Repair coatings as specified by appropriate AWWA standard, as recommended by manufacturer and as approved by the Project Manager.

D. Bonding Strap or Clip: Free of foreign material that may increase contact resistance between wire and strap or clip.

3.8 SECURING, SUPPORTING AND ANCHORING

A. Support piping as shown on the Drawings and as specified in this Section, to maintain line and grade and prevent transfer of stress to adjacent structures.

B. Where shown on the Drawings, anchor pipe fittings and bends installed on water line by welding consecutive joints of pipe together to distance each side of fitting. Restrained length, as shown on the Drawings, assumes that installation of pipe and subsequent hydrostatic testing begins upstream and proceed downstream, with respect to normal flow of water in pipe. If installation and testing differs from this assumption, submit for approval revised method of restraining pipe joints upstream and downstream of device used to test against (block valve, blind flange or dished head plug).

C. Use adequate temporary blocking of fittings when making connections to distribution system and during hydrostatic tests. Use sufficient anchorage and blocking to resist stresses and forces encountered while tapping existing water line.

3.9 POLYETHYLENE WRAP FOR DUCTILE IRON PIPE (DIP)

A. Double wrap pipe and appurtenances (except fire hydrants and fusion bond or polyurethane coated fittings) with eight (8) mil polyethylene film.

B. Do not use polyethylene wrap if pipe is cathodically protected.

C. Conform to requirements of Section 02260 – Polyethylene Wrap.

3.10 CLEANUP AND RESTORATION

A. Provide cleanup and restoration crews to work closely behind pipe laying crews and where necessary, during disinfection and hydrostatic testing, service transfers, abandonment of old water lines, backfill and surface restoration.

B. Unless otherwise approved by the Project Manager, comply with the following;

1. Once water line is installed to limits approved in layout

submitted, immediately begin preparatory work for disinfection effort.

2. Immediately after transfer of services, begin abandonment of old water lines and site restoration.
3. Do not exceed a total of fifty percent (50%) of total project linear feet of disturbed right-of-way and easement until site is restored in accordance with Section 01745 – Site Restoration.
4. Exceeding any of the above footage limitations shall be considered a material breach of the Contract and subject to termination in accordance with the General Conditions.

C. For large diameter water lines, do not install more than two thousand linear feet (2000 Lf) of water line, without previous two thousand linear feet (2000 Lf) being restored in accordance with Section 01745 – Site Restoration. Schedule paving crews so repaving work shall not lag behind pipe laying work by more than one thousand linear feet (1000 Lf). Failure to comply with this requirement shall be considered a material breach of the Contract and subject to termination in accordance with the General Conditions.

3.11 CLEANLINESS OF PIPING SYSTEMS

A. End Caps shall be used throughout storage of material and during installation as needed to assure dirt and debris does not enter the piping system. If there is Remove construction debris or foreign material and thoroughly broom clean and flush piping systems. Provide temporary connections, equipment and labor for cleaning.

3.12 DISINFECTION OF WATER LINES

A. Conform to requirements of Section 02455 – Disinfection of Waterlines.
1. No later than three (3) days after completing disinfection preparatory work, submit to the City appropriate request for disinfection.
2. Schedule City' Utilities Superintendent at least seventy-two hours (72 Hrs) before disinfection or blowing off of lines. The City Water personnel shall turn all valves on and off for the duration.
3. Water Lines shall not be placed into service until all Bac-T testing has passed.

3.13 FIELD HYDROSTATIC TESTS

A. Conform to requirements of Section 02450 – Hydrostatic Testing of Waterlines.

END OF SECTION