

CITY OF LIVERMORE
TECHNICAL SPECIFICATIONS

DIVISION 33 – UTILITIES

**SECTION 330130 - SANITARY SEWER AND
STORM DRAIN SYSTEM LEAKAGE TESTING**

PART 1 -- GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall provide all materials, equipment and labor to perform and complete pipeline flushing and testing, complete, for sanitary sewer and storm drain system piping, as specified herein.
- B. The CONTRACTOR shall be responsible for conveying test water from the source to the point of usage and also for proper disposal, as required, of water used in the testing operations. All costs associated with supply and disposal of test water shall be at the CONTRACTOR'S expense.
- C. Structural (Deflection) testing requirements for sanitary sewers and storm drains are as specified in the various appropriate piping sections.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. **Commercial Standards:**

ASTM C 828	Standard Test Method for Low-Pressure Air Test of Vitrified Clay Pipe Lines.
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1.3 CONTRACTOR SUBMITTALS

- A. A testing schedule, including proposed plans for conveyance, control and disposal of test water shall be submitted in writing to the ENGINEER for review a minimum of 72 hours before testing is to start.
- B. The CONTRACTOR shall submit laboratory calibration certificates for all gages to the ENGINEER for review along with the testing schedule.

PART 2 -- PRODUCTS

2.1 MATERIAL REQUIREMENTS

- A. All testing equipment and materials shall be provided by the CONTRACTOR. No materials shall be used which would be injurious to pipeline system or structure and future function. All test gages shall be laboratory-calibrated test gages and shall be recalibrated by a certified laboratory at the CONTRACTOR'S expense prior to the leakage test.

PART 3 -- EXECUTION

3.1 GENERAL

- A. All lines shall be cleaned and flushed prior to testing using a "Wayne Ball," high pressure sewer "jets," or other methods acceptable to the ENGINEER.
- B. CONTRACTOR will be solely responsible for the proper disposal of all water used in the flushing and testing process. Disposal of all water shall be in accordance with appropriate regulatory agency requirements.
- C. All flushing and testing operations shall be performed in the presence of the ENGINEER.

3.2 TESTING OF MAINTENANCE HOLES

- A. All sanitary sewer maintenance holes shall be vacuum tested for leakage after installation in the presence of the ENGINEER. Prior to vacuum testing all maintenance holes shall be visually inspected for leaks. All leaks, cracks and lift holes shall be repaired by the CONTRACTOR, prior to vacuum testing, to the satisfaction of the ENGINEER. All repairs shall be made with non-shrink grout. The CONTRACTOR shall test the maintenance hole up to and including the cone, and shall make all repairs as necessary to achieve a final passing test. Any alternative repair methods shall be approved by the ENGINEER. All pipe inlets and outlets in the maintenance hole shall be securely plugged to sufficiently hold against vacuum pressure during testing, and removed following successful completion of the testing. A rubberized test plate shall be placed on the maintenance hole dome after potential leaks on the top of the dome have been sealed.
- B. A suitable vacuum pump shall be used to reduce the pressure inside the maintenance hole to a vacuum of ten (10) inches of mercury, stabilizing the vacuum at ten (10) inches of mercury for one (1) minute. The vacuum pump shall be shut off, and with the valves closed, the increase (loss of vacuum) shall be measured inside the maintenance hole during the test hold period. The maximum allowable pressure increase (loss of vacuum) shall be one (1) inch of mercury over a sixty (60) second test hold period. If vacuum drops below nine (9) inches of mercury within the test period, the leakage shall be considered excessive. The CONTRACTOR shall make all repairs necessary to achieve a passing test and the maintenance hole shall be retested. Maintenance holes repairs and retesting shall proceed until a passing test is completed.

3.3 TESTING OF PIPING SYSTEMS

- A. **General:** All sanitary sewer and storm drain systems and service laterals shall be tested as specified. All sanitary sewer gravity lines shall be tested for leakage using a low pressure air test. All sanitary sewer maintenance holes shall be tested for leakage, as specified. Maintenance holes shall be tested prior to backfill placement, whereas all pipe shall be backfilled prior to testing. All leakage tests shall be completed and approved prior to placing of permanent surfacing. When leakage exceeds the amount allowed, the CONTRACTOR at its expense, shall locate the leaks and make the necessary repairs or replacements in accordance with the Specifications to reduce the leakage to the specified limits. Any individually detectable leaks shall be repaired, regardless of the results of the tests.
- B. During flushing of the sewer lines, the maintenance hole at the low end of the new line shall be plugged and incoming water pumped to a drain point approved by the CITY. Before the plug can be removed, all sand, silt, gravel and other foreign material shall be completely removed from the maintenance hole.
- C. **Deflection:** All PVC non-pressure pipe shall be tested for deflection obstructions and protruding laterals by passing a "mandrel" from the nearest downstream structure to the nearest upstream structure. The "deflection test" procedure shall be acceptable to the ENGINEER. The 'mandrel' diameter shall be 95 percent of the pipe inside diameter.
- D. **Air Pressure Test:** The CONTRACTOR shall furnish all materials, equipment and labor for making an air test. Air test equipment shall be approved by the ENGINEER.

The CONTRACTOR may conduct an initial air test of the sewer main line after densification of the backfill but prior to installation of the laterals. Such tests will be considered to be for the CONTRACTOR'S convenience and need not to be performed in the presence of the ENGINEER.

Each section of the sewer shall be tested between successive maintenance holes by plugging and bracing all openings in the main sewer line and the end of all laterals. Prior to any air pressure testing, all pipe plugs shall be checked with a soap solution to detect any air leakage. If any leaks

are found, the air pressure shall be released, the leaks eliminated and the test procedure started over again.

The final leakage test of the sewer main line and laterals shall be conducted in the presence of the ENGINEER. The time and procedure for air testing vitrified clay pipe (VCP) shall be calculated in accordance with ASTM C 828.

For other pipe types, the test procedure shall be conducted by first increasing the pressure within the line to approximately 4 psi using a compressed air supply. After the air supply is turned off or disconnected, there shall be a two minute waiting period to allow stabilization of air within the sewer line before the actual test begins. In no case shall the test pressure within the line be less than 3.5 psi when the test begins. The allowable air pressure loss shall not exceed 1 psi. After completion of the test, the air pressure shall be released slowly and the test plugs shall not be removed until the air pressure is no longer measurable. The test periods for all sewer pipes other than VCP shall be determined using the Ramseier's equation, as follows:

$$T = 0.085 * \frac{DK}{Q}$$

- Where: T = Shortest time, in seconds, allowed for the air pressure to drop to 1.0 psig.
K = 0.000419 DL, but not less than 1.0.
Q = 0.0015 cubic feet/minute/square feet of internal surface.
D = Nominal pipe diameter in inches.
L = Length of pipe being tested in feet.

At the CONTRACTOR'S option, joints may be air tested individually, joint by joint, with the use of specialized equipment. The CONTRACTOR shall submit its joint testing procedure for the ENGINEER'S review prior to testing. Prior to each test, the pipe at the joint shall be wetted with water. The maximum test pressure shall be 3.0 psi. The minimum allowable pressure drop shall be 1.0 psi over a 30-second test period.

- E. **T.V. Inspection:** All sanitary sewer systems shall be TV inspected. In addition, all storm drain systems are subject to TV inspection. In all paved areas the TV inspection must be coordinated by the CONTRACTOR to allow sufficient time for the TV inspection to be performed prior to the final lift of asphalt paving being placed. The CITY or approved TV testing company will perform the TV inspections. The CONTRACTOR shall repair all problems revealed by the TV inspection. The CONTRACTOR shall coordinate with the ENGINEER to arrange for a compatible time to conduct the inspection.
- F. **The Contractor shall contact the Water Resources Division for a list of approved TV testing companies.**
- G. **The Contractor shall submit the sanitary sewer video tape (VHS) to the City for review. Tape shall become the property of the City.**

3.4 FLOW TESTING OF EXISTING COMMERCIAL/INDUSTRIAL SEWER LATERALS

- A. Prior to connecting to all existing sewer laterals other than single family residential units, the CONTRACTOR shall flush test the existing sewer lateral with water in the presence of the ENGINEER to determine if the lateral is damaged

- END OF SECTION -

SECTION 330523 - STEEL CASING BORING AND JACKING

PART 1 -- GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall provide all materials, equipment and labor necessary to furnish and install bored or jacked steel casing, and all appurtenant work, complete and in place as shown on the Drawings and as specified herein. Carrier pipe installation within the steel casing shall be as specified herein.
- B. In the performance of the work, the CONTRACTOR shall comply with the lawful requirements of the affected public agencies, owners of public utilities or other facilities, and railway companies, relative to the safeguarding of traffic and improvements which might be endangered by the boring and jacking operations.
- C. If the CONTRACTOR is not ready to place the pipe in the casing at the time of completion of boring and jacking operations, the ends shall be bulkheaded, and the approach trenches shall be backfilled, plated, and barricaded: and in public streets the trenches shall be backfilled, temporary surfacing placed thereon, and the affected portion of the street reopened to traffic.
- D. The CONTRACTOR shall be responsible for maintaining the specified line and grade, and for preventing settlement of overlying structures, or other damage due to the boring and jacking operations.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 312300 Utility Earthwork.
- B. Section 331300 Pressure Pipeline Testing and Disinfection.
- C. Section 331102 Steel Pipe - Mortar-Lined and Mortar Coated.
- D. Section 330130 Sanitary Sewer and Storm Drain System Leakage Testing.
- E. Section 033050 Utility Cast-in-Place Concrete.
- F. Division 1 General Requirements.

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Codes:

California Labor Code.

Construction Safety Order of the State of California.

B. Commercial Standards:

ASTM A 283 Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.

ANSI/AWWS D1.1 Structural Welding Code Steel.

AWWA C200 Standard for Steel Water Pipe-6 In. (150mm) and Larger.

1.4 CONTRACTOR SUBMITTALS

- A. **Shop Drawings:** The CONTRACTOR shall submit shop drawings of pipe casing in accordance with the following requirements:
1. The CONTRACTOR, prior to beginning any trench or structure excavation 5 feet deep or over, shall submit to the ENGINEER for review for compliance with Section 6705 of the California Labor Code the CONTRACTOR'S detailed plan showing design of all shoring, bracing, sloping of the sides of excavation, or other provisions for worker protection against the hazard of caving ground during the excavation of such trenches or structure excavation. The CONTRACTOR'S attention is directed to the provisions for "Shoring and Bracing Drawings" in Section 6705 of the California Labor Code. If such plan varies from the shoring system standards established in the Construction Safety Orders of the State of California, such alternative systems plans shall be prepared by a civil or structural engineer licensed in the State of California at the CONTRACTOR'S expense.
 2. Casing installation schedules which include schedules of excavation, pipeline installation, and backfill operations.
 3. Material list including diameter, thickness, and class of steel casing.
 4. Detailed locations and sizes of all boring or jacking and receiving pits.
 5. Permits associated with the boring or jacking operations.
 6. Welders Certificates
- B. **Certificates of Compliance:** Certificates of Compliance shall be provided for all products and materials proposed to be used under this Section, including certificates for physical and chemical properties of all steel.
- C. All expenses incurred in making samples for certification and tests shall be borne by the CONTRACTOR.

1.5 QUALITY ASSURANCE

- A. All boring or jacking operations shall be done by a qualified CONTRACTOR with at least 5 years experience involving work of a similar nature.
- B. The CONTRACTOR shall give the ENGINEER a minimum of 3 days advance notice of the start of an excavation or boring operations.
- C. All work shall be performed in the presence of the ENGINEER, unless the ENGINEER has granted prior written approval to perform such work in its absence.
- D. **Welding Requirements:** CONTRACTOR shall furnish Certificates of Compliance for all welding procedures as required by the ENGINEER.
- E. All welding procedures used to fabricate and install steel casings shall be prequalified under the provisions of ANSI/AWS D1.1. Welding procedures shall be required for, but not necessarily limited to, longitudinal and girth or special welds for pipe cylinders, casing joint welds, reinforcing plates, and pressure grout coupling connections.
- F. All welding shall be done by skilled welders, welding operators, and tackers who have had adequate experience in the type of materials to be used. Welders shall be qualified under the provisions of

ANSI/AWS D1.1 by an independent local, approved testing agency not more than 6 months prior to commencing work on the casing or pipeline. Machines and electrodes similar to those used in the WORK shall be used in qualification tests. The CONTRACTOR shall furnish all material and bear the expense of qualifying welders.

- G. No exterior or interior joints of the carrier pipe shall have mortar grout applied over a seam until the seam has cooled. Exterior and interior joints of the carrier pipe shall be mortar coated and lined in the field, in accordance with the requirements of the specification Sections for the type of pipe material installed.

1.6 SAFETY

- A. The CONTRACTOR shall obtain from the California Division of Occupational Safety and Health Administration a preliminary gas classification for each bore, 30 inches in diameter and larger. It shall be the CONTRACTOR'S responsibility to see that the WORK is done in conformance with all applicable federal, state, and local safety requirements.

PART 2 -- PRODUCTS

2.1 GENERAL

- A. Steel casings shall be welded steel pipe of the diameters and plate thicknesses shown. The steel pipe casings shall conform to AWWA C200, subject to the following supplemental requirements. The casing shall be of the diameter and thickness as required by the owner of the utility of structure to be crossed, and shall be furnished complete with welded joint ends and, for pipes 24 inches and larger, pressure grout couplings. The CONTRACTOR, at its expense, may select a greater diameter or thickness for the method of work and loadings involved, site conditions, and possible interferences.

2.2 MATERIALS

- A. **Steel Casing:** The steel casing pipe shall be in accordance with ASTM A 283, Grade C, unless shown otherwise. Casing section joints shall be butt welded, lap welded, or welded using butt straps in the field. Each end of each casing section for butt welding shall be prepared by providing 1/4-inch by 45-degree chamfer on the outside edges.
- B. **Grout:** Grout shall consist of one part portland cement, 3 parts sand, and the minimum amount of water necessary to obtain the desired consistency; and, all grout mixtures shall contain 2 percent of bentonite by weight of the cement. Portland cement, water, and sand shall conform to the applicable requirements of the Section 03300, "Utility Cast-in-Place Concrete," except that sand to be used shall be of such fineness that 100 percent will pass a No. 8 sieve and at least 45 percent, by weight, will pass a No. 40 sieve. Bentonite shall be a commercial-processed powdered bentonite, Wyoming type, such as **Imacco-gel, Black Hills, or equal**.
- C. **Grout Connections:** The CONTRACTOR shall provide 2 inch grout connections regularly spaced at 5 feet on center alternating at 30 degrees from plumb each side of the vertical centerline for pipes 24 inches and larger. Longitudinal spacing between the grout connections may be decreased to provide more frequent grouting, but in no case shall the spacings shown or specified, be exceeded.
- D. **Casing Insulators and End Seals:** The CONTRACTOR shall provide casing insulators and resilient end seals with stainless steel bands designed sufficient to withstand earthload and hydraulic conditions. Casing Insulators shall be **Williamson M-2, Calpico Model M, or equal**, and seals shall be **Williamson Z-Seal, Calpico Model W, or equal**.
- E. **Steel Plate:** Steel plate for bridging shall be in conformance with Section 02315, "Utility Earthwork."

PART 3 -- EXECUTION

3.1 INSTALLATION OF STEEL CASING

- A. **Jacking Head:** A steel jacking head shall be fitted to the lead section of the casing in such a manner that it extends around the entire outer surface of the steel casing and projects at least 18 inches beyond the driving end of the casing. The jacking head shall not protrude more than 1/2-inch outside of the outer casing surface. The head shall be securely anchored to prevent any wobble or alignment variation during the boring or jacking operations. To minimize voids outside the casing, excavation shall be carried out entirely within the jacking head and not in advance of the head. Excavated materials shall be removed from the casing as the boring or jacking operation progresses and no accumulation of excavated materials within the casing shall be permitted.
- B. **Jacking Pit:** The excavations for the boring or jacking operations shall be adequately shored to safeguard existing substructures and surface improvements and to ensure against ground movement in the vicinity of the jack supports. Heavy guide timber, structural steel, or concrete cradles of sufficient length shall be provided to assure accurate control of boring or jacking alignment. The CONTRACTOR shall provide adequate space within the excavation to permit the insertion of the lengths of casing to be bored or jacked. Timbers and structural steel sections shall be anchored to ensure action of the jacks in line with the axis of the casing. A bearing block, consisting of a timber or structural steel framework, shall be constructed between the jacks and the end of the casing to provide uniform end bearing over the perimeter of the casing and distribute the jacking pressure evenly.
- C. **Control of Alignment and Grade:** The CONTRACTOR shall control the application of the jacking pressure and excavation of materials ahead of the casing as it advances to prevent the casing from becoming earthbound or deviating from the required line and grade. The CONTRACTOR shall restrict the excavation of the materials to the least clearance necessary to prevent binding in order to avoid loss of ground and consequent settlement or possible damage to overlying structures. Allowable grade deviations in horizontal and vertical alignments shall be no greater than 0.2 foot per 100 feet in any direction over the length of the jacking or boring to a maximum deviation of 0.5 foot.
- D. **Grouting:** Immediately after completion of the boring or jacking operations, the CONTRACTOR shall inject grout through the grout connections, for pipes 24 inch and larger, in such a manner as to completely fill all voids outside the casing pipe, whether natural voids or voids resulting from the boring or jacking operations. Grout pressure shall be controlled so as to avoid deformation of the steel casing and avoid movement of the surrounding ground. After completion of the grouting operations where grout connections are required, the CONTRACTOR shall close the grout connections with cast-iron threaded plugs.
- E. **Installation:** The installation of the casing shall be subject to the approval of the permitting agency, owner of the carrier pipe having jurisdiction over the facility and the area containing the boring or jacking operation, and the CITY.

3.2 INSTALLATION OF CARRIER PIPE

- A. All carrier pipes to have "Casing Insulators" installed at a maximum spacing of 10 feet.
- B. **Testing of the Carrier Pipe:** Testing of the carrier pipe shall be performed in accordance with the Section 331300, "Pressure Pipeline Testing and Disinfection," or Section 330130 "Sanitary Sewer and Storm Drain System Leakage Testing" as applicable. Testing shall be completed before the casing ends are sealed.
- C. CONTRACTOR shall install casing seals at each end of the casing, in accordance with the manufacturer's printed recommendations.

3.3 CLOSING OF PITS

A. After jacking equipment and excavated materials from the boring or jacking operations have been removed from the jacking pit, the CONTRACTOR shall:

1. Scarify and recompact the bottom of the jacking pit, remove all loose and disturbed materials below pipe grade to undisturbed earth and recompact the subgrade material.
2. Backfill the excavation in accordance with Section 312300 "Utility Earthwork."

3.4 STEEL PLATE

A. Steel plate used for bridging for the jacking and receiving pits shall be in conformance with Section 312300, "Utility Earthwork."

- END OF SECTION -

SECTION 330526 - PIPING IDENTIFICATION SYSTEMS

PART 1 -- GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall provide all materials, equipment, and labor necessary to furnish, mark, and install identification devices for piping, valves, and appurtenances using warning tape, buried wire, color codes, lettering, and related permanent identification devices as required and as specified herein.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 331219 Fire Hydrants.
- B. Section 055900 Ductile Iron Pipe
- C. Section 099000 Protective Coating
- D. Division 1 General Requirements.

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. **Commercial Standards:**

- ANSI A13.1 Scheme for the Identification of Piping Systems.

1.4 CONTRACTOR SUBMITTALS

- A. **Certificates of Compliance:** Certificates of Compliance shall be provided for all products and materials proposed to be used under this Section.

PART 2 -- PRODUCTS

2.1 IDENTIFICATION OF BURIED PIPING

- A. Identification of all buried pressure pipe shall be accomplished by color-coded warning tape consisting of a minimum 2 inch wide plastic tape with lettering giving a warning and a description of the pipe function (for example: "WARNING, WATER LINE BURIED BELOW"). For pipe diameters larger than 12 inches the warning tape shall be a minimum 6 inch wide. Identification color codes shall be as listed in the IDENTIFICATION SCHEDULE in PART 3 – "Execution" of this Section.
- B. Warning Tape manufacturer shall be **THOR ENTERPRISES, CALPICO, or equal.**
- C. In addition, for all non-metallic buried pressure pipe systems a No. 10 A.W.G. UF Insulated solid copper wire shall be attached to the pipeline.
- D. Tape to hold the wire in place shall be pipe wrap tape, 2 inches wide, 10 mil.

2.2 RECYCLED WATER SIGNING

- A. All identification signs and stickers for irrigation controllers for recycled water systems are to be purchased by the CONTRACTOR from the Water Resources Division located at 101 West Jack London Boulevard, Livermore, CA.

2.3 PAINT MANUFACTURERS AND COLORS

- A. Paint manufacturers and colors shall be as specified in Section 099000 "Protective Coating."

PART 3 -- EXECUTION

3.1 WARNING TAPE

- A. Warning tape shall be installed with all buried pressure piping. The tape shall be placed directly at the top of the Pipe Zone.

3.2 COPPER WIRE

- A. Buried non-metallic pressure pipelines for potable/recycled water systems, sewer force main systems and irrigation mains shall be provided with a No. 10 A.W.G. Insulated copper wire laid along the top of the pipe. On main line installations the wire shall be held in place with ties or tape spaced not more than 10 feet apart. On service laterals the wire shall be wrapped around the pipe. At all buried valves install copper tracer wire on the outside of the polyvinyl chlorite valve sleeve to a notch cut out at the top of the valve sleeve.

3.3 IDENTIFICATION SCHEDULE

A. Application of identifying water systems and devices shall conform to the following color codes.

- B Blue (Potable)
- G Green
- P Purple (Recycled)
- R Red
- W White
- Y Yellow

	FH	Valve Lid	Dist. /Type in Face of Curb	"W" on top of Curb over Service	Vent Pipe	Guard Post	Marker Post
Sanitary Sewer/Storm Drain System	-	-	-	-	-	-	G
Water Sampling Station	-	-	-	-	-	W	-
Potable Fire Hydrants	Y or R	W	R	-	-	W	-
Dedicated FS, street valves	-	-	R	W	-	-	-
All other main line potable valves	-	B	W	-	-	-	W with B top
Recycled	P	P	P	P	-	W	W with P top
Comm/Ind Dom/Fire	-	W	W	W	-	-	W with B top
Manifold	-	W	W	W	-	-	-
Air Release Valve	-	-	W	-	*W with B or P	-	-

* Vent pipe on Air Release valves: white post with top 6 inches of pipe B or P, with 3" "AR" in B or P 12" below top of pipe facing curb, color to match top 6" of pipe.

3.4 RECYCLED WATER SIGNING

A. All recycled hydrant signs will be installed on a square formed steel tube, telescoping metal breakaway type post in accordance with PART 2 "Products" and PART 3 "Execution" of Section 02891 "Signage." Signs shall be located behind the hydrant between 36" and 48" from the center of hydrant. The top of the sign shall be level with the top of the hydrant.

B. The locations of all signage for landscape irrigation systems shall be as approved by the Water Resources Division.

Irrigation controllers will also contain the purple recycled water sticker. The following message on the irrigation controller sticker will be printed in English and Spanish:

CONTROLLER OPERATES IRRIGATION SYSTEM USING RECYCLED WATER

1. Controller Operation hours: 10:00 p.m. p.m. to 6:00 a.m.
2. Operate controller to minimize overspray and runoff.
3. Maintain controller schedule and system map located inside.
4. Failure to comply may result in loss of service.

UNAUTHORIZED OPERATION PROHIBITED

- C. All recycled water piping and purple warning tape will be clearly marked stating “**Caution: Recycled Water - Do Not Drink.**” All purple polyethylene encasement for recycled water piping shall be clearly marked stating “**Caution: Recycled Water – Do Not Drink.**”
- D. All recycled water meters, valves, covers, backflow preventers and other appurtenances shall be painted purple.
- E. All recycled water stickers shall be purple, with white lettering.
- F. All internal signs (building interiors) shall be purple, with white lettering stating “**Caution: Recycled Water - Do Not Drink.**”
- G. Dual plumbed buildings shall have all internal and external water spigots clearly marked with the appropriate small blue metal sign for potable water or the small purple metal warning sign for recycled water.

- END OF SECTION -

SECTION 331100 - PIPING, GENERAL

PART 1 -- GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall provide all materials, equipment, and labor necessary to furnish and install all piping systems as shown on the Drawings and as specified herein. Each system shall be complete with all necessary fittings, hangers, supports, anchors, expansion joints, flexible connectors, valves, accessories, insulation, lining and coating, testing, disinfection, excavation, backfill and encasement, to provide a functional installation.
- B. The piping shown is intended to define the general layout, configuration, routing, method of support, pipe size, and pipe type. It is the CONTRACTOR'S responsibility to develop the details necessary to construct all mechanical piping systems, to accommodate the specific equipment provided, and to provide and install all spools, spacers, adapters, connectors, and appurtenances, for a complete and functional system.
- C. All pipe grades and elevations shown the Drawings are the pipe flow-line.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 312300 Utility Earthwork.
- B. Section 330523 Steel Casing, Boring and Jacking.
- C. Section 331300 Pressure Pipeline Testing and Disinfection.
- D. Section 033050 Utility Cast-in-Place Concrete.
- E. Section 033055 Cast-in-Place Concrete Pipe
- F. Section 055000 Miscellaneous Metalwork.
- G. Section 099000 Protective Coating.
- H. Section 330526 Piping Identification Systems.
- I. Section 331200 Miscellaneous Piping, Valves, Fittings, and Appurtenances.
- J. Division 1 General Requirements.
- K. Division 2 and 5 Pipe Sections as applicable.
- L. Division 15 As applicable.

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards:

- ANSI/ASME B1.20.1 Pipe Threads, General Purpose (inch).
- ANSI B16.5 Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and Other Special Alloys.

ANSI B31.1	ASME Code for Pressure Piping.
ANSI/AWS D1.1	Structural Welding Code.
ASTM A 307	Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile for Strength.
ASTM A 325	Specification for Structural Bolts, Heat Treated 120/105 ksi Minimum Tensile Strength.
ASTM C 564	Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
ASTM D 792	Test Methods for Specific Gravity (Relative Density) and Density of Plastics by Displacement.
ASTM D 2000	Classification System for Rubber Products in Automotive Applications.
AWWA C207	Standard for Steel Pipe Flanges for Waterworks Service - Sizes 4 In. Through 144 In.
AWWA C606	Standard for Grooved and Shouldered Joints.
AWWA Manual M-11	Restrained Joint Harness.

1.4 CONTRACTOR SUBMITTALS

- A. **Certificates of Compliance:** Certificates of Compliance shall be provided for all products and materials proposed to be used under this Section.
- B. The CONTRACTOR shall submit complete shop drawings and certificates, and test reports, for all products and materials proposed to be used for all piping systems. The shop drawings shall include all necessary dimensions and details on pipe joints, fittings, fitting specials, valves, appurtenances, design calculations, and material lists. The submittals shall include detailed layout, spool, or fabrication drawings which show all pipe spools, spacers, adapters, connectors, fittings, and pipe supports necessary to accommodate the equipment and valves provided in a complete and functional system.
- C. All expenses incurred in making samples for certification of tests shall be borne by the CONTRACTOR.
- D. The CONTRACTOR shall submit copies of welder's certificates to the ENGINEER.

1.4 QUALITY ASSURANCE

- A. **General:** All pipe shall be subject to inspection at the place of manufacture. During the manufacture of the pipe, the ENGINEER shall be given access to all areas where manufacturing is in progress and shall be permitted to make all inspections necessary to confirm compliance with the Specifications.
- B. **Tests:** Except where otherwise specified, all materials used in the manufacture of the pipe shall be tested in accordance with the applicable Specifications and Standards. The CONTRACTOR shall assure tests are performed at no additional cost to the CITY.

- C. **Welding Requirements:** Certificates of Compliance shall be supplied by the pipe fabricator for all welding procedures used to fabricate pipe and welding procedures shall be prequalified under the provisions of ANSI/AWS D1.1.
- D. **Welder Qualifications:** All welding shall be done by skilled welders, welding operators, and tackers who have had adequate experience in the methods and materials to be used. Welders shall be qualified under the provisions of ANSI/AWS D1.1 by an independent, local, approved testing agency not more than 6 months prior to commencing work on the pipeline. The CONTRACTOR shall furnish all material and bear the expense of qualifying welders.

1.5 MANUFACTURER'S SERVICE REPRESENTATIVE

- A. Where the assistance of a manufacturer's service representative is required, in order to obtain compliance for pipe fabrication and installation, the CONTRACTOR shall furnish such assistance at no additional cost to the CITY.

1.6 MATERIAL DELIVERY, STORAGE, AND PROTECTION

- A. All piping materials, fittings, valves, and accessories shall be delivered in a clean and undamaged condition and stored off the ground, to provide protection against oxidation caused by ground contact. All defective or damaged materials shall be replaced with new materials.

1.7 CLEANUP

- A. After completion of the work, all remaining pipe cuttings, joining and wrapping materials, and all other debris, shall be removed from the site. The entire piping system shall be left in a clean and functional condition.

PART 2 -- PRODUCTS

2.1 GENERAL

- A. All pipes, fittings, and appurtenances shall be furnished in accordance with the requirements of the applicable Sections of Divisions 2 through 15 and as specified herein.
- B. **Miscellaneous Pipes:** Miscellaneous pipes and fittings shall be in accordance with the requirements of Section 331200, "Miscellaneous Piping, Valves, Fittings, and Appurtenances" and as specified herein.
- C. **Lining:** All requirements pertaining to thickness, application, and curing of pipe lining, shall be in conformance with the requirements of the applicable piping specifications and Section 099000, "Protective Coating," unless otherwise specified.
- D. **Coating:** All requirements pertaining to thickness, application, and curing of pipe coating, shall be in conformance with the requirements of the applicable piping specifications, and Section 099000, "Protective Coating."
- E. **Pressure Rating:** All piping systems shall be designed for the maximum expected pressure and test pressure as defined in Section 331300, "Pressure Pipeline Testing and Disinfection," or as shown on the piping schedule.

2.2 THREADED INSULATING CONNECTIONS

- A. **General:** Threaded insulating bushings, unions, or couplings, as appropriate, shall be used for joining threaded pipes of dissimilar metals and for piping systems where corrosion control and cathodic protection are involved.
- B. **Materials:** Threaded insulating connections shall be of nylon, Teflon, polycarbonate, polyethylene, or other non-conductive materials, and shall have ratings and properties to suit the service and loading conditions.

2.3 COUPLINGS

- A. **Cast Couplings/Transition Couplings:** Flexible couplings for 4 inch through 12 inch pipe shall be ductile iron or steel, with ductile iron followers and Buna N gaskets, **APAC Style 341, Ford FC1 or FC3, or equal.** Cast transition couplings shall be **APAC Style 335, Ford FL2A, or equal.** The couplings shall have the manufacturer's factory fusion bonded epoxy coating and lining, and Type 304 stainless steel bolts and nuts.
- B. **Rigid PVC Coupling:** Rigid couplings for 4 inch through 12 inch pipe shall be PVC High Deflection Stop Couplings and Closure couplings, **Certain Teed C900 HD Stop and Closure Coupling, or equal.**
- C. **Sleeve-Type Couplings**
 - 1. **Construction:** Sleeve-type couplings shall be provided for pipe 14 inch and larger, steel with steel bolts, without pipe stop, and shall be of sizes to fit the pipe and fittings shown. The middle ring shall be not less than 1/4 inch in thickness and shall be either 5 or 7 inches long for standard steel couplings, and 16 inches long for long-sleeve couplings. The followers shall be single-piece contoured mill section welded and cold-expanded as required for the middle rings. They shall be of sufficient strength to accommodate the number of bolts necessary to obtain adequate gasket pressures without excessive rolling. The shape of the follower shall be of such design as to provide positive confinement of the gasket. Bolts and nuts shall conform to the requirements of Section 055000, "Miscellaneous Metalwork." Buried sleeve-type couplings shall be epoxy-coated at the factory in accordance with Section 099000, "Protective Coating."
 - 2. **Pipe Preparation:** The ends of the pipe, where specified or shown, shall be prepared for flexible couplings. Plain ends for use with couplings shall be smooth and round for a distance of 12 inches from the ends of the pipe, except for AC pipe, with outside diameter not more than 1/64 inch smaller than the nominal outside diameter of the pipe. For connections to existing AC pipe the tolerances will be established by the ENGINEER. The middle ring shall be tested by cold-expanding a minimum of one percent beyond the yield point, to proof-test the weld to the strength of the parent metal. The weld of the middle ring shall be subjected to air test for porosity.
 - 3. **Gaskets:** Gaskets for sleeve-type couplings shall be rubber-compound material that will not deteriorate from age or exposure to air under normal storage or use conditions. Gaskets for wastewater and sewerage applications shall be Buna "N," grade 60, or equivalent suitable elastomer. The rubber in the gasket shall meet the following specifications:
 - a. Color - Jet Black.
 - b. Surface - Non-blooming.
 - c. Durometer Hardness - 74 +/- 5.
 - d. Tensile Strength - 1000 psi Minimum.

- e. Elongation - 175 percent Minimum.

The gaskets shall be immune to attack by impurities normally found in water or wastewater. All gaskets shall meet the requirements of ASTM D 2000 - Classification System for Rubber Product in Automotive Applications, AA709Z, meeting Suffix B13 Grade 3, except as noted above. All gaskets shall be compatible with the piping service and use.

- 4. **Insulating Sleeve Couplings:** Where insulating couplings are required, both ends of the coupling shall have a wedge-shaped gasket which assembles over a rubber sleeve of an insulating compound in order to obtain insulation of all coupling metal parts from the pipe.
- D. **Flexible Joints:** Where harnesses are required for flexible sleeve-type couplings, they shall be in conformance with the Drawings. Hardware shall be stainless steel in conformance with Section 055000, "Miscellaneous Metals."
- E. **Repair Clamps:** Repair clamps shall be full circle repair clamps, **APAC Series 431, 432, and 433; Ford F1, F2, or F3; or equal**, with ductile iron lugs and Type 304 stainless steel bands, rubber gasket, and T-Head stainless steel bolts and nuts. The repair clamp shall have the manufacturer's standard coatings and linings for the appropriate service use.
- F. **Mechanical Compression Joints:** Mechanical compression joints shall have a synthetic SBR rubber body conforming to ASTM C 564 and shall have Type 302 stainless steel bands and clamps. They shall be manufactured by **Calder Couplings, Fernco, or equal**.

2.4 PIPE THREADS

- A. All pipe threads shall be in accordance with ANSI/ASME B1.20.

2.5 PRESSURE GAUGES

- A. Pressure gauges shall be provided on each side of pressure reducing valves, and where shown on the Drawings.
- B. Gauges shall be industrial quality type with stainless steel movement and stainless steel or alloy case, unless otherwise shown or specified, gauges shall have a 4-inch dial, 1/4 threaded connection, a Type 316 stainless steel snubber adapter, and a shut-off valve.
- C. **Manufacturers or Equal:**
 - 1. **Ashcroft Industrial Instruments (Dresser)**
 - 2. **Foxboro/Jordan, Inc.**
 - 3. **Duro Instrument, Corp., Series 100**

2.6 PIPE INSULATION

- A. Domestic backflow preventers and appurtenances without an approved protective enclosure shall be insulated.
- B. By-pass piping and appurtenances on Class 3, 4, 5, and 6 Fire Service Installations shall be insulated.
- C. Insulation shall be a prefabricated foam insulation material with an all-purpose jacket. The minimum insulation thickness shall be 2-inches. The insulation shall be **Polycell Insulating Foam, or equal**.

D. The insulation shall be wrapped with a 2-inch wide minimum, 10 mil black pipe tape.

2.7 RUBBER LINK SEALS

A. Rubber link seals shall be modular rubber sealing elements, with non-metallic pressure plates and galvanized folds, **Thunderline "Link Seals," O-Z Electrical "Thruwall" and "Floor Seals," or equal.**

2.8 FLANGED COUPLING ADAPTORS

A. Flanged coupling adapters for pressure reducing stations shall be factory fusion bonded epoxy **Ford FFCA or FFCA-1, APAC 201 or 221, or equal.** Nuts and bolts shall be for ductile iron pipe.

PART 3 -- EXECUTION

3.1 GENERAL

A. All pipes, fittings, and appurtenances shall be installed in conformance with the requirements of the applicable Sections of Divisions 2 and 15 and with the manufacturer's printed recommendations. All coatings shall be in conformance with Section 099000, "Protective Coatings."

B. Where the grade or alignment of the pipe is obstructed by existing utilities and structures such as conduits, ducts, pipes, maintenance holes, or other utility facilities, the obstruction shall be permanently supported, relocated, removed, or reconstructed by the CONTRACTOR in conformance with the requirements and approval of the owners of such utilities and structures.

C. All pipe shall be stockpiled and stored in conformance with the manufacturer's printed recommendations.

D. **Fill Material or Trench Support:** Overexcavation fill material, bedding, and trench subgrade shall be compacted as specified in Section 312300, "Utility Earthwork," and graded to provide a uniform and continuous support beneath the pipe at all points.

- END OF SECTION -

SECTION 331102 - PVC PRESSURE PIPE

PART 1 -- GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall provide all materials, equipment, and labor necessary to furnish and install 4 inch to 36 inch polyvinyl chloride (PVC) pressure pipe, and all appurtenant work, complete and operable, including all connections as shown on the Drawings and as specified herein.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 312300 Utility Earthwork.
- B. Section 331300 Pressure Pipeline Testing and Disinfection.
- C. Section 330130 Sanitary Sewer and Storm Drain System.
- D. Section 055900 Ductile Iron Pipe.
- E. Section 331100 Piping, General.
- F. Section 330526 Piping Identification Systems.
- G. Section 331200 Miscellaneous Piping, Valves, Fittings, and Appurtenances.
- H. Division 1 General Requirements.

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards:

- AASHTO Standard for Highway Bridges.
- ANSI/AWWA C104 Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
- ANSI/AWWA C110 Standard for Ductile-Iron and Gray-Iron Fittings, 3-In. through 48-In., for Water and Other Liquids.
- ANSI/AWWA C111 Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
- ANSI/AWWA C153 Standard for Ductile-Iron Compact Fittings, 3-In. through 6-In., for Water and other Liquids.
- AWWA C600 Installation of Ductile-Iron Water Mains and their Appurtenances.
- AWWA C900 Polyvinyl Chloride (PVC) Pressure Pipe, 4-In. through 12-In., for Water Distribution.
- AWWA C905 Polyvinyl Chloride (PVC) Water Transmission Pipe, Nominal Diameters 14-In. through 36-In.

1.4 CONTRACTOR SUBMITTALS

- A. **Certificates of Compliance:** Certificates of Compliance shall be provided for all products and materials proposed to be used under this Section, as specified in the referenced standards, and the following supplemental requirements:
1. Hydrostatic proof test reports.
 2. Sustained pressure test reports.
 3. Burst strength test reports.
- B. All expenses incurred in making samples for certification of tests shall be borne by the CONTRACTOR.

1.5 QUALITY ASSURANCE

- A. **Tests:** Except as modified herein, all materials used in the manufacture of the pipe shall be tested in accordance with the requirements of this Section, and as specified in the referenced standards, as applicable.
- B. The CONTRACTOR shall have said material tests performed at no additional costs to the CITY. The ENGINEER shall have the right to witness all testing provided, that the CONTRACTOR'S schedule is not delayed for the convenience of the ENGINEER.
- C. In addition to those tests specifically required, the ENGINEER may request additional samples of any material for testing by the CITY. The additional samples shall be furnished at no additional cost to the CITY.

PART 2 -- PRODUCTS

2.1 GENERAL

- A. PVC pressure pipe, 4 inch through 12 inch and 14 inch through 36 inch shall conform to the applicable requirements of AWWA C900 and AWWA C905, respectively, and shall be subject to additional requirements specified herein.
- B. All pipe material used for reclaimed water shall be purple such as **PW Purple Plus pipe as manufactured by PW Pipe, Purple Save Pipe as manufactured by J-M Manufacturing Company, Inc., Purple Centurion Pipe as manufactured by IPEX , or equal.**
- C. All PVC pipe shall be continuously marked in conformance with the appropriate ASTM. All purple PVC pipe shall be continuously marked in accordance with the requirements of Section 330526, "Piping Identification Systems."

2.2 PIPE DESIGN

- A. **General:** PVC pressure pipe shall be designed in accordance with the requirements of AWWA C900, or AWWA C905, as applicable, except that safety factors and surge pressure requirements of C900 shall be applied to all pipe, 4 inch through 36 inch. Pressure class shall be as shown on the Drawings, but in no case shall the dimension ratio be greater than 18 for C900 or 26 for C905 pipe. The pressure class for reclaimed water pressure pipe shall have a dimension ratio of 14 for C900 pipe or a dimension ratio of 18 for C905 pipe.

2.3 PIPE

- A. The pipe shall be of the diameter and pressure class as specified or shown, furnished complete with rubber gaskets, and all specials and fittings shall be provided as required. The dimensions and pressure classes for Dimension Ratios for PVC pressure pipe with Cast-Iron Pipe Equivalent O.D.'s shall conform to the requirements of AWWA C 900, or AWWA C 905, as applicable.
- B. **Joints:** All joints for the buried PVC pipe shall be an integral bell manufactured on the pipe employing a rubber ring joint. The bell shall be the same or greater thickness as of the pipe barrel.
- C. **Joint Deflection:** Deflection at the joint shall not exceed 1.0 degrees for AWWA C905 or 1.5 degrees for C900 or the maximum deflection recommended by the manufacturer. No deflection of the joint shall be allowed for joints which are over-belled or not belled to the stop mark.
- D. Bending of pipe shall not exceed recommendations of AWWA or manufacturers printed recommendations.

2.4 FITTINGS

- A. Fittings shall be ductile iron and shall conform to the requirements of AWWA C 110 or AWWA C153 minimum Class 250. Fittings shall be mechanical joint.
- B. Restrained joints shall be as approved in writing by the ENGINEER.
- C. All fittings shall be lined and coated in accordance with the requirements of Section 05060 "Ductile Iron Pipe."
- D. Each fitting shall be clearly labeled to identify its size and pressure class.
- E. **Service Saddles and Tapping Sleeves:** All service saddles, and tapping sleeves shall be in accordance with the requirements of Section 331200, "Miscellaneous Piping, Valves, Fittings, and Appurtenances."

PART 3 -- EXECUTION

3.1 GENERAL

- A. All laying, jointing, testing for defects and for leakage shall be performed in the presence of the ENGINEER, and shall be subject to its approval before acceptance. All material found during the progress to have defects will be rejected and the CONTRACTOR shall promptly remove such defective materials from the site of the work.
- B. Installation shall conform to the requirements of AWWA Manual M23, instructions furnished by the pipe manufacturer, and to the supplementary requirements or modifications specified herein. Wherever the provisions of this Section and the aforementioned requirements are in conflict, the more stringent provision shall apply.

3.2 PIPE HANDLING

- A. **Handling:** Pipe, fittings and accessories shall be carefully inspected before and after installation and those found defective shall be rejected. Pipe and fittings shall be free from fins and burrs. Before being placed in position, pipe, fittings, and accessories shall be cleaned, and shall be maintained in a clean and sanitary condition. Proper facilities shall be provided for lowering sections of pipe into trenches. Under no circumstances shall pipe, fittings or any other material be dropped or dumped into trenches.

3.3 STORAGE

- A. Pipe shall be stored, if possible, at the job site in unit packages provided by the manufacturer. Caution is to be exercised to avoid compression damage or deformation to bell ends of the pipe. Pipe shall be stored in such a way as to prevent sagging or bending and protected from exposure to direct sunlight by covering with an opaque material while permitting adequate air circulation above and around the pipe. Gaskets shall be stored in a cool, dark place out of the direct rays of the sun, preferably in original cartons. Pipe, fittings, or accessories improperly stored are subject to rejection by the ENGINEER.

3.4 TRENCHING AND BACKFILL

- A. Trench excavation and backfill shall conform to the requirements of Section 312300, "Utility Earthwork," and as specified herein.

3.5 INSTALLATION

- A. Bell and spigot pipe shall be laid with the bell end pointing in the direction of laying. Pipe shall be set to grade in straight lines, taking care to avoid the formation of any dips or low points. Pipe shall not be laid when the conditions of trench or weather are unsuitable as determined by ENGINEER. At the end of each day's work, open ends of pipe shall be closed temporarily with water-tight, expandable type plugs.
- B. Pressurized lines laid on a downhill grade shall be blocked and held in place until sufficient support is furnished by the following pipe to prevent movement. Water lines shall be laid uphill on grades exceeding 10 percent.
- C. Pipe shall be supported at its proper elevation and grade, care being taken to secure firm and uniform support. Wood support blocking will not be permitted. The full length of each section of pipe and fittings shall rest solidly on the pipe bed, with recessed excavation to accommodate bells and joints. Anchors and supports shall be provided where necessary and where indicated on the Drawings for fastening work into place. Fittings shall be independently supported.
- D. Joints shall be installed according to manufacturer's recommendations. Trenches shall be kept free of water until joints have been properly made. The maximum combined deflection at any coupling shall be in accordance with the manufacturer's printed recommendations.
- E. Pipe shall be cut by means of saws, power driven abrasive wheels or pipe cutters, which will produce a square cut. No wedge-type roller cutters will be permitted. After cutting, the end of the pipe shall be beveled using a beveling tool, portable type sander or abrasive disc.
- F. All necessary precautions shall be taken to prevent uplift or floating of the pipe prior to the completion of the backfilling operation. The CONTRACTOR shall assume full responsibility for any damage due to this cause and shall, at its own expense, restore and replace the pipe to its specified condition and grade if it is displaced due to floating.
- G. Each pipe elastomeric gasket joint shall be installed in conformance with the manufacturer's printed recommendations.

3.6 COPPER WIRE AND WARNING TAPE

- A. Installation of copper wire, warning tape, and pipe identification shall conform to Section 330526, "Piping Identification Systems."

3.7 SERVICE CONNECTIONS

- A. **Service Connections:** Service saddles or fittings for PVC pipe shall be used for all service connections on new pipeline installations. On existing PVC pipelines all service connections shall be tapping sleeves. Service saddles shall have a bearing area of sufficient width along the axis of the pipe, so that the pipe will not be distorted when the saddle is made tight. An internal shell cutter shall be used to drill through the corporation stop to minimize PVC shavings, retain the coupon, and reduce stress. **Single fluted shell cutters or twist drills will not be allowed.** Lubricate the cutting and tapping edges of the tool with cutting lubricant. Make the cuts slowly and use the follower very lightly. Do not force cutter through pipe wall. Shell cutter shall have sufficient throat depth to handle the heavy wall PVC pipe. Maximum outlet size permitted with service saddle is 2 inches.
- B. Tapping sleeves and valves shall be used for all outlets greater than 2 inches in diameter. Tapping sleeves shall be assembled and installed in accordance with the manufacturer's printed recommendations and Section 331200, "Miscellaneous Piping, Valves, Fittings, and Appurtenances."

3.8 TESTING AND DISINFECTION

- A. Field testing and disinfection of all pressure pipe shall conform to the requirements of Section 331300, "Pressure Pipeline Testing and Disinfection."

- END OF SECTION -

SECTION 331104 - STEEL PIPE - MORTAR-LINED AND MORTAR-COATED

PART 1 -- GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall provide all materials, equipment, and labor necessary to furnish and install mortar-lined and mortar-coated steel pipeline, and all appurtenant work, complete and operable, including all connections as shown on the Drawings and as specified herein.
- B. All steel pipe shall be cathodically protected and the cathodic protection system shall be designed on a case by case basis and signed and stamped by a Civil Engineer Registered in California.
- C. Connections to existing steel spiral wrapped pipe shall be designed by a registered Civil Engineer and submitted to the ENGINEER for review.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 02510 Pressure Pipeline Testing and Disinfection.
- B. Section 02513 Steel Pipe-Fabricated Specials.
- C. Section 03600 Grout.
- D. Section 09900 Protective Coating.
- E. Section 15050 Piping, General.
- F. Section 15075 Piping Identification Systems.
- G. Section 15105 Miscellaneous Piping, Valves, Fittings, and Appurtenances.
- H. Division 1 General Requirements.

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. **Commercial Standards:**

- AASHTO Standard Specifications for Highway Bridges.
- ANSI/AWS D1.1 Structural Welding Code Steel Thirteenth Edition (AWS).
- ASTM A 36 Specification for Structural Steel.
- ASTM A 139 Specification for Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4-in. and Over).
- ASTM A 283 Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
- ASTM A 570 Specification for Steel, Sheet and Strip, Carbon, Hot-Rolled, Structural Quality.
- ASTM A 572 Specification for High-Strength Low-Alloy Columbian-Vanadium Structural Steel.

ASTM C 150	Specification for Portland Cement.
ASTM E 165	Practice for Liquid Penetrant Inspection Method.
AWWA C200	Standard for Steel Water Pipe - 6-In. (150 mm) and Larger.
AWWA C205	Standard for Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4-In. and Larger - Shop Applied.
AWWA C206	Standard for Field Welding of Steel Water Pipe.
AWWA C208	Standard for Dimensions for Fabricated Steel Water Pipe Fittings.
AWWA C602	Standard for Cement-Mortar Lining of Water Pipelines-4-In. (100 mm) and Larger - in Place.
AWWA MANUAL M 11	Steel Pipe - A Guide for Design and Installation.

1.4 CONTRACTOR SUBMITTALS

- A. **Shop Drawings:** The CONTRACTOR shall submit shop drawings of pipe and fittings in accordance with the following supplemental requirements:
1. Joint and pipe fitting wall construction details which indicate the type and thickness of cylinder, the position, type, size and area of reinforcement, manufacturing tolerances, and all other pertinent information required for the manufacture of the product. Joint details shall be submitted where deep bell or butt strap joints are required for control of temperature stresses.
 2. Fittings and specials details such as elbows, wyes, tees, outlets, connections, test bulkheads, and nozzles or other specials where shown which indicate amount and position of all reinforcement. All fittings and specials shall be properly reinforced to withstand the internal pressure, both circumferential and longitudinal, and the external loading conditions as indicated in the approved design calculations.
 3. Design calculations including a complete stress analysis of each critical section of pipe wall, girth joints, and specials - all sufficient to ascertain conformance of pipe and fittings with these Specifications.
 4. Material lists and steel reinforcement schedules which include and describe all materials to be utilized.
 5. Line layout and marking diagrams which indicate the specific number of each pipe and fitting and the location of each pipe and the direction of each fitting in the completed line. In addition, the line layouts shall include: the pipe station and invert elevation at all changes in grade or horizontal alignment; the station and invert elevation to which the bell end of each pipe will be laid; all elements of curves and bends, both in horizontal and vertical alignment; and the limits of each reach of restrained and/or welded joints, or of concrete encasement.
 6. Full and complete information regarding location, type, size and extent of all welds shall be shown on the shop drawings. The shop drawings shall distinguish between shop and field welds. Shop drawings shall indicate by welding symbols or sketches the details of the welded joints and the preparation of parent metal required to make them. Joints or groups of joints in which welding

sequence or technique are especially important shall be carefully controlled to minimize shrinkage stresses and distortion.

7. Full and complete information regarding the cathodic protection system, designed and sealed by a corrosion engineer registered in the State of California.

B. **Certificate of Compliance:** Certificates of Compliance shall be provided for all products and materials proposed to be used under this Section, as specified in AWWA C200 and AWWA C205, respectively, and the following supplemental requirements:

1. Physical and chemical properties of all steel.
2. Hydrostatic test reports.
3. Results of production weld tests.

C. All expenses incurred in making samples for certification of tests shall be borne by the CONTRACTOR.

1.5 QUALITY ASSURANCE

A. **Inspection:** All pipe shall be subject to inspection at the place of manufacture in accordance with the provisions of AWWA C200 and AWWA C205, respectively, as supplemented by the requirements herein. The CONTRACTOR shall notify the ENGINEER, in writing, of the manufacturing starting date not less than 14 calendar days prior to the start of any phase of the pipe manufacture.

B. **Tests:** Except as modified herein, all materials used in the manufacture of the pipe shall be tested in accordance with the requirements of AWWA C200 and AWWA C205, as applicable.

1. After the joint configuration is completed and prior to lining with cement-mortar, each length of pipe of each diameter and pressure class shall be shop-tested and certified to a pressure of at least 80 percent of the yield strength of the pipe steel.
2. In addition to the tests required in AWWA C200, weld tests shall be conducted on each 5,000 feet of production welds and at any other times there is a change in the grade of steel, welding procedure, or welding equipment.

C. The CONTRACTOR shall perform said material tests at no additional cost to the CITY. The ENGINEER shall have the right to witness all testing conducted by the CONTRACTOR; provided, that the CONTRACTOR'S schedule is not delayed for the convenience of the ENGINEER.

D. In addition to those tests specifically required, the ENGINEER may request additional samples of any material including mixed concrete and lining and coating samples for testing by the CITY. The additional samples shall be furnished at no additional cost to the CITY.

E. **Welding Requirements:** All welding procedures used to fabricate pipe shall be prequalified under the provisions of ANSI/AWS D1.1. Welding procedures shall be required for, but not necessarily limited to, longitudinal and girth or spiral welds for pipe cylinders, spigot and bell ring attachments, reinforcing plates and ring flange welds and plates for lug connections.

F. **Welder Qualifications:** All welding shall be done by skilled welders, welding operators and tackers who have had adequate experience in the methods and materials to be used. Welders shall be qualified under the provisions of ANSI/AWS D1.1 by an independent local, approved testing agency not more than 6 months prior to commencing work on the pipeline. Machines and electrodes similar to those used on the project shall be used in qualification tests. The CONTRACTOR shall furnish all material and bear the expense of qualifying welders.

PART 2 -- PRODUCTS

2.1 GENERAL

- A. Mortar-lined and mortar-coated steel pipe shall conform to AWWA C200 and AWWA C205, subject to the following supplemental requirements:
1. The pipe shall be of the diameter and class shown on the Drawings, shall be furnished complete with rubber gaskets or welded joints, as specified, and all specials and bends shall be provided as specified or required.
 2. For pipe 14 inches in diameter and larger, the inside diameter after lining shall not be less than the nominal diameter specified or shown. Pipe smaller than 14 inches in diameter may be furnished in standard outside diameters.
- B. **Marking:** The CONTRACTOR shall insure all pipes and specials are legibly marked in accordance with the laying schedule and marking diagram. Each pipe shall be numbered in sequence and said number shall appear on the laying schedule and marking diagram in its proper location for installation. All special pipe sections and fittings shall be marked at each end with top field centerline.
- C. **Handling and Storage:** The pipe shall be handled by use of wide slings, padded cradles, or other devices, acceptable to the ENGINEER, designed and constructed to prevent damage to the pipe coating. The use of chains, hooks, or other equipment which might injure the pipe coating will not be allowed. Stockpiled pipe shall be suitably supported and shall be secured to prevent accidental rolling. All other pipe handling equipment and methods shall be acceptable to the ENGINEER.
- D. The CONTRACTOR shall be fully liable for the cost of replacement or repair of pipe which is damaged.
- E. Stockpiled pipe shall be supported on sand or earth berms free of rock exceeding 3 inches in diameter. The pipe shall not be rolled and shall be secured to prevent accidental rolling.
- F. **Strutting:** Adequate strutting shall be provided on all specials, fittings and straight pipe so as to avoid damage to the pipe and fittings during handling, storage, hauling and installation. For mortar-lined or mortar-coated steel pipe, the following requirements shall apply:
1. The strutting shall be placed as soon as practicable after the mortar lining has been applied and shall remain in place while the pipe is loaded, transported, unloaded, installed and backfilled at the jobsite.
 2. The strutting materials, size and spacing shall be adequate to support the earth backfill plus any greater loads which may be imposed by the backfilling and compaction equipment.
 3. Any pipe damaged during handling, hauling, storage, or installation due to improper strutting shall be repaired or replaced.
 4. The details of the strutting assembly shall be submitted for review by the ENGINEER prior to the start of pipe manufacture.
- G. **Laying Lengths:** Maximum pipe laying lengths shall be 40 feet with shorter lengths provided as required by the Shop Drawings.
- H. **Offset Tolerances:** For pipe wall thicknesses of 3/8-inch or less, the maximum radial offset (misalignment) for submerged arc and gas metal arc welded pipe shall be 0.1875 times the pipe wall

thickness or 1/16-inch, whichever is larger. For pipe wall thickness of greater than 3/8-inch, the maximum radial offset shall be 0.1875 times the wall thickness or 5/32-inch, whichever is smaller.

- I. **Lining:** The pipe lining shall have smooth dense interior surfaces and shall be free from fractures, excessive interior surface crazing and roughness.
- J. **Bonding and Electrical Conductivity:** All unwelded pipe joints shall be bonded for electrical conductivity in accordance with the approved cathodic protection system design. Insulated joints shall be provided as required by the approved cathodic protection system design.
- K. **Closures and Correction Pieces:** Closures and correction pieces shall be provided as required so that closures may be made due to different headings in the pipe laying operation and so that correction may be made to adjust the pipe laying to conform to pipe stationing shown on the Drawings. The locations of closure assemblies are shown on the Drawings. Any change in location or number of said items must be approved by the ENGINEER.

2.2 PIPE DESIGN

- A. **General:** The pipe furnished shall be steel pipe, mortar-lined and mortar-coated, with rubber gasketed or field welded joints. The pipe shall consist of a steel cylinder, shop-lined with cement-mortar and shop-coated with an exterior coating of cement-mortar. Pipes 60-in and larger pipe may be lined in-place with cement mortar.
- B. The pipe shall be designed, manufactured, tested, inspected, and marked according to applicable requirements specified herein and except as hereinafter modified, shall conform to AWWA C200.
- C. **Pipe Dimensions:** The pipe shall be of the diameter and class shown on the Drawings. The minimum steel cylinder thickness for each pipe size shall be as specified or shown on the Drawings but in no case shall the minimum steel cylinder thickness be less than 0.135 inches or the nominal pipe diameter in inches divided by 240, whichever is greater.
- D. **Fitting Dimensions:** The fittings shall be of the diameter and class shown on the Drawings.
- E. **Joint Design:** Unless welded joints are specifically required on the Drawings, the standard field joint for steel pipe shall be either a single-welded lap joint or a rubber-gasketed joint for all pipe sizes up to and including 60-inch diameter and shall be a single-welded lap joint for pipe sizes above 60-inch diameter. Flanged joints shall be required where shown on the Drawings. Butt-strap joints shall be used only where required for closures or where shown on the Drawings. The joints furnished shall have the same or higher pressure rating as the abutting pipe.
- F. Lap joints prepared for field welding shall be in accordance with AWWA C200. The method used to form, shape and size bell ends shall be such that the physical properties of the steel are not substantially altered. Bell ends shall be formed by an expanding press or by being moved axially over a die in such a manner as to stretch the steel plate beyond its elastic limit to form a truly round bell of suitable diameter and shape. Faying surfaces of the bell and spigot shall be essentially parallel, but in no case shall the bell slope vary more than 2 degrees from the longitudinal axis of the pipe.
- G. For bell-and-spigot ends with rubber gaskets, the clearance between the bells and spigots shall be such that when combined with the gasket groove configuration and the gasket itself, will provide watertight joints under all operating conditions when properly installed. The CONTRACTOR shall require the pipe manufacturer to submit details complete with significant dimensions and tolerances and also to submit performance data indicating that the proposed joint has performed satisfactorily under similar conditions. In the absence of a history of field performance, the results of a test program shall be submitted. Bell ends shall be formed by an expanding press or by being moved axially over a die in such a manner as to stretch the steel plate beyond its elastic limit to form a truly round bell of suitable diameter and shape. No process will be permitted in which the bell is formed by rolling.

Spigot ends with rolled gasket grooves shall be formed using dies conforming to the minimum radii specified in Appendix X1 of ASTM A570 and the actual yield strength of the steel used in the spigot rolling operation (i.e., yield strength values in mill certifications and subsequent destructive test results) shall be limited to 42,000 psi.

- H. Shop-applied interior linings and exterior coatings shall be held back from the ends of the pipe as shown on the Drawings.
- I. **Restrained Joints:** Where shown, restrained joints shall be field-welded joints. Designs shall include considerations of stresses induced in the steel cylinder, the joint rings and any field welds caused by thrust at bulkheads, bends, reducers and line valves resulting from the design working pressure. For field welded joints, design stresses shall not exceed 50 percent of the specified minimum yield strength of the grade of steel utilized, or 16,500 psi, whichever is less, for the part being examined when longitudinal thrust is assumed to be uniformly distributed around the circumference of the joint. At the CONTRACTOR'S option, the steel cylinder area may be progressively reduced from the point of maximum thrust to the end of the restrained length. All joints to be field welded for thrust restraint shall have the joint rings attached to the cylinder with double fillet welds.

2.3 MATERIALS

- A. **Cement:** Cement for mortar shall conform to the requirements of AWWA C205; provided, that cement for mortar coating shall be Type V and mortar lining shall be Type II or V. A fly ash or pozzolan shall not be used as a cement replacement.
- B. **Steel for Cylinders and Fittings:** Pipe manufactured under AWWA C200 shall be fabricated from sheet conforming to the requirements of ASTM A 570, Grades 30, 33, 36 or 40, or from plate conforming to the requirements of ASTM A 36; A 283, Grades C or D; or ASTM A 572, Grade 42 or coil conforming to the requirements of ASTM A 139, Grades B or C. All longitudinal and girth seams, whether straight or spiral, shall be butt welded using an approved electric-fusion-weld process.
- C. All steel used for the fabrication of pipe shall have a maximum carbon content of 0.25 percent and shall have a minimum elongation of 22 percent in a 2-inch gage length.
- D. **Welding of Joint Rings to Resist Thrust:** Where steel pipe with field-welded separate formed joint rings are used for thrust restraint, the joint rings shall be welded to the cylinder with double fillet welds.

2.4 PIPE FITTINGS AND SPECIALS

- A. Unless otherwise specified, all specials and fittings shall be in accordance with Section 02513, "Steel Pipe-Fabricated Specials" and shall conform to the dimensions of AWWA C208.
- B. Sufficient handholes shall be provided in fittings and specials to allow repair of linings after field welding. Handholes shall be 5 inch minimum, threaded outlets.

2.5 CEMENT-MORTAR LINING

- A. **Cement-Mortar Lining for Shop Application:** Except as otherwise provided herein, interior surfaces of all steel pipe, fittings, and specials shall be cleaned and lined in the shop with cement-mortar lining applied centrifugally in conformity with AWWA C205. During the lining operation and thereafter, the pipe shall be maintained in a round condition by suitable bracing or strutting.
- B. The nominal lining thickness shall be in accordance with AWWA C 205. The pipe shall be designed for deflection using the nominal lining thickness.
- C. The pipe shall be left bare where field joints occur. Ends of the linings shall be left square and uniform. Feathered or uneven edges will not be permitted.

- D. Defective linings, shall be removed from the pipe wall and shall be replaced to the full thickness required. Defective linings shall be cut back to a square shoulder in order to avoid feather edged joints.
- E. The progress of the application of mortar lining shall be regulated in order that all hand work, including the repair of defective areas is cured in accordance with the provisions of AWWA C205. Cement-mortar for patching shall be the same materials as the mortar for machine lining, except that a finer grading of sand and mortar richer in cement shall be used when field inspection indicates that such mix will improve the finished lining of the pipe.
- F. **Cement-Mortar Lining for Field Application:** The materials and design of in-place cement-mortar lining shall be in accordance with AWWA C602 and the following supplementary requirements:
 - 1. Admixtures shall contain no calcium chloride.
 - 2. The minimum lining thickness shall be as specified for shop-applied cement-mortar lining and finished inside diameter after lining shall be as shown on the Drawings.
- G. **Protection of Pipe Lining:** For all pipe and fittings with shop-applied cement-mortar linings, a polyethylene or other suitable bulkhead shall be provided on the ends of the pipe and on all special openings to prevent drying out of the lining. All bulkheads shall be substantial enough to remain intact during shipping and storage until the pipe is installed.

2.6 EXTERIOR COATING

- A. **Exterior Coating of Exposed Piping:** Unless otherwise specified by the ENGINEER the exterior surfaces of pipe which will be exposed to the atmosphere inside structures or above ground shall be thoroughly cleaned and then given a shop coat of rust-inhibitive primer conforming to the requirements of Section 09900, "Protective Coating."
- B. **Exterior Coating of Buried Piping:** All pipe for buried service, including bulkheads, shall be coated with cement-mortar coating, with thickness and tolerances in conformance with AWWA C205. Unless otherwise shown on the Drawings, exterior surfaces of pipe or fittings passing through structure walls shall be cement-mortar coated from the first flange inside the structure to the end of the underground portion of pipe or fitting. The coating shall be reinforced in accordance with AWWA C205.

2.7 PIPE APPURTENANCES

- A. Pipe appurtenances shall be in accordance with the requirements of Section 15050, "Piping, General."

PART 3 -- EXECUTION

3.1 INSTALLATION OF PIPE

- A. **Handling and Storage:** All pipe, fittings and specials, shall be carefully handled and protected against damage to lining and coating, impact shocks and free fall. Pipe shall not be placed directly on rough ground but shall be supported in a manner which will protect the pipe against injury whenever stored at the site of the work or elsewhere. No pipe shall be installed when the lining or coating show cracks as defined in AWWA C205. Such damaged lining and coating shall be repaired, or a new undamaged pipe shall be furnished and installed.
- B. The CONTRACTOR shall inspect each pipe and fitting to insure that there are no damaged portions of the pipe. The CONTRACTOR shall remove or smooth out any burrs, gouges, weld splatter or other small defects prior to laying the pipe.

- C. Installation of pipes in prepared trenches shall start at the lowest point, with the spigot ends pointing in the direction of flow.
- D. Before placement of pipe in the trench, each pipe or fitting shall be thoroughly cleaned of any foreign substance which may have collected thereon and shall be kept clean at all times thereafter. For this purpose, the openings of all pipes and fittings in the trench shall be closed during any interruption in the installation of the pipe.
- E. **Pipe Laying:** When the pipe is being laid, it shall be turned and placed where possible, so that any slightly damaged coating portion will be on top. The damaged area shall be repaired. All interior or exterior damaged areas shall be repaired using materials and methods in accordance with AWWA C205 and Section 03600, "Grout."
- F. Pipe shall be laid directly on the bedding material. No blocking will be permitted, and the bedding shall be such that it forms a continuous, solid bearing for the full length of the pipe. Excavations shall be made as needed to facilitate removal of handling devices after the pipe is laid. Bell holes shall be formed at the ends of the pipe to prevent point loading at the bells or couplings. Excavation shall be made as needed outside the normal trench width at field joints to permit adequate access to the joints for field connection operations and for application of coating on field joints.
- G. Each section of pipe shall be laid in the order and position shown on the laying schedule. In laying pipe, it shall be laid to the set line and grade, within approximately one inch plus or minus. Renumbering of pipe or using pipe out of sequence will not be allowed. The CONTRACTOR has the option of having spare pipe lengths on site for use as replacement lengths at its own expense.
- H. Vertical or horizontal grade changes, where approved by the ENGINEER, may be made by the deflection of joints or by the use of bevel adapters. In no case shall the deflection in the joint exceed the maximum deflection recommended by the pipe manufacturer. No joint shall be misfit any amount which will be detrimental to the strength and water tightness of the finished joint.
- I. Except for short runs which may be permitted by the ENGINEER, pipes shall be laid uphill. Pipe which is laid on a downhill grade shall be blocked and held in place until sufficient support is furnished by the following pipe to prevent movement. Pipes shall be laid uphill on grades exceeding 10 percent.
- J. Pipe struts shall be left in place until backfilling operations have been completed for pipe 42 inches in diameter and larger. The struts shall remain the property of the CONTRACTOR. Struts in pipe smaller than 42 inches may be removed immediately after laying, provided, that the deflection of the pipe during and after backfilling does not exceed that specified.
- K. **Cold Weather Protection:** No pipe shall be installed upon a foundation into which frost has penetrated or at any time that there is a danger of the formation of ice or penetration of frost at the bottom of the excavation. No pipe shall be laid unless it can be established that the trench will be backfilled before the formation of ice and frost occurs.
- L. **Pipe and Specials Protection:** The openings of all pipe and specials where the pipe and specials have been cement-mortar lined in the shop shall be protected with appropriate bladders or bulkheads to maintain a moist atmosphere and to prevent unauthorized access by persons, animals, water or any undesirable substance. The bulkheads shall be so designed to prevent drying out of the interior of the pipe. Plywood will not be allowed. The CONTRACTOR shall introduce water into the pipe to keep the mortar moist where moisture has been lost due to damaged bulkheads.
- M. All necessary precautions shall be taken to prevent uplift or floating of the pipe prior to the completion of the backfilling operation. The CONTRACTOR shall assume full responsibility for any damage due to this cause and shall, at its own expense, restore and replace the pipe to its specified condition and grade if it is displaced due to floating.

- N. **Pipe Cleanup:** As pipe laying progresses, the CONTRACTOR shall keep the pipe interior free of all debris. The CONTRACTOR shall completely clean the interior of the pipe of all sand, dirt, mortar splatter and any other debris following completion of pipe laying, pointing of joints and any necessary interior repairs prior to testing and disinfecting the completed pipeline.

3.2 RUBBER GASKETED JOINTS

- A. **Rubber Gasketed Joints:** Immediately before jointing pipe, the spigot end of the pipe shall be thoroughly cleaned, and a clean rubber gasket lubricated with an approved vegetable-based lubricant shall be placed in the spigot groove. The volume of the gasket shall be "equalized" by moving a metal rod between the gasket and the spigot ring around the full circumference of the spigot ring. The bell of the pipe already in place shall be carefully cleaned and lubricated with a vegetable-based lubricant. The spigot of the pipe section shall then be inserted into the bell of the previously laid joint and telescoped into its proper position. Tilting of the pipe to insert the spigot into the bell will not be permitted. After the pipe units have been joined, a feeler gage shall be inserted into the recess and moved around the periphery of the joint to detect any irregularity in the position of the rubber gasket. If the gasket cannot be "felt" all around, the joint shall be disassembled. If the gasket is undamaged, as determined by the ENGINEER, it may be reused, but only after the bell ring and gasket have been relubricated.

3.3 WELDED JOINTS

- A. **General:** Field welded joints shall be in accordance with AWWA C206.
- B. Where exterior welds are performed, adequate space shall be provided for welding and inspection of the joints.
- C. During installation of welded steel pipe in either straight alignment or on curves, the pipe shall be laid so that at any point around the circumference of the joint there is a minimum lap of 1/2-inch and a minimum space of 3/4-inch plus the thickness of the steel pipe wall between the spigot end of the pipe and the nearest tangent to a bell radius.
- D. Butt straps, where used or required, shall be a minimum of 6-inches wide, the same thickness as the pipe wall and shall provide for a minimum of 3/4-inch lap at each pipe joint.
- E. After the pipe and pipe joint are properly positioned in the trench, the length of pipe between joints shall be backfilled to at least one foot above the top of the pipe. Care shall be exercised during the initial backfilling to prevent movement of the pipe and to prevent any backfill material from being deposited on the joint.
- F. To control temperature stresses, the unbackfilled joint areas of the pipe shall be shaded from the direct rays of the sun by the use of properly supported awnings, umbrellas, tarpaulins, or other suitable materials for a minimum period of 2 hours prior to the beginning of the welding operation and until the weld has been completed. Shading materials at the joint area shall not rest directly on the pipe but shall be supported to allow air circulation around the pipe. Shading of the pipe joints need not be performed when the ambient air temperature is below 45 degrees F.
- G. Prior to the beginning of the welding procedure, any tack welds used to position the pipe during laying shall be removed. Any annular space between the faying surfaces of the bell and spigot shall be equally distributed around the circumference of the joint by shimming, jacking, or other suitable means. The weld shall then be made in accordance with AWWA C206. Where more than one pass is required, each pass except the first and final one shall be peened to relieve shrinkage stresses; and all dirt, slag, and flux shall be removed before the succeeding bead is applied.
- H. As soon as practicable after welding of each joint, all field-welded joints shall be tested by the liquid penetrant inspection procedure conforming to the requirements of ASTM E 165 under Method "B" and

"Leak Testing." All defects shall be chipped out, rewelded and retested. Upon retest, the repaired area shall show no leaks or other defects. All CITY costs for re-tests after the first re-test shall be paid for by the CONTRACTOR.

- I. Following tests of the joint, the exterior joint spaces shall be coated, and interior linings shall be repaired in accordance with these specifications.
- J. **Qualifications of Procedures and Welders:** All welding procedures used to install pipe shall be prequalified under provisions of ANSI/AWS D1.1. Welding procedures shall be required for field attachments and field welded joints. Copies of welders certificates shall be provided to the ENGINEER.
- K. **Joints:** The pipe ends shall be cut straight on joints where butt straps are used for realignment, adjustment, or deflection, and fillet welds shall be made as shown on the Drawings.
- L. Unless double fillet welds are shown on the Drawings, field welded lap joints may, at the CONTRACTOR'S option, be made on either the inside or the outside of the pipe.

3.4 JOINT COATING AND LINING

- A. **General:** The interior and exterior joint recesses shall be thoroughly wiped clean and all water, loose scale, dirt and other foreign material shall be removed from the inside surface of the pipe. Joint grout shall be non-shrink grout as specified in Section 03315, "Grout."
- B. **Joint Coating:** After the pipe has been laid and after sufficient backfill has been placed between the joints to hold the pipe securely in place, the outside annular space between pipe sections shall be completely filled with non-shrink grout formed by the use of grout bands. The grout shall be thoroughly mixed with water to a consistency of thick cream. The grout space prior to filling shall be flushed with water so that the surface of the joint to be in contact with the grout will be thoroughly moistened when the grout is poured. The joint shall be filled with grout by pouring from one side only, and shall be rodded with a wire or other flexible rod or vibrated so that the grout completely fills the joint recess by moving down one side of the pipe, around the bottom of the pipe and up the opposite side. Pouring and rodding the grout shall be continued to allow completion of the filling of the entire joint recess in one operation. Care shall be taken to leave no unfilled space. Grouting of the outside joint spaces shall be kept as close behind the laying of the pipe as possible except that in no case shall grouting be closer than 3 joints of the pipe being laid.
- C. **Grout Bands (Diapers):** The grout bands or heavy-duty "diapers" shall either be polyethylene foam-lined fabric with steel strapping or polypropylene fabric with fabric backing. The materials shall be of sufficient strength to hold the fresh mortar, resist rodding of the mortar and allow excess water to escape. The foam plastic shall be 100 percent closed cell, chemically inert, insoluble in water and resistant to acids, alkalis, and solvents, and shall be **Dow Chemical Company "Ethafom 222," or equal.** The polypropylene fabric shall be a minimum of 3 ounces per square yard and shall be manufactured by **Dupont, Typar, or equal.**
- D. The fabric backing shall be cut and sewn into 9-inch wide strips with slots for the steel strapping on the outer edges. The polyethylene foam shall be cut into strips 6-inches wide and slit to a thickness of 1/4-inch which will expose a hollow or open cell surface on one side. The foam liner shall be attached to the fabric backing with the open or hollow cells facing towards the pipe. The foam strip shall cover the full interior circumference of the grout band with sufficient length to permit an 8-inch overlap of the foam at or near the top of the pipe joint. Splices to provide continuity of the material will be permitted. The polyethylene foam material shall be protected from direct sunlight.
- E. The polyethylene foam-lined grout band shall be centered over the joint space with approximately equal widths extending over each pipe end and securely attached to the pipe with the steel straps. After filling the exterior joint space with non-shrink grout, the flaps shall be closed and overlapped in a

manner that fully encloses the grout with polyethylene foam. The grout band shall remain in position on the pipe joint.

- F. **Joint Lining:** After the backfill has been completed to final grade, the interior joint recess shall be filled with non-shrink grout of stiff consistency. The mortar shall be tightly packed into the joint recess and troweled flush with the interior surface, and all excess shall be removed. At no point shall there be an indentation or projection of the mortar exceeding 1/16-inch. With pipe smaller than 24 inches in diameter, before the spigot is inserted into the bell, the bell shall be daubed with non-shrink grout. The spigot end then shall be forced to the bottom of the bell and excess mortar on the inside of the joint shall be swabbed out.
- G. **Handholes:** Handholes shall be provided for applying cement mortar lining in the field at butt-strap connections. Handholes shall be 5-inch standard steel couplings and shall be furnished with malleable iron plugs.
- H. **Cement-Mortar Lining, Field-Applied:** For pipe diameters of 60 inches or larger, the CONTRACTOR may construct the cement-mortar lining in-place. The application of in-place cement-mortar lining shall be in accordance with AWWA C602.
- I. Equipment and machines shall conform to AWWA C205. The CONTRACTOR shall perform all work in a thorough and workmanlike manner by trained personnel, under the supervision of experienced personnel skilled in machine application of cement-mortar lining.
- J. Curing of the in-place cement-mortar lining shall be in accordance with AWWA C602. The CONTRACTOR shall provide additional protective devices as required to ensure that the airtight covers, which maintain a moist condition in the pipeline, are not damaged.
- K. Defective areas encompassing the full diameter of the pipe shall be replaced by machine wherever the length measured along the pipe centerline is greater than 5 feet; otherwise defective areas may be replaced by hand.

3.5 INSTALLATION OF PIPE APPURTENANCES

- A. **Protection of Appurtenances:** Where the joining pipe is concrete or coated with cement mortar, buried appurtenances shall be coated with a minimum thickness of one inch of cement mortar having one part cement to not more than 2 parts plaster sand.
- B. **Installation of Flanged Joints:** Before the joint is assembled, the flange faces shall be thoroughly cleaned of all foreign material with a power wire brush. The gasket shall be centered and the connecting flanges drawn up watertight without unnecessarily stressing the flanges. All bolts shall be tightened in a progressive diametrically opposite sequence and torqued with a suitable, approved and calibrated torque wrench. All clamping torque shall be in conformance with the manufacturers printed recommendations and shall be applied to the nuts only.
- C. All buried flanges shall be coated and protected in accordance with Section 09900, "Protective Coating."
- D. **Insulated Joints:** Insulated joints and appurtenant features shall be made by the CONTRACTOR as shown on the Drawings or as required by the approved cathodic protection system design. The CONTRACTOR shall exercise special care when installing these joints to prevent electrical conductivity across the joint. After the insulated joint is completed, an electrical resistance test will be performed by the ENGINEER. Should the resistance test indicate a short circuit, the CONTRACTOR shall remove the insulating units to inspect for damages, replace all damaged portions and reassemble the insulating joint. The insulated joint shall then be retested to assure proper insulation.

- E. **Flexible Coupled Joints:** When installing flexible couplings, care shall be taken that the connecting pipe ends, couplings and gaskets are clean and free of all dirt and foreign matter with special attention being given to the contact surfaces of the pipe, gaskets and couplings. The couplings shall be assembled and installed in conformity with the recommendation and instruction of the coupling manufacturer. Sleeve type coupling shall conform to the requirements of Section 15050, "Piping, General."
- F. Wrenches used in bolting couplings shall be of a type and size recommended by the coupling manufacturer. Coupling bolts shall be tightened so as to secure a uniform annular space between the follower rings and the body of the pipe with all bolts tightened approximately the same amount. Diametrically opposite bolts shall be tightened progressively and evenly. Final tightening shall be done with a suitable, approved and calibrated torque wrench set for the torque recommended by the coupling manufacturer. All clamping torque shall be applied to the nut only.
- G. Upon completion of the coupled joint, the coupling and bare metal of the pipe shall be cleaned, primed and protected in accordance with the requirements of Section 09900, "Protective Coating."
- H. Installation of warning tape shall be in conformance with Section 15075, "Piping Identification Systems."

3.6 CORROSION CONTROL

- A. **Joint Bonding:** Except where otherwise specified, all joints shall be cleaned to bare bright metal at the point where the bond is installed.
- B. **Cathodic Protection:** Corrosion mitigation and testing materials, such as cathodic protection system with or without impressed current, magnesium anodes, deep well anode bed sand bed rectifiers, reference electrodes and test lead wires shall be furnished and installed when required in conformance with the approved cathodic protection system design.
- C. Electrolysis test station design and installation shall be submitted for review by the ENGINEER and shall be installed where shown on the drawings.

3.7 TESTING AND DISINFECTION

- A. Field testing and disinfection of all steel pipe shall conform to the requirements of Section 02510, "Pressure Pipeline Testing and Disinfection."

- END OF SECTION -

SECTION 331106 - STEEL PIPE - FABRICATED SPECIALS

PART 1 -- GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall provide all materials, equipment and labor necessary to furnish and install, all closure and correction pieces, bends, reducers, nozzles, wyes, tees, crosses, outlets, manifolds and other steel plate specials and all appurtenant work, complete and operable, including connections as shown on the Drawings and as specified herein.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 02510 Pressure Pipeline Testing and Disinfection.
- B. Section 02512 Steel Pipe - Mortar-Lined and Mortar-Coated.
- C. Section 03600 Grout.
- D. Section 09900 Protective Coating.
- E. Section 15050 Piping General.
- F. Section 15105 Miscellaneous Piping, Valves, Fittings, and Appurtenances.
- G. Division 1 General Requirements.

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards:

- AWWA C200 Standard for Steel Water Pipe 6 in. (150mm) and Larger.
- AWWA C 205 Standard for Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4 in. and Larger - Shop applied.
- AWWA C208 Standard for Dimensions for Fabricated Steel Water Pipe Fittings.
- ASTM A 105 Specification for Carbon Steel Forgings for Piping Applications.
- ASTM A 216 Specification for Steel Castings, Carbon, suitable for Fusion Welding, for High Temperature Service.
- ASTM A 234 Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
- ASTM E 165 Practice for Liquid Penetrant Inspection Method.
- AWWA Manual M 11 Steel Pipe - A Guide for Design and Installation.

1.4 CONTRACTOR SUBMITTALS

- A. **Shop Drawings:** The CONTRACTOR shall submit shop drawings and laying diagrams of all pipe, joints, closure and correction pieces, bends, reducers, nozzles, wyes, tees, crosses, outlets, manifolds and other steel plate specials.
- B. Design calculations shall be submitted to the ENGINEER for review prior to manufacture of pipe specials.
- C. **Certificates of Compliance:** Certificates of Compliance shall be provided for all products or materials proposed to be used under this Section.

1.5 QUALITY ASSURANCE

- A. **Shop Testing of Steel Plate Specials:** Upon completion of the welding, but prior to lining and coating, each steel plate special shall be bulkheaded and tested under a hydrostatic pressure of 1-1/2 times the design pressure. Hydrostatic testing will not be required if the straight pipe used in fabricating the specials has been previously tested and meets the requirements of the applicable piping Section, provided that all other welded seams are tested by the liquid penetrant inspection procedure conforming to ASTM E 165, under Method "B" and "Leak Testing" or where applicable by the soap and compressed air method at an air pressure of 25 psi. Any pin holes or porous welds which may be revealed by the test shall be chipped out and rewelded and the pipe or fitting retested.
- B. No outside mortar shall be applied over a seam prior to testing; however, mortar lining may be applied over a seam prior to hydrostatic testing, but under such conditions said pressure test shall be held on the pipe or fitting for a period of not less than 30 minutes.
- C. **Field Testing:** Field testing shall conform to the requirements of Section 02510, "Pressure Pipeline Testing and Disinfection."

PART 2 -- PRODUCTS

2.1 GENERAL

- A. Specials are defined as fittings, closure pieces, correction pieces, bends, reducers, nozzles, wyes, tees, crosses, outlets, manifolds and other steel plate specials wherever located.

2.2 PIPE DESIGN

- A. **Design:** Except as otherwise provided herein, materials, fabrication and shop testing of straight pipe shall conform to the requirements of AWWA C200, and shall conform to the dimensions of AWWA C208.

2.3 FABRICATION AND MATERIALS

- A. **General:** Reinforcement for closure and correction pieces, bends, reducers, nozzles, wyes, tees, crosses, outlets, manifolds and other steel plate specials shall be designed in accordance with AWWA Manual M-11. Reinforcement shall be designed for the design pressure specified or shown and shall be in accordance with the design details shown. Specials and fittings shall be equal in pressure design strength and shall have the same lining and coating as the adjoining pipe. Unless otherwise shown, the minimum radius of elbows shall be 2.5 times the pipe diameter and the maximum miter angle on each section of the elbow shall not exceed 11-1/4 degrees.
- B. Specials and fittings that cannot be mechanically lined and coated shall be lined and coated by hand-application, using the same materials as are used for the pipe and in accordance with the applicable AWWA or ASTM Standards. Coating and lining applied in this manner shall provide protection equal to that specified for the pipe. Fittings may be fabricated from pipe that has been mechanically lined

and/or coated. Areas of lining and coating that have been damaged by such fabrication shall be repaired by hand-applications in accordance with applicable AWWA or ASTM Standards.

- C. Access maintenance holes with covers shall be as detailed on the Drawings.
- D. All threaded outlets shall be forged steel suitable for 3000 psi service per ASTM A 105 or ASTM A 216, and shall be as manufactured by **Bonnie Forge Co., "Threadolet," Allied Piping Products Co., "Branchlet" or equal.**
- E. Moderate deflections and long radius curves may be made by means of beveled joint rings, by pulling standard joints, by using short lengths or pipe, or a combination of these methods; provided that pulled joints shall not be used in combination with bevels. The maximum total allowable angle for beveled joints shall be 5 degrees per pipe joint. Bevels shall be provided on the bell ends. Mitering of the spigot ends will not be permitted. The maximum allowable angle for pulled joints shall be in accordance with the manufacturer's recommendations or the angle which results from a 3/4 inch pull out from normal joint closure, whichever is less. All horizontal deflections or fabricated angles shall fall on the alignment. In congested areas or at locations where underground structures are encountered, the chord produced by deflecting the pipe shall be no further than 6 inches from the alignment shown.
- F. All vertical deflections shall fall on the alignment and at locations adjacent to underground obstructions, points of minimum earth cover, and pipeline outlets and structures, the pipe angle points shall match the angle points shown.
- G. **Outlets, Nozzles, Tees, Wyes, and Crosses:** All outlets 12 inch and smaller may be fabricated from Schedule 30 or heavier steel pipe in the standard outside diameters, i.e., 12-3/4 inch, 10-3/4 inch, 8-5/8 inch, 6-5/8 inch, and 4-1/2 inch.
- H. The design of outlet reinforcement shall be in accordance with the procedures given in Chapter 13 of AWWA Manual M-11, except that the design pressure, P, used in the AWWA Manual M-11 procedure shall equal the greater of $1.25 P_w$ or $0.9375 P_t$. Unless otherwise shown outlets 2 inches in diameter and smaller, Weld-O-Let as specified in Section 15105, "Miscellaneous Piping, Valves, Fittings and Appurtenance," need not be reinforced.
- I. In lieu of saddle or wrapper reinforcement as provided by the design procedure in AWWA Manual M-11, pipe or specials with outlets may be fabricated in their entirety of steel plate having a thickness equal to the sum of the pipe wall plus the required reinforcement.
- J. Where required by the AWWA Manual M-11 design procedure crotch plate reinforcement shall be furnished.
- K. **Steel Welded Fittings:** Steel welded fittings shall conform to ASTM A 234.
- L. **Ends for Mechanical-Type Couplings:** Except as otherwise provided herein, where mechanical-type couplings are indicated, the ends of pipe shall be banded with Type C collared ends using double fillet welds.
- M. **Lining:** All requirements pertaining to thickness, application and curing of lining specified for straight pipe shall apply to specials, with the following additional requirements. If the special cannot be lined centrifugally, it shall be lined by hand. In such case, the lining shall be reinforced with 2-inch by 4-inch by No. 12 welded wire fabric positioned approximately in the center of the lining. The wires, spaced 2 inches on centers, shall extend circumferentially around the pipe with the fabric securely fastened to the pipe. Splices shall be lapped 4 inches and the free ends tied or looped to assure continuity.
- N. **Coating:** All requirements pertaining to thickness, application and curing of coating specified for straight pipe shall apply to specials. Unless otherwise shown, the mortar coating on the buried portion of a pipe section passing through a structure wall shall extend to the first flange located inside the

structure. Pipe above ground or in structures shall be field-painted as specified in Section 09900, "Protective Coating."

- O. **Marking:** A mark indicating the true vertical axis of the special shall be placed on the top and bottom of the special.

PART 3 -- EXECUTION

3.1 GENERAL

- A. Unless otherwise provided, the CONTRACTOR shall furnish and install all fittings, correction and closure pieces, bends, reducers, wyes, tees, crosses, nozzles, outlets, manifolds, and other steel plate specials, bolts, nuts, gaskets, jointing materials, and all other appurtenances as shown and as required to provide a complete and workable installation. Where pipe support details are shown, the supports shall conform to the details, and shall be placed as indicated; provided, that the support for all exposed piping shall be complete and adequate to support the pipe specials regardless of whether or not supporting devices are specifically shown. Where required by the drawings, concrete thrusts blocks and welded joints shall be provided. At all times when the WORK of installing pipe is not in progress, all openings into the pipe and specials and the ends of the pipe in trenches or structures shall be kept tightly closed to prevent entrance of animals and foreign materials. The CONTRACTOR shall take all necessary precautions to prevent the pipe and specials from floating due to water entering the trench from any source. The CONTRACTOR shall assume full responsibility for any damage due to this cause and shall at its own expense restore and replace the pipe and specials to its specified condition and grade if it is displaced due to floating. The CONTRACTOR shall maintain the inside of the pipe and specials free from foreign materials and in a clean and sanitary condition until its acceptance by the CITY.

3.2 INSTALLATION

- A. Trenches shall be in a reasonable dry condition when the pipe and special are laid. Necessary facilities including slings shall be provided for lowering and properly placing the pipe and specials in the trench without damage. No pipe shall be installed when the lining or coating show cracks as detailed in the AWWA C 205. Such damaged lining and coating shall be repaired or a new undamaged pipe shall furnished and installed. The pipe and specials shall be laid to the line and grade shown and they shall be closely jointed to form a smooth flow line.

Immediately before placing each section of pipe special in final position for jointing, the bedding for the pipe shall be checked for firmness and uniformity of surface.

- B. Installation of pipes and specials in prepared trenches shall start at the lowest point, with the spigot ends pointing in the direction of flow.
- C. Cathodic protection shall be installed in conformance with the approved cathodic protection system design as specified in Section 02512, "Steel Pipe - Mortar-Lined and Mortar-Coated."

3.3 TESTING

- A. Pipeline testing shall be in accordance with Section 02510, "Pressure Pipeline Testing and Disinfection."

- END OF SECTION -

**SECTION 331200 - MISCELLANEOUS PIPING, VALVES, FITTINGS,
AND APPURTENANCES**

PART 1 -- GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall provide all materials, equipment, and labor necessary to furnish and install all exposed and buried piping, complete, including but not necessarily limited to small steel pipe, small valves, red brass pipe, copper tubing, solvent-welded PVC pipe, fittings, gaskets, bolts, insulating connections, and all such other specialties as required for a complete and operable piping system, as shown on the Drawings and as specified herein.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- | | |
|---------------------|--------------------------------|
| A. Division 2 and 5 | Piping Sections. |
| B. Section 331219 | Fire Hydrants. |
| C. Section 055000 | Miscellaneous Metalwork. |
| D. Section 099000 | Protective Coating. |
| E. Section 331100 | Piping, General. |
| F. Section 330526 | Piping Identification Systems. |
| G. Division 1 | General Requirements. |

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. **Commercial Standards:**

- | | |
|------------------|--|
| ANSI B16.22 | Wrought Copper and Copper Alloy Solder Joint Pressure Fittings. |
| ANSI/ASME B16.3 | Malleable Iron Threaded Fittings, Classes 150 and 300. |
| ANSI/ASME B16.15 | Cast Bronze Threaded Fittings, Classes 125 and 250. |
| ANSI/ASME B31.1 | Power Piping, DoD Adopted. |
| ASTM A 53 | Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless. |
| ASTM A 106 | Specification for Seamless Carbon Steel Pipe for High- Temperature Service. |
| ASTM A 325 | Specification for Structural Bolts, Steel, Heat-Treated, 120/105 ksi minimum tensile strength. |
| ASTM B 43 | Specification for Seamless Red Brass Pipe, Standard Sizes. |
| ASTM B 62 | Specification for Composition Bronze or Ounce Metal Castings. |

ASTM B 88	Specification for Seamless Copper Water Tube.
ASTM D 1785	Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
ASTM D 2239	Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR). Based on Controlled Inside Diameter.
ASTM D 2737	Specification for Polyethylene (PE) Plastic Tubing.
AWWA C207	Standard for Steel Pipe Flanges for Waterworks Service - Sizes 4 inch through 144 inch.
AWWA C507	Standard for Ball Valves 6 In. Through 48 In. (150mm through 1200mm).
AWWA C 800	Standard for Underground Service Line Valves and Fittings.
AWWA Manual M 11	Steel Pipe - A Guide for Design and Installation.

1.4 CONTRACTOR SUBMITTALS

- A. **Certificates of Compliance:** Certificates of Compliance shall be provided for all products and materials proposed to be used under this Section.

1.Manufacturers product specifications and performance details shall be provided for all products and materials proposed to be used under this Section.

PART 2 -- PRODUCTS

2.1 SMALL STEEL PIPE

- A. Galvanized steel pipe shall conform to the requirements of ASTM A 53, and shall be Schedule 40 or 80. NPT fittings for galvanized steel pipe shall be of galvanized malleable iron.

2.2 POLYETHYLENE PLASTIC PIPE AND TUBING (FOR WATER SERVICES)

- A. Polyethylene plastic pipe, for 1 inch Residential Joint Domestic/Fire Services only, shall be PE 3408 with SIDR 7, iron pipe size conforming to the requirements of ASTM D 2239, and a rating of 200 psi. Polyethylene plastic tubing, for 1 inch, 1-1/2 inch, and 2 inch services, shall be PE 3408 with SIDR 9, copper tubing size conforming to the requirements of ASTM D 2239, and a rating of 160 psi.

- B. All joints connecting Polyethylene Plastic Pipe or Tubing shall utilize "Pack Joint Type" compression fittings.

2.3 BRASS PIPE

- A. Brass pipe shall conform to the requirements of ASTM B 43. Fittings shall be of bronze conforming to the requirements of ASTM B 62 with threaded ends, conforming to ANSI/ASME B16.15.

- B. Two inch brass street elbows, for Dead End and In-Line Blowoffs shall be **Jones 2619, Ford F84.77-G, or equal.**

2.4 COPPER TUBING

- A. Copper tubing shall conform to the requirements of ASTM B 88 and shall be Type K, soft temper, joint free, for buried tubing; and hard-drawn joint free, for above-ground applications. All fittings connecting copper tubing shall be compression fittings.

2.5 PVC (POLYVINYL CHLORIDE) PRESSURE PIPE, SOLVENT-WELDED

- A. PVC pipe shall be made from all new rigid unplasticized polyvinyl chloride and shall be Schedule 40 or 80, as specified, conforming to ASTM D 1785. Joints and fittings shall be of the same material as the pipe and shall be solvent-welded construction.

2.6 CORPORATION STOP VALVES

A. **Tapered Plug Type**

1. Tapered plug style valves shall be brass conforming to AWWA C800.
2. The connection joint to the service saddle shall be in conformance with AWWA C800 iron pipe thread.
3. The connection joint to the service lateral shall be a "Pack Joint Type" compression joint.
4. Tapered plug style valves on steel or ductile iron pipe shall utilize a threaded insulating bushing between the tapping outlet or service saddle on the water main and the stop valve.

B. **Manufacturers, or Equal**

1. Iron Pipe Sizes, 1" Residential Joint Domestic/Fire Service only:

	Mueller	Jones	Ford
Size			
1"	n/a	J-3404	F-1101-4

2. Copper Tubing sizes, 1", 1-1/2", and 2" service:

	Mueller	Jones	Ford
Size			
1"	n/a	J-3403	F-1100-4
1-1/2"	n/a	n/a	n/a
2"	n/a	n/a	n/a

C. **Ball Valve Type**

1. Ball valve style valves shall be brass conforming to AWWA C800.
2. The connection joint to the service saddle shall be in conformance with AWWA C800 iron pipe thread.
3. The connection joint to the service lateral shall be a "Pack Joint Type" compression joint.
4. Ball valve style valves on steel or ductile iron pipe shall utilize a threaded insulating bushing between the tapping outlet or service saddle on the water main and the stop valve.

D. **Manufacturers, or equal.**

1. Iron pipe sizes, 1" Residential Joint Domestic/Fire Service only:

	Mueller	Jones	Ford
Size			
1"	E-25029	J-1936	FB-1101-4

2. Copper tubing sizes, 1", 1-1/2", 2" services:

	Mueller	Jones	Ford
Size			
1"	P25028	J-1935	FB-1100-4
1 1/2"	P-25028	J-1935	FB-1100-6
2"	P-25028	J-1935	FB- 1100-7

2.7 ANGLE METER STOP VALVES

- A. Angle meter stop valves shall be a brass ball valve or brass angle meter valve with a 90-degree lock wing. The connection joint to the water service line shall be a "Pack Joint Type" compression joint.

B. **Manufacturers, or Equal**

1. Iron pipe sizes, 1" Residential Joint Domestic/Fire Service only:

	Mueller Jones Ford		
Size			
1"	n/a	J-1962W	BA63-444W

2. Copper tubing sizes, 1", 1-1/2", and 2" services:

	Mueller	Jones	Ford
Size			
1"	P-24258	J-1963W	BA43-444W
1-1/2"	P-24276	J-1975W	BA43-666W
2"	P-24276	J-1975W	FV43-777W

2.8 METER ADAPTERS

- A. Slotted meter adapters shall be used for piston meter sizes 1" and smaller when service lateral size is 1-1/2" or 2".
- B. Manufacturers shall be **Ford A47 slotted adapter, Jones or equal.**

2.9 LOCKABLE BALL VALVES

- A. Lockable ball valves for commercial services shall be a brass ball valve with iron pipe threads on both ends with padlock wings.

B. Manufacturers, or equal.

1. Female iron pipe threads both ends for turbine meter installation:

	Mueller	Jones	Ford
Size			
1"	B-20200	J-1900W	B11-444
1-1/2"	B-20200	J-1900W	B11-666
2"	B-20200	J-1900W	B11-777

2. Female iron pipe threads by meter swivel for piston meter:

	Mueller	Jones	Ford
Size			
1"	B-24351	n/a	BF13-444W
1-1/2"	B-24337	J-1912W	BF13-666W
2"	B-24337	J-1912W	B13-777W

2.10 POLYETHYLENE PIPE TUBING LINERS

- A. Stainless steel liners shall be used with all compression fittings on polyethylene pipe and tubing.

B. Manufacturers, or equal.

1. Iron pipe sizes, 1" Residential Joint Domestic/Fire Service only:

	Mueller	Jones	Ford
Size			
1"	505142	J-2806	72

2. Copper tubing sizes, 1", 1-1/2", 2" services:

	Mueller	Jones	Ford
Size			
1"	504385	J-2805	52
1-1/2"	506139	J-2105	54
2"	506141	J-2805	55

2.11 TAPPING SLEEVES

- A. Tapping sleeves shall be cast iron, mechanical-joint sleeves with a rated working pressure of at least 150 psi, stainless steel with stainless steel nuts and bolts, or steel, mortar lined and coated, with stainless steel nuts and bolts. Bolts and nuts on epoxy lined sleeves shall be Type 304 or 316 stainless steel.

B. Manufacturers, or equal

Pipe Type	APAC	Clow	Ford	Mueller	Tyler
Plastic	512 (14-30")	F-5205 (4-16")	FTSC* (14-30")	H-615 (4-12")	5-149
	512 (6-12")*	F 5207** (4-12")	FTSC (4-12")*	H-304 (14-24")	
Ductile Iron	512 (4-30")	F-5205 (4-16')	FTSC (4-30")	H-615 (4-24")	5-149
				H-304 (4-24")	
Asbestos Cement	512 (6-30) *	F-5207 (4-12") **	FTSC (14-30")* FTSS (SS)(4-12")	H-619 (4-12") H-304 (14-16")	5-349
Steel	504 (4-36")	--	FWS (4-16")		

* allowed only if the pipe is out of round and it is approved by Water Resources.

** for Class 100 pipe, 10" and 12", use the F-5205.

2.12 TAPPING OUTLETS

- A. Tapping outlets for steel mortar-lined and coated pipe shall be designed and fabricated to comply with design procedures in AWWA Manual M-11. The tapping outlets shall be designed for the pressure rating of the pipeline to which they are attached, with a minimum rated working pressure of 150 psi.
- B. Tapping outlets for mortar-lined and coated steel pipe shall be factory fusion bonded epoxy lined and coated steel in conformance with Section 099000, "Protective Coatings," with stainless steel nuts and bolts.
- C. **Manufacturers for steel pipe, or equal:**

APAC	Ford
534	FWS

2.13 SERVICE SADDLES

- A. Service saddles shall be bronze or stainless steel for use on plastic; bronze for use on asbestos cement ; and steel or iron for use on ductile iron pipe.
- B. Service saddles will not be allowed on mortar lined and coated steel pipe. Tapping outlets shall be used on mortar-lined and coated steel pipe.
- C. Service saddles shall be double strap type except for service saddles on plastic pipe.
- D. The service tap on the service saddle shall have an AWWA C800 iron pipe thread.

E. **Manufacturers, or equal**

Pipe Type	APAC	Mueller	Jones	Ford
Asbestos Cement	113	BR 2B 0684 IP to BR 2B 1732 IP	J-979	202 B
Ductile Iron	102 to 103	DR 2A 0659 IP to DR 2A 1740 IP	n/a	202
Plastic PVC C900	n/a	H-13491 to H-13494	J-996	S-91
Plastic PVC C905	n/a	n/a	n/a	202 BS

2.14 WELD-O-LETS

- A. For 1", 1-1/2", and 2" service connections to steel mortar lined and coated pipe use 3000#, forged steel, **Bonney Forge Co., "Weldolet," Allied Piping Products Co., "Branchlet; or equal.**

2.15 SANITARY SEWER LATERAL CONNECTIONS TO EXISTING MAINS

- A. Lateral connections to existing vitrified clay pipe, PVC, and ductile iron pipe sanitary sewer mains shall be made using the "Tap-Tite" Method or the Saddle-Type Method with a sewer pipe saddle manufactured by **Sealtite, Romac, or equal.**
- B. Lateral connections to existing ABS and PVC composite pipe shall be made with solvent welded saddle fittings in accordance with the manufacturer's printed recommendations.

2.16 SANITARY SEWER LATERAL CLEAN OUTS

- A. Two-way Sanitary Sewer Clean outs on 4 inch sanitary sewer laterals shall be cast iron **ANACO, Two-Way Combination Clean-out; American Brass and Iron, Two-Way Clean-out fitting (Kelly); or equal.** Sanitary sewer cleanouts on 6 inch and larger pipe shall be a combination Wye and 1/8th bend, **ANACO; American Brass and Iron; or equal.**

2.17 AIR RELEASE VALVES

- A. Air release valves shall be **Crispin P-Series, APCO 200 Series, or equal.**

2.18 THREADED INSULATING BUSHING

- A. Male threaded by compression or slip insulating bushings of PVC shall be provided at CITY water meters.

2.19 WATER SAMPLING STATION

- A. Water Sampling Station housing, base flange, internal valve and support and bolts will be supplied and installed by the CITY and paid for by the developer. The CONTRACTOR shall furnish all other products and materials required to install Water Sampling Stations and as shown on the Drawings.

2.20 PIPE SUPPORTS

- A. All piping systems and pipe connections to equipment shall be properly supported to prevent undue deflection, vibration and stresses on piping, equipment and structures. All supports and parts thereof shall conform to the requirements of ANSI/ASME B31.1, except as supplemented or modified by this Section.

2.21 STOCK PARTS

- A. Where not specifically shown or detailed use stock or production parts wherever possible. Such parts shall be new, of best commercial quality, designed and rated for the intended purpose.

2.22 PIPE FLANGES

- A. **Flanges:** Where the design pressure is up to a maximum of 275 psi, flanges shall conform to either AWWA C207 Class E or ANSI B16.5 for 150-pound flanges. Flanges shall have flat faces and shall be attached with bolt holes straddling the vertical axis of the pipe unless otherwise shown. Attachment of the flanges to the pipe shall conform to the applicable requirements of AWWA C207. Flanges for miscellaneous pipes shall be in accordance with the appropriate Specification Sections for these pipes.
- B. **Blind Flanges:** Blind flanges shall be in accordance with AWWA C207, or with the appropriate Specification Sections for the various pipe types.
- C. **Flange Coating:** All machined faces of metal blind flanges and pipe flanges shall be coated with a temporary rust-inhibitive coating to protect the metal until the installation is completed.
- D. **Flange Bolts:** All bolts and nuts shall conform to Section 055000, "Miscellaneous Metalwork." Studs and bolts shall extend through the nuts a minimum of 1/4 inch. All-thread studs shall be used on all valve flange connections where space restrictions preclude the use of regular bolts. Flange bolts for fire hydrant installations shall be in accordance with Section 331219, "Fire Hydrants."
- E. **Insulating Flange Sets:** Insulating flange sets shall be provided where shown. Each insulating flange set shall consist of an insulating gasket, insulating sleeves and washers and a steel washer. Insulated flanges shall have bolt hole diameter 1/4 inch greater than the bolt diameter. Insulating sleeves shall be 1/32 inch thick NEMA LI-1 (1989) Grade G-10 fiberglass epoxy. Washers shall be 5/32 inch thick NEMA LI-1 (1989) Grade G-10 fiberglass epoxy. Steel washers, bolts and nuts shall be in accordance with ASTM A 325. Insulating gaskets shall be 1/8 inch thick full-face Neoprene-faced phenolic.
- F. **Insulating Flange Manufacturers, or Equal:**
 - 1. **JM Red Devil, Type E**
 - 2. **Maloney Pipeline Products Co.**
 - 3. **PSI Products, Inc.**
- G. **Flange Gaskets:** Gaskets for flanged joints shall be full-faced, 1/16 inch thick compressed sheets of aramid fiber base, with nitrile binder and non-stick coating, suitable for temperatures to 700 degrees F, a pH

of one to 11, and pressures to 1000 psig. Blind flanges shall have drop-in gaskets. Drop-in gaskets shall be 1/4 inch smaller than the inside edge of the bolt holes. Ring gaskets will not be allowed.

2.23 SEWER LATERAL BACKFLOW PREVENTOR

- A. Sanitary sewer lateral backflow preventors shall be as manufactured by National Diversified Sales, Lindsay, CA, Flow Control Inc., Burbank, CA, or equal.

PART 3 -- EXECUTION

3.1 INSTALLATION

- A. **Small Steel Pipe:** Galvanized steel pipe shall be coated as specified in Section 099000, "Protective Coating."
- B. **Plastic Pipe:** PVC pipe joints shall be solvent-welded in accordance with the manufacturer's printed instructions.
- C. **Couplings:** Pipe couplings shall be installed in strict accordance with the manufacturer's printed recommendations, using the correct style coupling and gasket as appropriate.
- D. **Gaskets for Flanged Joints:** Gaskets shall be in accordance with the requirements of Section 331100, "Piping, General."
- E. **Insulating Connections:** All insulating connections shall be installed in accordance with manufacturer's printed instructions and Section 331100 "Piping, General." Care shall be exercised to prevent damage to insulating fittings while making up the joints.
- F. Unless otherwise shown on the Drawings, service saddles, tapping sleeves, tapping outlets and Weld-O-Lets shall be field coated equal to the existing pipe coating.
- G. Tapping of any existing main shall be coordinated with the ENGINEER. A minimum of 48 hours notice shall be given to the ENGINEER before installation. The ENGINEER will be present during the tapping process. After completion of the tap the Coupon ("Cookie") shall be given to the ENGINEER.
- H. Plastic water service pipe or tubing shall be installed joint free between the corporation stop valve and angle meter stop valve.
- I. Water Sampling Stations shall be installed at the locations shown and in conformance with the Drawings.
- J. Installation of warning tape and copper wire shall be in conformance with Section 330526, "Piping Identification Systems."

- END OF SECTION -

SECTION 331213

BACKFLOW PREVENTION ASSEMBLIES AND PRESSURE REDUCING VALVES

PART 1 -- GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall provide all materials, equipment, and labor necessary to furnish and install Backflow Prevention Assemblies and small and large Pressure Reducing Valves, complete and operable including accessories and, where designated operators, as shown on the Drawings and as specified herein.

1.2 RELATED WORK SPECIFIED ELSEWHERE:

- A. Section 331100 Piping, General.
- B. Section 331200 Miscellaneous Piping, Valve Fittings, and Appurtenances.
- C. Section 331215 Valves, General.
- D. Division 1 General Requirements.

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. CITY OF LIVERMORE Backflow Preventer Ordinance.
- B. **Commercial Standards:**
 - ANSI B16.1 Cast Iron Pipe Flanges and Flanged Fittings.
 - ASTM B 62 Specification for Composition Bronze or Ounce Metal Castings.
 - AWWA C 510 Double Check Backflow-Prevention Assembly.
 - AWWA C 511 Reduced-Pressure Principle Backflow-Prevention Assembly.
 - USC University of Southern California, Manual of Cross-Connection Control.

1.4 CONTRACTOR SUBMITTALS

- A. **Certificates of Compliance:** Certificates of Compliance shall be provided for all products and materials proposed to be used under this Section.

1.5 QUALITY ASSURANCE

- A. **Valve Testing:** Unless otherwise specified, each valve body shall be tested under a test pressure equal to twice its design water-working pressure.
- B. **Bronze Parts:** Unless otherwise specified, all interior bronze parts of valves shall conform to the requirements of ASTM B 62.

PART 2 -- PRODUCTS

2.1 GENERAL

- A. The CONTRACTOR shall contact the Water Resources Division for a list of the approved Backflow Prevention Assemblies, and testing services.
- B. All exposed, manually operated butterfly valves shall have operators with position indicators.

2.2 BACKFLOW PREVENTION ASSEMBLIES

- A. Backflow Prevention Assemblies shall be as follows:
 - 1. For low hazard Industrial/Commercial Fire Services: Double-Check Detector-Check Backflow Prevention Assembly.
 - 2. For high hazard Industrial/Commercial Fire Services: Reduced-Pressure Detector-Check Backflow Prevention Assembly.
 - 3. For low hazard domestic or non-CITY owned irrigation: Double Check Backflow Prevention Assembly.
 - 4. For high hazard domestic or non-CITY owned irrigation: Reduced-Pressure Backflow Prevention Assembly.
 - 5. For CITY owned irrigation: Reduced-Pressure Backflow Prevention Assembly.

2.3 INSULATED ENCLOSURES

- A. Insulated enclosures are required for Backflow Prevention Devices 2 inches and smaller. Insulated enclosures shall be an above ground fiberglass rock enclosure by **Hot Box- Hot Rok, , Dekorra Products LLC, or equal**, and as shown on the Drawings.

2.4 PRESSURE REDUCING VALVES

- A. Small pressure reducing valves (2 inch and smaller)
 - 1. **General:** Small Pressure Reducing Valves, 2 inches and smaller, shall be of the spring-loaded diaphragm type with a pressure rating not less than 250 psi, with bronze body, nickel alloy or stainless steel seat, and threaded ends. Each valve shall be furnished with built-in or separate strainer and union ends.
 - 2. **Manufacturers, or Equal:**
 - a. **Mueller Company**
 - b. **Watts Regulator Company**
 - c. **Wilkins Regulator**

- B. Large pressure reducing valves (4 inch and larger)
 - 1. The CONTRACTOR shall purchase all large pressure reducing valves 4 inches and larger from the Water Resources Division. The CONTRACTOR shall provide all required connections and fittings.

PART 3 -- EXECUTION

3.1 INSTALLATION

- A. All Backflow Prevention Assemblies and Pressure Reducing Valves shall be installed in accordance with the manufacturer's printed recommendations, as required by the CITY'S Backflow Prevention Ordinance, and applicable codes and regulations.
- B. **Valve Accessories:** Where combinations of valves, sensors, switches, and controls are specified, it shall be the responsibility of the CONTRACTOR to properly assemble and install these various items so that all systems are compatible and operating properly.
- C. Backflow Prevention Assemblies shall be installed in potable and recycled water lines where required by City of Livermore Backflow Prevention Ordinance, Title 17 California Code of Regulations, applicable codes or regulations, or wherever there is any danger of contamination, and where shown on the Drawings.
- D. Backflow Prevention Assemblies shall be installed in the location shown on the Drawings and in conformance with the CITY'S Backflow Prevention Ordinance, Title 17 California Code of Regulations, and City Standard Detail.
- E. Backflow Prevention Assemblies shall be tested by an approved testing service prior to putting the assemblies into service. The CONTRACTOR shall contact the City's Water Resource Division for a list of approved testing services. All costs of testing shall be at the CONTRACTOR'S expense.
- F. Insulated enclosures for backflow prevention assemblies 2 inches and smaller shall be installed as required and in conformance with the manufacturer's printed recommendations and as shown on the Drawings.
- G. The CONTRACTOR shall install all CITY supplied large Pressure Reducing Valves in accordance with manufacturer's printed recommendations.

- END OF SECTION -

SECTION 331215 - VALVES, GENERAL

PART 1 -- GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall provide all materials, equipment, and labor necessary to furnish, install, and test all valves and all appurtenant work, complete and operable as shown on the Drawings and as specified herein. Where buried valves are shown, the CONTRACTOR shall furnish and install valve boxes to grade, with covers, sleeves, and valve extensions.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 034800 Precast Concrete Vaults, Utility Boxes, and Storm Water Field Drop Inlets.
- B. Section 055000 Miscellaneous Metalwork.
- C. Section 099000 Protective Coating.
- D. Section 331100 Piping, General.
- E. Division 1 General Requirements.
- F. Divisions 2 and 15 As applicable.

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. **Commercial Standards:**

- ANSI B16.1 Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800.
- ANSI B16.5 Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and Other Special Alloys.
- ASTM B 62 Specification for Composition Bronze or Ounce Metal Castings.

1.4 CONTRACTOR SUBMITTALS

- A. **Certificates of Compliance:** Certificates of Compliance shall be provided for all products and materials proposed to be used under this Section.

1.5 QUALITY ASSURANCE

- A. **Valve Testing:** Unless otherwise specified, each valve body shall be tested in conformance with the appropriate AWWA Standard for the specific type of valve being used.
- B. **Bronze Parts:** Unless otherwise specified, all interior bronze parts of valves shall conform to the requirements of ASTM B 62.

PART 2 -- PRODUCTS

2.1 VALVES

- A. **General:** The CONTRACTOR shall furnish all valves, valve-operating units, stem extensions and other accessories as shown or specified. All valves shall be new and of current manufacture. Where buried, all valves shall be provided with valve boxes and covers and valve extensions as required.
- B. **Valve Flanges:** The flanges of valves shall be in accordance with Section 331100, "Piping, General."
- C. **Elastomers:** All elastomers used in valves shall be made of EPDM synthetic polymers that are specifically developed for their chemical resistance. EPDM elastomers are to be used in both the gate valves and butterfly valves.
- D. **Protective Coating:** Except where otherwise specified, ferrous surfaces, exclusive of stainless steel surfaces, in the water passages of all valves, as well as the exterior surfaces of all valves, shall be coated as specified in Section 099000, "Protective Coating."
- E. All unburied manual operators shall have handwheels.
- F. All buried valves shall have operating nuts, valve boxes and other features as shown on the Drawings. Stem extensions shall be provided when valve is more than 8 feet deep.
- G. **Bolts and Nuts:** All nuts and bolts on valve flanges and supports shall be in accordance with Section 055000, "Miscellaneous Metalwork."
- H. **Valve Traffic Boxes and Covers:** Traffic boxes and covers shall be as specified in Section 034800, "Precast Concrete Vaults, Utility Boxes, and Storm Water Field Drop Inlets."

PART 3 -- EXECUTION

3.1 VALVE INSTALLATION

- A. **General:** All valves, operating units, stem extensions, valve boxes and accessories shall be installed in accordance with the manufacturer's printed instructions and as shown and specified. Valves shall be firmly supported to avoid undue stresses on the pipe.
- B. **Access:** All exposed valves shall be installed to provide easy access for operation, removal and maintenance and to avoid conflicts between valve operators, structural members, or piping.
- C. All valves shall be handled in a manner to prevent any injury or damage to any part of the valve. All joints shall be thoroughly cleaned and prepared prior to installation. All valves shall be installed so that the valve stem is plumb and valve is in the location shown on the Drawings.
- D. Prior to installation of any valve the CONTRACTOR shall operate each valve and, as necessary, adjust stem packing to ensure proper operation.

- END OF SECTION -

SECTION 331216 - GATE VALVES

PART 1 -- GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall provide all materials, equipment, and labor necessary to furnish and install gate valves, 4 inch to 12 inch, complete and operable, including but not necessarily limited to operators, epoxy lining and coating, and appurtenant work, as shown on the Drawings and as specified herein. Unless otherwise shown or specified, all shut-off valves 12 inches and smaller shall be Gate Valves.
- B. All manual shutoff valves over 12 inches shall be Butterfly Valves in accordance with Section 331217, "Butterfly Valves."

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 099000 Protective Coating.
- B. Section 331215 Valves, General.
- C. Section 331217 Butterfly Valves.
- D. Division 1 General Requirements.

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards:

- AWWA C509 Standard for Resilient-Seated Gate Valves for Water and Sewerage Systems.
- AWWA C550 Standard for Protective Epoxy Interior Coating for Valves and Hydrants.

1.4 CONTRACTOR SUBMITTALS

- A. **Certificates of Compliance:** Certificates of Compliance shall be provided for all products and materials proposed to be used under this Section.

PART 2 -- PRODUCTS

2.1 GATE VALVES

- A. **General:** All gate valves shall be resilient-seated, of the inside screw type. Valves shall be capable of being repacked under line pressure. All ferrous surfaces of the valves shall be factory fusion bonded epoxy lined and coated, as specified, in conformance with AWWA C550 and Section 099000, "Protective Coating" for exterior coating.
- B. **Elastomers:** All elastomers used in valves shall be made of EPDM synthetic polymers that are specifically developed for their chemical resistance. EPDM elastomers are to be used in both the gate valves and butterfly valves.
- C. Resilient-seated gate valves conforming to AWWA C509 shall be provided. Resilient-seated gate valves shall have cast iron bodies with flanged or mechanical joint ends,

elastomer-coated cast iron wedge/disc, flanged bonnet, bronze stem, O-ring seals, and operators with handwheel or square nut, unless otherwise shown.

D. Manufacturers, or Equal:

1. **American Flow**
2. **M and H No. 4067, Kennedy 1500, Clow**
3. **Mueller A-2370**

PART 3 -- EXECUTION

2.3 INSTALLATION

- A. All gate valves shall be installed in accordance with AWWA Standards and the manufacturer's printed recommendations, and in accordance with the applicable provisions of Section 331215, "Valves, General."

- END OF SECTION -

SECTION 331217 - BUTTERFLY VALVES

PART 1 -- GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall provide all materials, equipment, and labor necessary to furnish and install manually-operated full body butterfly valves, complete and operable, including epoxy lining and coating, appurtenances, operators, and accessories as shown on the Drawings and as specified herein. Unless otherwise shown or specified, all shutoff valves 14 inches and larger shall be Butterfly Valves. Wafer style Butterfly Valves will not be allowed.
- B. All manual shut-off valves 12 inches and smaller shall be Gate Valves in conformance with Section 331216, "Gate Valves."

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 099000 Protective Coating.
- B. Section 331215 Valves, General.
- C. Section 331216 Gate Valves.
- D. Division 1 General Requirements.

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. **Commercial Standards:**

- ANSI/AWWA C504 Standard for Rubber-Seated Butterfly Valves.
- AWWA C550 Standard for Protective Epoxy Interior Coatings for Valves and Hydrants.

1.4 CONTRACTOR SUBMITTALS

- A. **Certificate of Compliance:** Certificates of Compliance shall be provided for all products and materials proposed to be used under this Section.

PART 2 -- PRODUCTS

2.1 BUTTERFLY VALVES

- A. **General:** Butterfly valves shall conform to ANSI/AWWA C504 subject to the following requirements. Valves shall be of the size shown. Flanged valves shall be a 150-pound class B type valve drilled with a 125-pound bolt pattern and unless otherwise shown, may be either short-bodied or long-bodied. When flanged valves are installed on the Recycled Water System or on the Potable Water System where the working pressure exceeds 150 psi, the valves shall be a 250-pound class type valve drilled with a 125-pound bolt pattern and unless otherwise shown, may be either short-bodied or long-bodied. Mechanical Joint Ends are allowed except when using PVC C900 DR14 and C905 DR18 pipe. Shaft seals shall be designed for use with standard split-V type packing, or other acceptable seal. The interior passage of butterfly valves shall not have any obstructions or stops. The rubber seat shall be positively clamped or bonded into the disc or body of the valve. Cartridge-type seats will not be allowed. All interior ferrous surfaces of valves shall be factory applied epoxy lined in

conformance with AWWA C550. Exterior ferrous surfaces of valves exclusive of the flange faces, shall be factory applied epoxy in conformance with Section 099000, "Protective Coating" for exterior coating.

- B. **Elastomers:** All elastomers used in valves shall be made of EPDM synthetic polymers that are specifically developed for their chemical resistance. EPDM elastomers are to be used in both the gate valves and butterfly valves.
- C. **Manual Operators:** Operators shall conform to ANSI/AWWA C504, subject to the following requirements. Unless otherwise shown, all unburied manually-operated butterfly valves shall be equipped with a handwheel and position indicator. Buried valves shall be equipped with a 2 inch square operating nut. All operators shall be side mounted.
- D. **Manufacturers, or Equal:**
 - 1. **Kennedy Valve/M&H/Clow**
 - 2. **Mueller/Pratt**

PART 3 -- EXECUTION

3.1 INSTALLATION

- A. The installation of all butterfly valves shall be in accordance with Section 331215 "Valves, General."
- B. All buried butterfly valves shall be oriented so that the operating nuts are on the side of the water main closest to the curb.
- C. Where butterfly valves are connected to a "Tee" or "Cross" fitting, a 12-inch spool shall be installed between the fitting and the valve. An adaptor (FLGxMJ) is required between the valve and the pipe when PVC C-900 DR14 and PVC C905 DR18 pipe are used.
- D. Where butterfly valves are installed with PVC C-900 DR14 and PVC C905 DR18 pipe, an adaptor (FLGxMJ) is required on both sides of the valve.
- E. All exposed butterfly valves shall be installed with a coupling that can be used in removing the complete valve assembly without dismantling the valve or operator.

- END OF SECTION -

SECTION 331218 - CHECK VALVES

PART 1 -- GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall provide all materials, equipment and labor necessary to furnish and install all check valves in the types and sizes shown and specified, complete and operable, including epoxy lining and coating as appropriate, appurtenances and accessories, as shown on the Drawings and as specified herein.
- B. All valves on Fire Service Installations shall be Factory Mutual approved or Underwriters Laboratories listed.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 099000 Protective Coating.
- B. Section 331215 Valves, General.
- C. Division 1 General Requirements.

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. **Commercial Standards:**

ANSI/ASME B1.20.1	Standard for Pipe Threads, General Purpose.
ANSI B16.1	Standard for Cast Iron Pipe Flanges and Flanged Fittings
ASTM A126	Specifications for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
ASTM B 61	Specifications for Stream or Valve Bronze Castings.
ASTM B 62	Specification for Composition Bronze or Ounce Metal Castings.
ASTM B 148	Specifications for Aluminum-Bronze Sand Castings.
AWWA C508	Standard for Swing-Check Valves for Waterworks Service, 2-In Through 24-In, NPS.
AWWA C550	Protective Epoxy Interior Coatings for Valves and Hydrants.
FM	Factory Mutual Engineering of Research Corp.
UL	Underwriters Laboratories Inc. Standards.

1.4 CONTRACTOR SUBMITTALS

- A. **Certificates of Compliance:** Certificates of Compliance shall be provided for all products and materials proposed to be used under this Section.

PART 2 -- PRODUCTS

2.1 SWING CHECK VALVES (3 INCH AND LARGER)

- A. **General:** Swing check valves 3 inch or larger for general service shall be of the outside lever and spring or weight type, in accordance with AWWA C508, unless otherwise specified below, full-opening; designed for a water-working pressure of 250 psi unless otherwise shown, and shall have a flanged cover piece to provide access to the disc. All ferrous surfaces of valves shall be factory fusion bonded epoxy lined and coated in conformance with AWWA C550 and Section 099000, "Protective Coating."
- B. **Body:** The valve body and cover shall be of cast iron conforming to ASTM A 126, with flanged ends conforming to ANSI B 16.1, or mechanical joint ends, as shown.
- C. **Disc:** The valve disc shall be of cast iron, ductile iron, or bronze conforming to ASTM B 62.
- D. **Seat and Rings:** The valve seat and rings shall be of bronze to conforming ASTM B 62 or B 148, or Buna-N.
- E. **Hinge Pin:** The hinge pin shall be of bronze or stainless steel.
- F. **Manufacturers, or Equal:**
 - 1. **Mueller Company**
 - 2. **Kennedy Valve**
 - 3. **Hersey**

2.2 SWING CHECK VALVES (2-1/2 INCH AND SMALLER)

- A. **General:** Swing check valves in sizes 2-1/2 inch and smaller shall be suitable for a water pressure of 300 psi. They shall have screwed ends, unless otherwise shown, and screwed caps.
- B. **Body:** The valve body and cap shall be of bronze conforming to ASTM B 61 and with threaded ends conforming to ANSI/ASME B1.20.1.
- C. **Disc:** Valves shall have bronze discs.
- D. **Hinge Pin:** The hinge pins shall be of bronze or stainless steel.
- E. **Manufacturers, or Equal:**
 - 1. **Ford**
 - 2. **Mueller**
 - 3. **Stockham**

2.3 DOUBLE-LEAF CHECK VALVES

- A. **General:** Double-leaf check valves shall be of the wafer-type designed to fit between ANSI B16.1 flanges for 125-pound rating. The check valve leaves shall be spring-loaded. Flow from one direction shall cause the valve to open, and upon valve shutoff, the spring shall shut the valve leaves before reverse flow starts and at a point of zero velocity, for non-slam

closure. The spring-tension of each valve shall be designed for the individual operating condition.

- B. **Body:** The valve body shall be of cast iron with integrally-cast seat, rated for minimum 150-psi working pressure. All ferrous surfaces of valves shall be factory fusion bonded epoxy lined and coated in conformance with AWWA C550 and Section 099000, "Protective Coating."
- C. **Leaves:** The leaves shall be of bronze, aluminum bronze, or ductile iron, revolving on stainless steel or monel hinge pins with retainers.
- D. **Seat:** The valves shall have resilient seats for bubble-tight shut-off. The seat rings shall be firmly attached to the body or disc by compression-molding or similar acceptable method.
- E. **Springs:** The springs shall be of Type 316 stainless steel, or Inconel.
- F. **Manufacturers, or Equal:**
 - 1. **APCO 900 Series**
 - 2. **TRW Mission**
 - 3. **VAL-MATIC**

2.4 DETECTOR CHECK VALVES

- A. Detector check valves shall conform to the requirements of PART 2 – "Products" of this Section herein, except that valves shall be provided with a full-faced rubber clapper seal and an elevated bypass meter. The elevated bypass shall be comprised of a shutoff valve, check valve, and either a magnetic turbine or positive displacement meter. The bypass pipe shall be either copper or brass pipe. When the pressure loss through the bypass exceeds a preset amount, the valve automatically opens, allowing unrestricted flow.
- B. **Manufacturers, or Equal:**
 - 1. **Mueller A-2132-6 (4"-10")**
 - 2. **Hersey**

PART 3 -- EXECUTION

3.1 GENERAL

- A. All valves shall be installed in accordance with provisions of Section 331215, "Valves, General."

- END OF SECTION -

SECTION 331219 - FIRE HYDRANTS

PART 1 -- GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall provide all materials, equipment, and labor necessary to furnish and install fire hydrants, complete and operable including all appurtenances and accessories, as shown on the Drawings and as specified herein.
- B. All valves on fire hydrant Installations shall be in conformance with 331216, "Gate Valves."
- C. All valves on Fire Service laterals shall be Gate Valves for laterals 8 inch and less and Butterfly Valves for laterals larger than 8 inches.
- D. In the California Water Service Area the CONTRACTOR shall contact California Water Service Company for their requirements.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 331300 Pressure Pipeline Testing and Disinfection.
- B. Section 099000 Protective Coating.
- C. Section 330526 Piping Identification System.
- D. Section 331215 Valves, General.
- E. Section 331216 Gate Valves.
- F. Section 331217 Butterfly Valves.
- G. Division 1 General Requirements.

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. **Commercial Standards:**

AWWA C503 Standard for Wet-Barrel Fire Hydrants.

1.4 CONTRACTOR SUBMITTALS

- A. **Certificates of Compliance:** Certificates of Compliance shall be provided for all products and materials proposed to be used under this Section.

PART 2 -- PRODUCTS

2.1 WET-BARREL FIRE HYDRANTS

- A. **Construction:** Fire hydrants shall be of the wet-barrel type, in accordance with AWWA C 503. Fire hydrants shall have a factory supplied buried section of mortar lined ductile iron and a solid spool that has a minimum diameter of 10" and a minimum length of 12" connected to the hydrant head. When located in residential areas, the hydrant shall have one 4-1/2 inch steamer connection and one 2-1/2 inch hose connection. For commercial and industrial areas, hydrants shall have one 4-1/2 inch steamer connection and two 2-1/2 inch hose connections. The hydrant inlet shall be 6 inches in diameter. The hose and steamer connections shall be provided with cast iron caps and metal chains. Hose connection threads shall be American National Fire Hose Threads. The hydrants shall be tested to 300 psig and they shall be

suitable for a working pressure of 150 psig. All interior and exterior surfaces of fire hydrant, spool, and bury shall be coated in accordance with Section 099000, "Protective Coating."

B. Fire hydrants shall have a minimum weight of 190 pounds.

C. **Manufacturers or Approved Equal:**

a. Hydrants for residential areas shall be:

1. **Clow Corporation East Bay Series, Model 5; or Ranger 900 Series, Model 950.**

b. Hydrants for commercial/industrial areas shall be:

1. **Clow Corporation Ranger 900 Series, Model 960.**

2.2 BOLTS AND NUTS

A. See notes on City Standard Detail W-1C.

2.3 IDENTIFICATION

A. All valve lids on potable and reclaimed water systems shall be identified in conformance with Section 330526, "Piping Identification Systems." Valve lids in reclaimed water systems shall be factory purple.

PART 3 -- EXECUTION

3.1 INSTALLATION

A. All fire hydrants shall be installed in strict accordance with the manufacturer's printed recommendations, AWWA Standards, and all applicable codes, and the applicable provisions of Section 331215, "Valves, General." Any deviation from installation requirements or specified location is subject to prior approval of the Fire Department.

B. All fire hydrant lateral gate valves shall be flanged by mechanical joint valves. All fire hydrant buries shall be installed with a concrete thrust block. Fire hydrant flange bolts shall be installed with the bolt end facing up. Slotted on offset spools shall be used only when approved by the ENGINEER.

C. The 4-1/2 inch steamer connection shall be installed perpendicular to the street. The fire hydrant lateral must be installed perpendicular to the water main.

D. Hydrants, fire hydrant valve lids and guard posts shall be painted in accordance with Section 099000 "Protective Coatings."

3.2 TESTING

A. Testing for fire flows shall be in accordance with Section 331300, "Pressure Pipeline Testing and Disinfection."

- END OF SECTION -

SECTION 331233 - WATER METERS

PART 1 -- GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall provide all materials, equipment, and labor necessary to furnish and install water meters, radio read meter transceiver units and other appurtenances in the CITY'S water service area, complete and operable as shown on the Drawings and specified herein.
- B. In the CITY'S Water Service Area the CONTRACTOR shall purchase all meters, radio read meter transceiver units and other appurtenances from the CITY. The CONTRACTOR shall provide all water meter parts and accessories not purchased with the CITY'S water meter packages.
- C. All meters, radio read meter transceiver units and appurtenances purchased from the CITY shall be inventoried and controlled by the CONTRACTOR. Any meters found to be defective must be returned to the CITY for exchange. Damaged meters will not be eligible for exchange.
- D. In the California Water Service Area the CONTRACTOR shall contact California Water Service Company for their requirements.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 034800 Precast Concrete Vaults, Utility Boxes, and Storm Water Inlets.
- B. Division 1 General Requirements.
- C. Divisions 2 and 15 As applicable.

1.3 CONTRACTOR SUBMITTALS

- A. **Certificates of Compliance:** Certificates of Compliance shall be provided for all products and materials proposed to be used under this Section.

PART 2 -- PRODUCTS

2.1 WATER METER STRAINERS

- A. Separate strainers shall be purchased from the CITY for all turbine meter installations 3 inches and larger.

PART 3 -- EXECUTION

3.1 INSTALLATION

- A. The CONTRACTOR shall assemble and install all equipment specified herein, in strict accordance with the manufacturer's printed instructions, and as shown on the Drawings.
- B. Care shall be taken to protect the meters from damage, dirt or foreign material.
- C. For all turbine meters 3 inches and larger the CONTRACTOR shall install a separate strainer purchased from the CITY.

- END OF SECTION -

SECTION 331300 - PRESSURE PIPELINE TESTING AND DISINFECTION

PART 1 -- GENERAL

1.1 REQUIREMENT

- A. The CONTRACTOR shall furnish all materials, equipment, and labor to perform and complete flushing and testing of all pipelines and appurtenant piping, and disinfection of all pipelines and appurtenant piping for potable and recycled water, complete, including conveyance of test water from CITY-designated source to point of use and all disposal thereof, and as specified herein.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. **Commercial Standards:**

AWWA B300 Standard for Hypochlorites.

AWWA C651 Standard for Disinfecting Water Mains.

1.3 CONTRACTOR SUBMITTALS

- A. **Certificates of Compliance:** Certificates of Compliance shall be provided for all products and materials proposed to be used under this Section.
- B. A testing schedule, including proposed plans for water conveyance, control, disposal, and disinfection shall be submitted in writing to the ENGINEER for review a minimum of 72 hours before testing is to start.

1.4 TESTING AND DISINFECTION

- A. The CONTRACTOR will test the pipe for pressure and disinfection. All testing will be conducted in the presence of the ENGINEER.

PART 2 -- PRODUCTS

2.1 MATERIAL REQUIREMENTS

- A. All test equipment, chemicals for chlorination, temporary valves or assemblies, bulkheads, or other water control equipment and materials shall be determined and furnished by the CONTRACTOR subject to the ENGINEER'S review. No materials shall be used which would be injurious to the piping system or its proposed function.
- B. Chlorine for disinfection shall be in the form of sodium hypochlorite solution, or calcium hypochlorite granules or tablets.
- C. Sodium hypochlorite and calcium hypochlorite shall be in accordance with the requirements of AWWA B300.

PART 3 -- EXECUTION

3.1 GENERAL

- A. The CITY will furnish the water for the first hydrostatic test, and for the first disinfection test up through the first flushing sequence. All water for any re-testing shall be paid for by the CONTRACTOR. The CONTRACTOR shall make all necessary provisions for conveying the water from the CITY-designated source to the points of use.
- B. All pressure pipelines shall be tested. Disinfection shall be accomplished by chlorination. All chlorinating and testing operations shall be performed in the presence of the ENGINEER.
- C. Bacteriological testing will be performed by the ENGINEER. Results of the bacteriological testing must meet the requirements of the State Department of Health Services.

3.2 HYDROSTATIC TESTING OF PIPELINES

- A. Connections for testing of pipe shall be in conformance with the Drawings. Backflow assemblies used to comply with City Standard Detail W-7 shall be tested and approved by a certified backflow assembly tester. A passing test report on the backflow assembly shall be provided by the CONTRACTOR to the CITY before the assembly is used.
- B. The CONTRACTOR shall test all pipelines as a single unit, or in sections if approved by the ENGINEER. No section of the pipeline shall be tested until all field-placed concrete or mortar has attained an age of 72 hours. The test may be made by closing new valves when available, or by placing temporary bulkheads in the pipe and filling the line slowly with water. Unless approved by the ENGINEER testing shall not be performed against existing system closed valves. The CONTRACTOR shall be responsible for ascertaining that all test bulkheads are suitably restrained to resist the thrust of the test pressure without damage to, or movement of, the adjacent pipe. Any unharnessed sleeve-type couplings, expansion joints, or other sliding joints shall be restrained or suitably anchored prior to the test, to avoid movement and damage to piping and equipment. The CONTRACTOR shall provide sufficient temporary air release assemblies to allow for evacuation of all entrapped air in each pipe unit or section to be tested. After completion of the tests, such taps shall be permanently plugged. Care shall be taken to see that all air release assemblies are open during filling.
- C. The pipeline shall be filled at a rate which will not cause any surges or exceed the rate at which the air can be released through the air release assemblies at a reasonable velocity and all the air within the pipeline shall be properly purged. After the pipeline unit or section thereof has been filled, it shall be allowed to stand under pressure for at least 24 hours to allow the pipe concrete or mortar lining, as applicable, to absorb what water it will and to allow the escape of air from any air pockets. During this period, bulkheads, valves, and connections shall be examined for leaks. If leaks are found, corrective measures satisfactory to the ENGINEER shall be taken.
- D. The hydrostatic test shall consist of holding the test pressure on the pipeline for a period of 4 hours. The test pressure for pipelines shall be 100 percent of the pipe pressure class. The test pressure for piping shall be as shown or specified, measured at the lowest point of the pipeline unit or section being tested. All visible leaks shall be repaired in a manner acceptable to the ENGINEER.

E. Maximum Leakage

1. The maximum allowable leakage for pressure pipelines shall be in accordance with the following formula:

Design Basis

$$L = \frac{ND\sqrt{P}}{7400}$$

Where: L = allowable leakage (gal/hr)
N = number of joints in the tested line
D = nominal diameter of pipe (in.)
P = average test pressure (psi)

Pipe with welded joints, flanged joints, and service lateral pipe shall have no leakage.

2. In the case pipelines fail to pass the prescribed leakage test, the CONTRACTOR shall determine the cause of the leakage, shall take corrective measures necessary to repair the leaks, and shall again test the pipelines.

3.3 DISINFECTING PIPELINES

- A. **General:** All potable and recycled water pipelines shall be disinfected. Pipeline disinfection operations shall be performed at the Primary Jumper location in conformance with the Drawings.
- B. **Chlorination:** Hypochlorite shall be used to chlorinate the piping system in accordance with the requirements of AWWA C651 and as modified by this Section. Care shall be taken to prevent chlorine solution in the pipeline being disinfected from flowing back into the pipeline supplying the water. Any one of the following 2 methods as listed in the AWWA standard (brief summary of two methods as modified below) can be used for the initial disinfection; however, if the pipeline fails a bacteriological test, it must be disinfected again by the slug method:
 1. The continuous feed method consists of placing calcium hypochlorite granules in the main during construction, completely filling the main to remove all air pockets, flushing the completed main to remove particulates, and filling the main with potable water. The potable water shall be chlorinated so that after a minimum 24 hour holding period in the main there will be a free chlorine residual of not less than 25 mg/l.
 2. The slug method consists of placing calcium hypochlorite granules in the main during construction, completely filling the main to eliminate all air pockets, flushing the main to remove particulates and slowly flowing through the main a slug of water dosed with chlorine to a concentration of 100 mg/l.
- C. **Retention Period:** Chlorinated water shall be retained in the pipeline long enough to destroy all non-spore-forming bacteria. This period shall be at least 24 hours but disinfecting solution higher than 50 mg/l shall not remain in the pipeline for more than 96 hours. After the chlorine-treated water has been retained for the required time, the free chlorine residual at the pipeline extremities and at other representative points shall be at least 25 mg/l.

- D. **Valve Disinfection:** During the process of chlorinating the pipelines, all valves and other appurtenances shall be operated while the pipeline is filled with the heavily-chlorinated water.
- E. **Final Flushing:** After the retention period, the heavily chlorinated water shall be flushed from the pipeline until chlorine measurements show that the concentration in the water leaving the pipeline is no higher than that generally prevailing in the existing system. The CONTRACTOR shall apply a reducing agent to the water to thoroughly neutralize the chlorine residual remaining in the water prior to disposal of the water. The CONTRACTOR will be solely responsible for the proper disposal of all water used for the disinfection process in accordance with regulatory agency requirements. With prior approval by the ENGINEER, the CONTRACTOR may discharge the heavily chlorinated water into the sanitary sewer system in lieu of the above neutralization requirements.
- F. **Bacteriological Testing:** Pipe shall be left for a period of 24 hours after final flushing before any sample is collected. A sample, or samples will be collected by the ENGINEER and will be tested for bacteriological quality in accordance with the requirements of the State Department of Health Services and AWWA C651. Should the initial disinfection treatment fail to produce satisfactory bacteriological test results, the disinfection procedure shall be repeated until acceptable results are obtained. All lab costs for subsequent bacteriological testing after the initial test shall be borne by the CONTRACTOR. All lab costs for initial bacteriological testing will be paid by the CITY. All costs for water used for flushing, and re-filling of the pipeline after failure of a bacteriological test shall be borne by the CONTRACTOR.

3.4 CONNECTIONS TO EXISTING SYSTEM

- A. Where connections are to be made to an existing potable water system, the interior surfaces of all pipe and fittings used in making the connections shall be swabbed or sprayed with a sodium hypochlorite solution in conformance with the requirement of AWWA C651, except that the solution shall be 5 percent, before they are installed.

3.5 TESTING

- A. Fire flow testing of fire service lines and fire hydrant laterals will be tested by the CITY and approved by the ENGINEER prior to acceptance of the pressure pipeline installation.

- END OF SECTION -

SECTION 333100 - REINFORCED CONCRETE PIPE (PVC-LINED)

PART 1 -- GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall provide all materials, equipment and labor necessary to furnish and install PVC-lined reinforced concrete pipe and all appurtenant work, complete and operable, including all connections as shown on the Drawings and as specified herein.
- B. All sanitary sewer lines in industrial areas shall be vitrified clay pipe in conformance with Section 333106, "Vitrified Clay Pipe."

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 312300 Utility Earthwork.
- B. Section 333106 Vitrified Clay Pipe.
- C. Section 333900 Precast Concrete Maintenance Holes.
- D. Section 330130 Sanitary Sewer and Storm Drain System Leakage Testing.
- E. Section 033050 Utility Cast-in-Place Concrete.
- F. Section 036000 Grout.
- G. Section 331100 Piping, General.
- H. Division 1 General Requirements.

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. **Commercial Standards:**

- ASTM C 76 Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
- ASTM C 150 Specification for Portland Cement.
- ASTM C 361 Specification for Reinforced Concrete Low-Head Pressure Pipe.
- ASTM D 412 Test Methods for Rubber Properties in Tension.
- ASTM D 2240 Test Method for Rubber Property - Durometer Hardness.
- AWWA C302 Standard for Reinforced Concrete Pressure Pipe, Noncylinder Type, for Water and Other Liquids.

1.4 CONTRACTOR SUBMITTALS

- A. The CONTRACTOR shall submit certificates, test reports, shop drawings and laying diagrams of all pipe, joints and piping appurtenances.

- B. Design calculations of each critical section of pipe wall and specials shall be submitted and shall be sufficient to ascertain conformance of pipe and fittings to these Specifications. Submittals will be reviewed by an independent engineer hired by the CITY. All expenses incurred in making samples for certification of tests shall be borne by the CONTRACTOR.
- C. **Certificates of Compliance:** Certificates of Compliance shall be provided for all products or materials proposed to be used under this Section and the following:
- D. Hydrostatic test reports of rubber gasket joints.
 - 1. Three-edge-bearing strength (D-load) test reports as a proof of design for one pipe section of each size and strength class.
 - a. PVC liner test reports.

1.5 QUALITY ASSURANCE

- A. **Inspection:** All pipe will be subject to inspection at the place of manufacture in accordance with the provisions of the applicable referenced standards as supplemented by the requirements of this Section. The CONTRACTOR shall notify the ENGINEER, in writing, of the manufacturing schedule not less than 14 calendar days prior to the start of any phase of pipe manufacture.
- B. **Tests:** Unless otherwise specified, all materials used in the manufacture of the pipe shall be tested in accordance with the requirements of the applicable referenced standards. The CONTRACTOR shall have said material tests performed at no additional cost to the CITY. The ENGINEER shall have the right to witness all testing conducted by the CONTRACTOR'S provided, that the CONTRACTOR'S schedule is not delayed for the convenience of the ENGINEER. In addition to those tests specifically required, the ENGINEER may request additional samples of any material for testing by the CITY. The additional samples shall be furnished at no additional cost to the CITY.
- C. All pipe shall be subject to testing for compliance with the applicable specifications and standards, including (1) a 3-edge-bearing strength (D-load) test in accordance with ASTM C 76; (2) a hydrostatic test of the rubber gasket joints in accordance with ASTM C 361 or AWWA C 302 except test pressure shall be 5 psi; and (3) PVC liner tests as specified herein.
- D. **Basis of Acceptance for PVC-Lined Reinforced Concrete Pipe:**
 - 1. The basis of acceptance of reinforced concrete pipe manufactured in compliance with this Section shall be in accordance with Section 5.1.1 of ASTM C 76 and as follows:
 - a. ENGINEER review of required submittals.
 - b. Three-edge-bearing test loads shall be applied to produce a 0.01 inch maximum crack except that applied test loading may be terminated without producing a 0.01 inch maximum crack if or when such loading has reached 110 percent of that required for and relative to the specified D-load for the subject pipe.
 - c. Test results shall be submitted to the ENGINEER prior to shipment of the pipe/product to the jobsite. Results shall indicate Project Name, testing agency and operator performing the test, test date, pipe size, and specified D-load applied.
 - 2. For PVC-lined pipe, all PVC liner sheets; joints, corner, or weld strips shall have the following physical properties when tested at 77 degrees F. +/- 5 degrees F.

<u>Property</u>	<u>Initial</u>	<u>Exposure</u> ⁽¹⁾
Tensile strength	2200 psi min.	2100 psi min.
Elongation at break	200 percent min.	200 percent min.
Shore Durometer, Type D	within 1 sec. 50-60 within 10 sec. 35-50	+/- 5 ⁽²⁾ +/- 5 ⁽²⁾
Weight change	---	1.5 percent ⁽²⁾

Note: (1) For 112 days in chemical solutions listed in paragraph 1.5.D.3 below
(2) With respect to initial test result.

- a. Tensile and elongation specimens shall be prepared and tested in accordance with ASTM D 412 using Die B.
- b. Indentation hardness test shall be in accordance with ASTM D 2240 using a Type D durometer except that a single thickness of material will be used.
- c. Weight change and indentation hardness specimens shall be 1 inch by 3 inch samples of the sheet thickness.
- d. Specimens may be taken from sheet and strip at any time prior to final acceptance.

3. All PVC liner sheets, joints, corner, and weld strips shall resist the following chemicals:

<u>Chemical Solution</u>	<u>Concentration</u>
Sulfuric acid	20 percent ⁽¹⁾
Sodium hydroxide	5 percent
Ammonium hydroxide	5 percent ⁽¹⁾
Nitric acid	1 percent ⁽¹⁾
Ferric chloride	1 percent
Soap	0.1 percent
Detergent (linear alkyl benzyl sulfonate or LAS)	0.1 percent

Note: (1) Volumetric percentages of concentrated C.P. grade reagents.

- a. After conditioning to constant weight at 110 degrees F, test specimens shall be exposed to each of the above solutions for a period of 112 days at 77 degrees F. +/- 5 degrees F.
 - b. At 28-day intervals, test specimens shall be removed from each of the chemical solutions and tested. If any specimen fails to meet the 112-day requirements before completion of the 112-day exposure, the material will be subject to rejection.
4. PVC-liner locking extensions embedded in concrete shall withstand a test pull of at least 100 pounds per linear inch, applied perpendicularly to the concrete surface for a period of one minute, without rupture of the locking extensions or withdrawal from embedment. This test shall be made at a temperature of 75 degrees F. +/- 5 degrees F., inclusive.

5. Shop-welded joints, used to fuse individual sections of PVC-liner together, shall be at least equal to the minimum requirements of the PVC-liner for thickness, corrosion resistance and impermeability. Welds shall show no cracks or separations and shall be tested for tensile strength. Tensile strength measured across the welded joint in accordance with ASTM D 412 using Die B shall be at least 2000 psi. Test temperature shall be 77 degrees F +/- 5 degrees F and the measured minimum width and thickness of the reduced section shall be used.
6. All PVC-liner shall be shop-tested for holes with a spark tester set to provide from 15,000 to 20,000 volts. Sheets having holes shall be satisfactorily repaired in the shop prior to shipment from the Manufacturer's plant. Repairs shall be made by welders qualified in accordance with the following requirements.

E. PVC-Liner Welder Qualifications:

1. Each PVC-liner welder shall pass a qualification welding test acceptable to the CITY before doing any welding field joints in PVC liners. Requalification may be required at any time deemed necessary by the CITY.

PART 2 -- PRODUCTS

2.1 GENERAL

- A. PVC-lined reinforced concrete pipe shall be a minimum of Class III and shall conform to the requirements of ASTM C 76. Class I and II pipe will not be allowed.

2.2 PIPE DESIGN

- A. Reinforced concrete pipe (PVC-Lined) shall be manufactured and provided to meet the pipe strength classifications as shown on the Drawings and in accordance with ASTM C 76, but in no case shall be less than Class III for Wall B or Wall C.
- B. Wall A pipe shall not be allowed.

2.3 MATERIALS

- A. **General:** Materials shall comply with Section 6 of ASTM C 76 as modified below. All reinforcement shall be circular. Elliptical reinforcing will not be allowed.
- B. **Cement:** Cement used in the manufacture of reinforced concrete pipe shall be Type V in conformance with ASTM C 150.
- C. **Admixtures:** No admixture shall be used unless otherwise specified or accepted in writing by the ENGINEER.
- D. **Rubber Gaskets:** Rubber gaskets shall be neoprene and shall comply with the requirements of ASTM C 361 or AWWA C 302.
- E. **PVC-Liner:** PVC-liner shall be **Ameron Amer-Plate T-Lock, Poly-Tee Inc., or equal**. The liner shall be installed with 360 degrees coverage of the pipe interior surface.
 1. The material used in the liner and in all joints, corners, and welding strips shall be a combination of polyvinyl chloride resin, pigments, and plasticizers, especially compounded to remain flexible. Polyvinyl chloride resin shall constitute not less than 99

percent, by weight, of the resin used in the formulation. Copolymer resins will not be permitted.

2. All PVC liner sheets, including locking extensions, all joints, corners and welding strips, shall be free of cracks, cleavages or other defects adversely affecting the protective characteristics of the material.
3. Minimum thicknesses of sheet with integral locking extensions, plain sheet, joint strip and weld strip are 0.065, 0.094, 0.075 and 0.094 inches, respectively. Locking extensions shall be approximately 2-1/2 inches apart and shall be at least 0.375- inches high.
4. Pipe lining shall be supplied as pipe-size sheets, fabricated by shop-welding the basic size sheets. Shop welds shall be made by lapping sheets a minimum of 1/2-inch and applying heat and pressure to the lap to produce a continuous welded joint.
5. Sheets shall have transverse strap channels cut in the locking extensions so that the strap can be placed into and perpendicular to the locking extensions.
6. These channels shall be not less than 3/4 inch and not more than 1-1/4 inch wide and shall be cut so that a maximum of 3/16 inch of the base of the locking extension remains in the base of the strap channel. Strap channels shall be provided at intervals of not less than 15 inches nor more than 20 inches center to center. The strap channels shall not be cut through the final 2 locking extensions on each edge of the sheet.
7. Transverse flaps shall be provided at the ends of sheets for pipe. Locking extensions shall be removed from flaps so that a maximum of 1/64-inch of the base of the locking extension is left on the sheet.
8. Weld strips shall be approximately one inch wide. The edges of weld strips shall be beveled in the manufacturing process. Thickness of weld strip shall be equivalent to that of the liner.
9. Joint strips for pipe shall be 4 inches wide. Thickness of joint strips shall be equivalent to that of the liner.
10. Prior to preparing the sheets for shipment, they shall be tested for holes using an electrical spark tester set at 20,000 volts minimum. Any holes shall be repaired and retested.

2.4 JOINTS

- A. Joint assembly design shall be reinforced concrete bell and spigot type incorporating a fully retained single rubber gasket in accordance with ASTM C 361 or AWWA C 302.

PART 3 -- EXECUTION

3.1 GENERAL

- A. PVC-lined reinforced concrete pipe shall be installed in accordance with the Manufacturer's printed recommendations, the requirements of Section 312300, "Utility Earthwork" and the following additional requirements.

3.2 PIPE HANDLING

- A. **General:** All laying, jointing and testing for defects and for leakage shall be performed in the presence of the ENGINEER. All material found to have defects will be rejected and the CONTRACTOR shall promptly remove such defective material from the site of the work.
- B. **Handling of Pipe and Accessories:** Pipe shall be lifted in such a manner as to minimize bending of the pipe section and prevent damage to the pipe. When being transported, pipe shall be supported in a manner that will prevent distortion or damage to the pipe. When not being handled, pipe shall be stockpiled on timber cradles or properly prepared ground with all rock points eliminated. Any pipe section that becomes damaged as a result of improper handling or stockpiling shall be repaired to the satisfaction of the ENGINEER or shall be replaced with a new unit at no additional cost to the CITY. Necessary facilities shall be provided for lowering and properly placing the pipe sections and specials in the trench without damage. Slings shall bear uniformly against the pipe. When not being handled, all pipe shall be supported on timber cradles, sand bags, or mounds of earth.

3.3 PIPE LAYING

- A. **Excavation:** Bell holes shall be excavated at each joint to provide full length barrel support of the pipe and to prevent point loading at the bells.
- B. **Pipe Laying:** Unless otherwise required, all pipe shall be laid straight between the changes in alignment and at uniform grade between changes in grade. Pipe shall have a minimum laying length of approximately 8 feet, except for closure and other special pieces as approved by the Engineer. The length of the incoming and outgoing concrete pipe at each structure shall not exceed 4 feet.
- C. Installation of pipes in prepared trenches shall start at the lowest point, with the spigot ends pointing in the direction of flow.
- D. **Rubber Gasket Joints:** The rubber gasket joint shall be made by properly lubricating the rubber gasket with a suitable vegetable compound soap before it is placed in the groove at the spigot end. The gasket shall be stretched over the spigot end of the pipe and carefully seated in the groove, with care taken to equalize the stress in the gasket around the circumference of the joint. The gasket shall not be twisted, rolled, cut, crimped, or otherwise injured or forced out of position during the closure of the joint. A feeler gauge shall be used to check the position of the rubber gasket after the joint has been assembled. Where a joint placement is found to be improper, the tested pipe section shall be removed, the gasket checked for damage, a new gasket installed, if necessary, the pipe relaid and the gasket placement rechecked.

3.4 PVC-LINER INSTALLATION

- A. **General:** PVC sheets for pipe, and structures shall be prepared and applied in conformance with the following:
 - 1. Installation of the lining, including pre-heating of sheets in cold weather and the welding of all joints, shall be done in accordance with the printed recommendations of the Manufacturer.
 - 2. Coverage of the lining shall not be less than the minimum shown.
 - 3. The lining shall be installed with the locking extensions running parallel with the longitudinal axis of the pipe.

4. The lining shall be held snugly in place against inner forms by means of steel banding straps or other means recommended by the Manufacturer. Banding straps must be located in the pre-cut strap channels to prevent crushing or tilting of the locking extensions.
5. If banding strips are used, a steel channel, angle, or bar may be inserted along the edge locking extension of each liner sheet for concrete pipe or cast-in-place structures. Steel channel, angle, or bar shall be of sufficient stiffness to hold the longitudinal edges of the lining snugly against the form. These may be removed after the concrete is vibrated into place.
6. Locking extensions shall terminate not more than 1/2 inch from the end of the inside surface of the pipe section. Joint flaps, when used, shall extend approximately 4 inches beyond the end of the inside surfaces.
7. Concrete poured against lining shall be vibrated, spaded, or compacted in a careful manner to protect the lining and produce a dense, homogenous concrete, securely anchoring the locking extensions into the concrete.
8. In removing forms, care should be taken to protect the lining from damage. Sharp instruments shall not be used to pry forms from lined surfaces. When forms are removed, any nails that remain in the lining shall be pulled, without tearing the lining, and the resulting holes clearly marked. Form tie holes shall be marked before ties are broken off and all areas of serious abrasion or damage shall be marked.
9. All nail and tie holes and all cut, torn, and seriously abraded areas in the lining shall be patched. Patches made entirely with welding strip shall be fused to the liner over the entire patch area. Larger patches may consist of smooth liner sheet applied over the damaged area with adhesive. All edges must be covered with welding strip fused to the patch and the sound lining adjoining the damaged area.
10. Hot joint compounds, such as coal tar, shall not be poured or applied to the lining.
11. The CONTRACTOR shall take all necessary measures to prevent damage to installed lining from equipment and materials used in or taken through the WORK.

B. Structure Connections to Concrete Pipe - Special Requirements:

1. The lining shall be set flush with the inner edge of the bell or spigot end of a pipe section and shall extend to the opposite end or to approximately 4 inches beyond the opposite end depending upon the type of lining joint to be made with the adjoining concrete pipe.
2. Wherever concrete pipe or cast-in-place structures protected with lining joint structures not so lined (such as precast concrete, pipe, cast-in-place structures or clay pipe), the lining shall be extended over and around the end of the pipe and back into the structure for not less than 4 inches. This protecting cap may be molded or fabricated from the lining material but need not be locked into the pipe.
3. Where a pipe lateral (not of plastic-lined concrete) is installed through lined concrete pipe, the seal between the lined portion and the lateral shall be made by the method prescribed for cast-in-place structures under this Section.
4. On pipe having a 360-degree liner coverage, the longitudinal edges of the sheet shall be butt welded.

5. No pipe with damaged lining will be accepted until and unless the damage has been repaired to the satisfaction of the ENGINEER.

C. Field Joints in Lining for Concrete Pipe:

1. The joint between sections of lined pipe shall be prepared in the following manner. The inside joint shall be filled and carefully pointed with non-shrink grout in accordance with Section 036000, "Grout," in such a manner that the grout shall not, at any point, extend into the pipe beyond a straight line connecting the surfaces of the adjacent pipe sections. No lining joint shall be made until after the trench has been backfilled and consolidated. Pipe joints must be dry before lining joints are made.
2. All grout and other foreign material shall be removed from lining surfaces adjacent to the pipe joint, leaving them clean and dry.
3. Field joints in the lining at pipe joints may be either of the following described types:

Type P-1 The joint shall be made with a separate 4-inch joint strip and 2 welding strips. The 4-inch joint strip shall be centered over the joint, tack-welded to the lining, then welded along each edge to adjacent liner sheets with a one inch weld strip. The width of the space between adjacent sheets shall not exceed 2 inches. The 4-inch joint strip shall lap over each sheet a minimum of one inch.

Type P-2 The joint shall be made with a joint flap with locking extensions removed and extending approximately 4 inches beyond the pipe end. The joint flap shall overlap the lining in the adjacent pipe section a minimum of one inch and be tack welded in place prior to welding. The field joint shall be completed by welding the flap to the lining of the adjacent pipe using a one inch welding strip.

Care shall be taken to protect the flap from damage. Excessive tension and distortion in bending back the flap to expose the pipe joint during laying and joint grouting shall be avoided.

The joint flap or strip on beveled pipe shall be trimmed to a width (measured from the end of the spigot) of approximately 4 inches for the entire circumferential length of the lining.

All welding of joints is to be in strict conformance with the printed specifications and instructions of the lining Manufacturer.

Welding shall fuse both sheets together to provide a continuous joint equal in corrosion resistance and permeability to the liner plate.

Hot-air welding guns shall provide effluent air to the sheets to be joined at a temperature between 500 and 600 degrees. Welding guns shall be held approximately 1/2 inch from and moved back and forth over the junction of the 2 materials to be joined. The gun shall be moved slowly enough as the weld progresses to cause a small bead of molten material to be visible along both edges of the weld strip.

The following special requirement shall apply when the liner coverage is 360 degrees. When groundwater is encountered, the lining joint shall not be made until pumping of groundwater has been discontinued for at least three days and no visible leakage is evident at the joint.

D. Application to Cast-in-Place Concrete Structures - Special Requirements (where required):

1. Liner sheets shall be closely fitted and properly secured to the inner forms. Sheets shall be cut to fit curved and warped surfaces using a minimum number of separate pieces. If liner joints are to be type C-3 joints as described below, the adjacent sheets shall be butted with not more than 0.125 inch opening between the sheets. A welding strip fusion-welded on the back of butt joints or other means acceptable to the ENGINEER shall be used to prevent wet concrete from flowing around the edges.
2. Unless otherwise shown, the lining shall be returned 4 inches at the surface of contact between the concrete structure and items not of concrete (including maintenance hole frames, gate guides, clay pipe, or brick manholes, and clay or cast-iron pipes). The same procedure shall be followed at joints where the type of protective lining is changed or the new work is built to joint existing unlined concrete. At each return, the return liner shall be sealed to the item in contact with the plastic-lined concrete using the adhesive system recommended by the liner manufacturer. If the liner cannot be sealed with this adhesive because of the joint at the return being too wide or rough or because of safety regulations, the joint space shall be densely caulked with lead wool or other approved caulking material to a depth of 2 inches.

E. Joints in Lining for Cast-in-Place Concrete Structures (where required):

1. Lining at joints shall be free of all grout and other foreign material and shall be clean and dry before joints are made.
2. Field joints in the lining shall be of the following described types, used as prescribed:

Type C-1 The joint shall be made with a separate 4-inch joint strip and 2 welding strips. The 4-inch joint strip shall be centered over the joint, tack-welded to the liner, then welded along each edge to adjacent sheets with one-inch weld strips. The width of the space between adjacent sheets shall not exceed 2 inches. The 4-inch joint strip shall lap over each sheet a minimum of one inch. It may be used at any transverse or longitudinal joint.

Type C-2 The joint shall be made by lapping sheets not less than one inch. One welding strip is required. The upstream sheet shall overlap the one downstream. The lap shall be tack-welded into place prior to welding.

Type C-3 The joint shall be made by applying one welding strip on the back of the butt joint or by some other method approved by the ENGINEER to prevent wet concrete from getting under the sheet. After the forms have been stripped, a second welding strip shall be applied over the butt joint on the face of the sheet.

All welding is to be in strict conformance with the specifications of the lining Manufacturer and this Section.

F. Testing and Repairing Damaged Surfaces:

1. After the pipe is installed in the trench, CONTRACTOR shall test all surfaces covered with lining, including welds, with an approved electrical hole detector with the instrument set at 20,000 volts, minimum. Testing shall be performed in the presence of the

ENGINEER. All imperfections and holidays detected shall be repaired to the satisfaction of the ENGINEER.

3.5 TESTING

- A. Air Pressure Testing and other requirements shall conform to Section 330130, "Sanitary Sewer and Storm Drain System Leakage Testing."

- END OF SECTION -

SECTION 333102 - ABS AND PVC COMPOSITE PIPE

PART 1 -- GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall provide all materials, equipment, and labor necessary to furnish and install all acrylonitrile-butadiene-styrene (ABS) and polyvinyl chloride (PVC) composite pipe gravity sanitary sewers, and all appurtenant work, complete and operable, including all connections as shown on the Drawings and as specified herein.
- B. The pipe shall consist of two concentric extruded thermoplastic tubes integrally braced across the annulus. The resultant annular space shall be filled with inert material such as light-weight portland cement concrete to provide continuous support between the inner and outer tubes.
- C. All sanitary sewer lines in industrial areas shall be vitrified clay pipe in conformance with Section 333106 "Vitrified Clay Pipe."

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 312300 Utility Earthwork.
- B. Section 330130 Sanitary Sewer and Storm Drain System Leakage Testing.
- C. Section 333104 Small ABS and PVC Nonpressure Pipe.
- D. Section 333106 Vitrified Clay Pipe.
- E. Section 331100 Piping, General.
- F. Section 330526 Piping Identification Systems.
- G. Section 331200 Miscellaneous Piping, Valves, Fittings, and Appurtenances.
- H. Division 1 General Requirements.

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards:

- ASTM D 2564 Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings.
- ASTM D 2680 Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Composite Sewer Piping.

1.4 CONTRACTOR SUBMITTALS

- A. **Certificates of Compliance:** Certificates of Compliance shall be provided for all products and materials proposed to be used under this Section.

PART 2 -- PRODUCTS

2.1 GENERAL

- A. Composite Pipe shall be continuously and permanently marked with the manufacturer's name, pipe size, ASTM Specification Number, type of plastic, and extrusion code, including date and location of manufacture.

2.2 PIPE DESIGN

- A. Composite Pipe shall be manufactured and provided to meet the pipe strength classifications as shown on the Drawings and in accordance with ASTM D 2680, but in no case shall have a pipe stiffness less than 200 lb/in/in.

2.3 PIPE AND FITTINGS

- A. Composite Pipe and fittings shall conform to the requirements of ASTM Designation D 2680, and shall have either solvent cement joints or elastomeric gasket joints.
- B. "WYE" fittings are required on all new mains. Connections to existing mains shall be made by Tap-tite method or solvent welded, banded, saddle "wye" fittings.
- C. Sanitary sewer clean outs shall be in conformance with in Section 331200, "Miscellaneous Piping, Valves, Fittings, and Appurtenances."
- D. Sewer lateral connections shall accommodate solid wall pipe, PVC or ABS as specified in Section 333104, "Small ABS and PVC Nonpressure Pipe."

2.4 SOLVENT CEMENT JOINTS

- A. Cement for ABS joints shall be MEK containing a minimum of 20 percent by weight of dissolved ABS and shall comply with ASTM D 2564.
- B. Cement for PVC joints shall comply with ASTM D 2564 except that the minimum resin content shall be 16 percent and minimum viscosity shall be 3500 cP.

2.5 ELASTOMERIC GASKET JOINTS

- A. Composite Pipe with gasketed joints shall comply with ASTM D 2680 and shall be manufactured with a socket configuration which will prevent improper installation of the gasket and will ensure that the gasket remains in place during the joining operation. The gasket shall be manufactured from a synthetic elastomer containing not less than 50 percent by volume of first-grade synthetic rubber.

PART 3 -- EXECUTION

3.1 GENERAL

- A. All laying, jointing, testing for defects and for leakage shall be performed in the presence of the ENGINEER, and shall be subject to its approval before acceptance. All material found during the progress to have defects will be rejected and the CONTRACTOR shall promptly remove such defective material from the site.

3.2 BEDDING

- A. Pipe bedding shall conform to the requirements of Section 312300, "Utility Earthwork."

3.3 PIPE LAYING

- A. Composite Pipe shall be installed in conformance with the requirements of the pipe manufacturer's recommendations and the provisions of this Section.

- B. Bell and spigot pipe shall be laid with the bell end at the lowest point with the spigot end pointing in the direction of the flow.
- C. Handling of the pipe shall be done with care to insure that the pipe is not damaged in any manner during storage, loading, transit, unloading, and installation.
- D. The pipe shall be laid to the lines and grades shown on the Drawings and the sections shall be closely jointed to form a smooth flow line. Immediately before placing each section of pipe in final position for jointing, the bedding for the pipe shall be checked for firmness and uniformity of surface.
- E. Proper implements, tools, and facilities as recommended by the pipe manufacturer's standard printed installation instructions shall be provided and used by the CONTRACTOR for safe and efficient installation. All pipe and accessories shall be carefully lowered into the trench by means of derrick, ropes, or other suitable equipment in such a manner as to prevent damage to pipe and fittings. Under no circumstances shall pipe or accessories be dropped or dumped into the trench.
- F. Cutting and machining of the pipe shall be accomplished in accordance with the pipe manufacturer's standard procedures for this operation. Pipe shall not be cut with a cold chisel, standard iron pipe cutter, nor any other method that may fracture the pipe or will produce ragged, uneven edges.
- G. The pipe and accessories shall be inspected for defects prior to lowering into the trench. Any defective, damaged or unsound pipe shall be repaired or replaced. All foreign matter or dirt shall be removed from the interior of the pipe before lowering into position in the trench. Pipe shall be kept clean during and after laying. All openings in the pipe line shall be closed with water tight expandable type sewer plugs or test plugs at the end of each day's operation or whenever the pipe openings are left unattended. The use of burlap, wood, or other similar plugs will not be permitted.
- H. Adequate protection and maintenance of all underground and surface utility structures, drains, sewers, and other obstructions encountered shall be furnished by the CONTRACTOR at its own expense.
- I. Installation of warning tape shall conform to Section 330526, "Piping Identification Systems."

3.4 FIELD JOINTING

- A. **General:** The pipe shall not be deflected either vertically or horizontally in excess of the manufacturer printed recommendations.
- B. When pipe laying is not in progress, the open ends of the pipe shall be closed by approved means to prevent trench water from entering pipe. Adequate backfill shall be deposited on pipe to prevent floating of pipe. Any pipe which has floated shall be removed from the trench, cleaned, and relaid in an acceptable manner. No pipe shall be laid when, in the opinion of the ENGINEER, the trench conditions or weather are unsuitable for such work.
- C. **Solvent-Weld Joints:** Each solvent-weld pipe joint shall be sealed with solvent cement in conformance with the requirements of ASTM D 2680 and the manufacturer's printed recommendations. The spigot and socket shall be wiped clean before the solvent cement is applied. After insertion of the spigot end into the solvent weld bell end the inside surfaces shall be wiped clean of excess cement.
- D. **Gasketed Joints:** Each gasketed pipe joint shall be joined with a lock-in elastomeric gasket. The gasket and the gasket seal inside the bell shall be wiped clean before the gasket is inserted. At this time a liberal amount of lubricant shall be applied to the gasket and to the outside of the clean pipe end. Lubricant other than that furnished with the pipe shall not be used. The end of the pipe shall then be forced into the bell to complete the joint. On field cut spigot ends, the outer pipe wall shall be chamfered with a file to remove all burrs and rough spots.

- E. All Composite Pipe ends which are not factory sealed shall be sealed with an approved epoxy sealing material prior to installation.

3.5 SANITARY SEWER CLEAN OUTS

- A. Sanitary Sewer cleanouts shall be installed in conformance with Section 331200, "Miscellaneous Piping, Valves, Fittings, and Appurtenances."

3.6 TESTING

- A. Testing shall conform to the requirements of Section 330130, "Sanitary Sewer and Storm Drain System Leakage Testing."

- END OF SECTION -

SECTION 333104 - SMALL ABS AND PVC NONPRESSURE PIPE

PART 1 -- GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall provide all materials, equipment, and labor necessary to furnish and install all 4 inch to 15 inch polyvinyl chloride (PVC) solid wall nonpressure pipe; 4 inch and 6 inch acrylonitrile-butadiene-styrene (ABS) solid wall nonpressure pipe; and all appurtenant work, complete and operable, including all connections as shown on the Drawings and as specified herein. All 4 inch and 6 inch ABS nonpressure pipe will only be allowed for sanitary sewer laterals.
- B. All sanitary sewer lines in industrial areas shall be vitrified clay pipe in conformance with Section 333106, "Vitrified Clay Pipe."

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 312300 Utility Earthwork.
- B. Section 330130 Sanitary Sewer and Storm Drain System Leakage Testing.
- C. Section 333102 ABS and PVC Composite Pipe.
- D. Section 333106 Vitrified Clay Pipe.
- E. Section 033050 Utility Cast-in-Place Concrete.
- F. Section 331100 Piping, General.
- G. Section 330526 Piping Identification Systems.
- H. Section 331200 Miscellaneous Piping, Valves, Fittings, and Appurtenances.
- I. Division 1 General Requirements.

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards:

- ASTM C 425 Specification for Compression Joints for Vitrified Clay Pipe and Fittings.
- ASTM D 1784 Specification for Rigid Poly Vinyl Chloride (PVC) Compounds and Chlorinated Poly Vinyl Chloride (CPVC) Compounds.
- ASTM D 1869 Specification for Rubber Rings for Asbestos-Cement Pipe.
- ASTM D 2241 Specification for Poly Vinyl Chloride (PVC) Pressure-Rated Pipe (SDR-Series).
- ASTM D 2321 Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.

ASTM D 2751	Specification for Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe.
ASTM D 3034	Specification for Type PSM Poly Vinyl Chloride (PVC) Sewer Pipe and Fittings.

1.4 CONTRACTOR SUBMITTALS

- A. **Certificates of Compliance:** Certificates of Compliance shall be provided for all products and materials proposed to be used under this Section.

1.5 QUALITY ASSURANCE

- A. **Tests:** All materials used in the manufacture of the pipe shall be tested in accordance with the requirements of the referenced standards as applicable.
- B. All costs of such inspection and tests shall be borne by the CONTRACTOR.
- C. The pipe shall be subjected to the specified hydrostatic strength tests, flexure tests, and crushing tests. The crushing tests shall be made on samples taken from the center of full-length sections of pipe.

PART 2 -- PRODUCTS

2.1 GENERAL

- A. All solid wall pipe shall be continuously and permanently marked in conformance with the appropriate ASTM.
- B. The CONTRACTOR shall also require the manufacturer to mark the date of extrusion on the pipe.
- C. Pipe shall be of the pipe pressure class as shown on the Drawings.

2.2 PIPE

- A. All PVC pipe shall be joined by compression joints unless otherwise specified or as shown on the Drawings, and shall conform to the following requirements:
 1. Polyvinyl chloride pipe (PVC) shall conform to the requirements of ASTM D 3034, and shall have a maximum SDR of 35 and a minimum pipe stiffness of 46 psi. Material for PVC pipe shall conform to the requirements of ASTM D 1784 for Class 12454-B or 12454-C as defined therein.
 2. Flexible rubber rings for elastomeric gasket joints for PVC pipe and fittings shall conform to the requirements of ASTM D 1869.
- B. ABS solid wall pipe shall conform to the requirements of ASTM D 2751, and shall have a maximum SDR of 35, or a minimum SDR of 23.5 with solvent welded joints.

2.3 FITTINGS

- A. All fittings including wyes and sanitary sewer lateral cleanouts for PVC pipe shall conform to the requirements of ASTM D 2241. The ring groove and gasket ring shall be compatible with PVC pipe ends.

- B. ABS solid wall fittings shall be of the same SDR rating as the pipe and provided with solvent welded joints.
- C. The strength class of the fittings shall be not less than the strength class of any adjoining pipe.

2.4 BEDDING MATERIAL

- A. Unless otherwise specified or shown, all material used for pipe bedding shall conform to the requirements for bedding in Section 312300, "Utility Earthwork."

2.5 FLEXIBLE COUPLINGS

- A. Flexible couplings used for repairs shall be rubber, full-circle, clamp-on type conforming with ASTM C 425 and provided with 2 stainless steel band screw-clamps to secure the coupling tightly to entering and exiting pipes. All screw-clamp hardware shall be Type 304 or Type 316 stainless steel. Rubber material shall be suitable for use on sewage systems.

2.6 LATERAL CONNECTIONS TO SANITARY SEWER

- A. Service lateral connections to new sewers shall be made with wye fittings, installed as the sewer pipe is laid.
- B. Service lateral connections to existing sewers shall be made by "Tap-Tite" method, or with approved "Sealtite" type saddle fittings which utilize neoprene gasket seals and stainless steel bands.
- C. Sanitary sewer cleanouts, shall be in conformance with Section 331200, "Miscellaneous Piping, Valves, Fittings, and Appurtenances."

PART 3 -- EXECUTION

3.1 GENERAL

- A. All laying, jointing, testing for defects and for leakage shall be performed in the presence of the ENGINEER, and shall be subject to its approval before acceptance. All material found during the progress to have defects will be rejected and the CONTRACTOR shall promptly remove such defective materials from the site of the WORK.
- B. Installation shall conform to the requirements of ASTM D 2321 and to the supplementary requirements or modifications specified herein. Wherever the provisions of this Section and the requirements of ASTM D 2321 are in conflict, the more stringent provision shall apply.
- C. The CONTRACTOR shall perform the deflection 'mandrel' test as specified in Section 330130 "Sanitary Storm Drain Sewer System Leakage Testing." If the amount of allowable pipe deflection is exceeded, the CONTRACTOR shall uncover the pipe and shall improve the quality of the Pipe Zone backfill material and/or compaction to the extent that the allowable pipe deflection is not exceeded.

3.2 TRENCHING AND BACKFILL

- A. Trench excavation and backfill shall conform to the requirements of Section 312300, "Utility Earthwork," and as specified herein.

3.3 PIPE LAYING

- A. The pipe shall be installed in conformance with the requirements of ASTM D 2321, as specified herein and as shown on the Drawings. The pipe sections shall be closely jointed to form a smooth flow line. Immediately before placing each section of pipe in final position for connecting joints, the bedding for the pipe shall be checked for firmness and uniformity of surface.
- B. Proper implements, tools, and facilities as recommended by the pipe manufacturer's printed instructions shall be provided and used by the CONTRACTOR for safe and efficient execution of the work. All pipe, fittings, and accessories shall be carefully lowered into the trench by means of derrick, ropes, or other suitable equipment in such a manner as to prevent damage to pipe and fittings. Under no circumstances shall pipe or accessories be dropped or dumped into the trench.
- C. Cutting and machining of the pipe shall be accomplished in accordance with the pipe manufacturer's standard procedures for this operation. Pipe shall not be cut with a cold chisel, standard iron pipe cutter, nor any other method that may fracture the pipe or will produce ragged, uneven edges.
- D. Installation of pipes in prepared trenches shall start at the lowest point, with the spigot ends pointing in the direction of flow.
- E. The pipe and accessories shall be inspected for defects prior to lowering into the trench. Any defective, damaged or unsound pipe shall be repaired or replaced. All foreign matter or dirt shall be removed from the interior of the pipe before lowering into position in the trench. Pipe shall be kept clean during and after laying. All openings in the pipe line shall be closed with water tight expandable type sewer plugs or PVC test plugs at the end of each day's operation or whenever the pipe openings are left unattended. The use of burlap, wood, or other similar temporary plugs will not be permitted.
- F. Adequate protection and maintenance of all underground and surface utility structures, drains, sewers, and other obstructions encountered in the progress of the work shall be furnished by the CONTRACTOR at its own expense.
- G. Installation of warning tape shall conform to Section 330526, "Piping Identification Systems."

3.4 PIPE HANDLING

- A. Handling of all pipe shall be done with care to insure that the pipe is not damaged in any manner during storage, transit, loading, unloading, and installation.
- B. Pipe shall be inspected both prior to and after installation in the trench and all defective lengths shall be rejected and immediately removed from the working area.

3.5 PVC FIELD JOINTING

- A. Each pipe elastomeric-gasket joint shall be installed in conformance with the manufacturer's printed recommendations.
- B. The ring and the ring seat inside the bell shall be wiped clean before the gasket is inserted. At this time a thin film of lubricant shall be applied to the exposed surface of the ring and to the outside of the clean pipe end. Lubricant other than that furnished with the pipe shall not be used. The end of the pipe shall be then forced into the ring to complete the joint.
- C. The pipe shall not be deflected either vertically or horizontally in excess of the printed recommendations of the manufacturer.

- D. When pipe laying is not in progress, the open ends of the pipe shall be closed to prevent trench water from entering pipe. Adequate backfill shall be deposited on pipe to prevent floating of pipe. Any pipe which has floated shall be removed from the trench, cleaned, and relaid in an acceptable manner. No pipe shall be laid when, in the opinion of the ENGINEER, the trench conditions or weather are unsuitable for such work.

3.6 ABS FIELD JOINTING

- A. ABS pipe shall be solvent welded in strict accordance with the manufacturer's printed recommendations.

3.7 FITTINGS

- A. All fittings shall be installed utilizing standard installation procedures. Fittings shall be lowered into trench by acceptable means without damage to the fittings. Fittings shall be carefully connected to pipe or other facility, and joint shall be checked to insure a sound and proper joint.

3.8 SANITARY SEWER CLEANOUTS

- A. Sanitary sewer cleanouts shall be installed in conformance with Section 331200, "Miscellaneous Piping, Valves, Fittings, and Appurtenances."

3.9 TESTING

- A. Field testing of pipe shall conform to the requirements of Section 330130, "Sanitary Sewer and Storm Drain System Leakage Testing."

- END OF SECTION -

SECTION 333106 - VITRIFIED CLAY PIPE

PART 1 -- GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall provide all materials, equipment, and labor necessary to furnish and install all vitrified clay pipe and all appurtenant work, complete and operable, including all connections as shown on the Drawings and as specified herein.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 312300 Utility Earthwork.
- B. Section 330130 Sanitary Sewer and Storm Drain System Leakage Testing.
- C. Section 333900 Precast Concrete Maintenance Holes.
- D. Section 331100 Piping, General.
- E. Section 330526 Piping Identification Systems.
- F. Section 331200 Miscellaneous Piping, Valves, Fittings, and Appurtenances.
- G. Division 1 General Requirements.

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. **Commercial Standards:**

- - National Clay Pipe Institute - "Clay Pipe Engineering Manual."
- AASHTO Standard Specifications for Highway Bridges.
- ASTM C 12 Practice for Installing Vitrified Clay Pipe Lines.
- ASTM C 301 Test Methods for Vitrified Clay Pipe.
- ASTM C 425 Specification for Compression Joints for Vitrified Clay Pipe and Fittings.
- ASTM C 700 Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated.
- ASTM C 828 Test Method for Low-Pressure Air Test of Vitrified Clay Pipe Lines.

1.4 CONTRACTOR SUBMITTALS

- A. **Certificates of Compliance:** Certificates of Compliance shall be provided for all products and materials proposed to be used under this Section.

1.5 QUALITY ASSURANCE

- A. **Testing at Manufacturer's Plant:** All pipe shall be subject to a hydrostatic pressure test and a 3-edge bearing test at the manufacturer's plant. The ENGINEER may select at random and test as specified one length of pipe for each 1000 feet or fraction thereof to be installed for the test as specified in ASTM C 301. The cost of pipe and the test shall be borne by the CONTRACTOR. Pipe will be acceptable under the test requirements specified herein when all test specimens conform to the test requirements. Should any of the test specimens fail to meet the test requirements, the manufacturer will be allowed to retest 2 additional specimens for each specimen that failed, and the pipe shall be acceptable only when all the retest specimens meet the strength requirements.
- B. **Inspection of Materials:** All pipe and fittings shall be true, circular, and concentric with the barrel of the pipe, cut off on a plane at right angles to the longitudinal axis of the pipe. At no point shall the thickness of the shell of the extreme outer end of the spigot be less in thickness than the shell of the main body of the pipe. Socket ends shall be square with the longitudinal axis and shall be true, circular, and concentric with the barrel of the pipe. All pipe shall be subject to inspection at the place of manufacture. The CONTRACTOR shall notify the ENGINEER, in writing, of the manufacturing starting date not less than 14 days prior to the start of any phase of the pipe manufacture.
- C. All pipe and fittings shall have smooth interiors and shall be free from injurious cracks, checks, blisters, broken extremities, or other imperfections.
- D. The following imperfections in the barrel or socket of a pipe or fitting will be considered injurious and cause for rejection:
1. A single crack in the barrel of the pipe or fitting extending through the entire thickness, regardless of the length of such crack; a single crack which extends through 1/5 of the barrel thickness and is over 3 inches long; any surface fire crack which is more than 1/32-inch wide at its widest point.
 2. Lumps, blisters, pits, or flakes on the interior surface of a pipe or fitting.
 3. When spigot or bell of the pipe varies from a true circle more than 3 percent of its nominal diameter.
 4. Any piece broken from the spigot end which extends through the barrel.
 5. Tramp clays, grog, or other foreign matter which is fused permanently to the exterior or interior surface of the pipe or fittings.

PART 2 -- PRODUCTS

2.1 PIPE AND FITTINGS

- A. All pipe and fittings shall conform to the following requirements:
- Clay pipe and fittings shall be extra strength, unless otherwise shown and shall conform to the requirements of ASTM C 700.
- B. Service Laterals:
1. Service laterals in new sewers shall be installed using wye-type fittings.
 2. Service laterals into existing sewers shall be in conformance with Section 331200, "Miscellaneous Piping, Valves, Fittings, and Appurtenances."

- C. Sanitary sewer cleanouts shall conform to the requirements of Section 331200, "Miscellaneous Piping, Valves, Fittings, and Appurtenances."

2.2 VITRIFIED CLAY PIPE

Vitrified clay pipe shall be extra strength pipe and shall be in accordance with ASTM C 12 and C 700.

2.3 JOINTS

Joints in vitrified clay pipe shall be made up using a factory-made bell and spigot compression joint for all pipe diameters. For connections to existing VCP up to 12 inches in diameter, a synthetic rubber collar with stainless steel shear ring and stainless steel take-up clamps, bolts and nuts, meeting the requirements of ASTM C 425, may be used.

PART 3 -- EXECUTION

3.1 GENERAL

- A. The VCP pipe shall be constructed to the alignment and grade shown. The grade line shown on the profile is the invert of the pipe. The excavation shall be made a sufficient distance below the grade line to allow for the placing of the sewer pipe and embedment. Should the trench be excavated to a depth greater than required, the CONTRACTOR shall refill such excess over-excavation according to the requirements of Section 312300, "Utility Earthwork."
- B. Installation of warning tape shall conform to Section 330526, "Piping Identification Systems."

3.2 INSTALLATION OF PIPE

- A. Installation of pipe shall be in accordance with ASTM C 12. Pipe laying shall proceed upgrade starting at lowest point with spigot ends pointing in direction of flow. After a section of pipe has been lowered into the prepared trench and immediately before joining the pipe, the ends of the pipe to be joined shall be cleaned and the gasket lubricated, all in accordance with the pipe manufacturer's written instructions. Assembly of the pipe length shall be in accordance with the recommendations of the manufacturer of the type of joint used. All special tools and appliances required for joining the pipe shall be provided by the CONTRACTOR. When cutting or machining of the pipe is necessary, only tools and methods recommended in writing by the pipe manufacturer and reviewed by the ENGINEER shall be employed.
- B. The CONTRACTOR shall take all necessary precautions to prevent excavated or other foreign material from getting into the pipe during the laying operations. At all times, when laying operations are not in progress and at the close of the day's work, the ends of the pipe in the trench shall be closed with appropriate bladders, to prevent entry to animals and foreign materials. Plywood will not be allowed.
- C. All necessary precautions shall be taken to prevent uplift or floating of the pipe prior to the completion of the backfilling operation. The CONTRACTOR shall assume full responsibility for any damage due to this cause and shall, at its own expense, restore and replace the pipe to its specified condition and grade if it is displaced due to floating.

3.3 TESTING

Testing shall conform to the requirements of Section 330130, "Sanitary Sewer and Storm Drain System Leakage Testing."

- END OF SECTION -

SECTION 333900 - PRECAST CONCRETE MAINTENANCE HOLES

1.1 THE REQUIREMENT

The CONTRACTOR shall provide all materials, equipment, and labor to furnish and install all prefabricated maintenance holes complete with frame, cover, pipe connections, and cast-in-place or prefabricated base, and all other appurtenances complete in place, as shown on the Drawings and as specified herein.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 312300 Utility Earthwork.
- B. Section 333100 Reinforced Concrete Pipe (PVC-Lined).
- C. Section 330130 Sanitary Sewer and Storm Drain System Leakage Testing.
- D. Section 033050 Utility Cast-in-Place Concrete.
- E. Section 036000 Grout.
- F. Section 034800 Precast Concrete Vaults, Utility Boxes, and Storm Field Drop Water Inlets.
- G. Division 1 General Requirements.

1.3 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Commercial Standards:

- ASTM A 48 Specification for Gray Iron Castings.
- ASTM C 150 Specification for Portland Cement.
- ASTM C 478 Specification for Precast Reinforced Concrete Manhole Sections.

1.4 CONTRACTOR SUBMITTALS

Certificates of Compliance: Certificates of Compliance shall be provided for all products and materials proposed to be used under this Section.

PART 2 -- PRODUCTS

2.1 MATERIALS

- A. **Maintenance Holes:** Maintenance holes shall be constructed of concentric precast reinforced concrete sections in accordance with ASTM C 478. Precast concrete sections shall be manufactured by a process that will produce a dense, homogeneous concrete section of first quality. Steps or rungs will not be allowed in maintenance holes. The sections shall have a minimum wall thickness of 4 inches for 48-inch diameter sections and a minimum wall thickness of 6 inches for 60 inch diameter sections. Cement used in manufacturing the sections for sanitary sewer maintenance holes shall be Type V portland cement as specified in ASTM C 150. Maintenance hole sections shall be sealed using preformed joint material as specified in Section 034800, "Precast Concrete Vaults, Utility Boxes, and Storm Water Inlets" and grout as specified in Section 036000, "Grout." All maintenance holes shall have reinforced cast-in-place or reinforced precast concrete bases and formed channels with inverts to match the adjoining pipes. Maintenance hole sections shall be designed for a minimum of HS-20 traffic loading plus earth loads. Calculate earthload with a unit weight of 130 pcf.

- B. Maintenance holes in sewers constructed of PVC lined reinforced concrete pipe shall be provided with compatible PVC lining from the top of the base up to and including 1/2-inch minimum of the cast iron frame. PVC-lining shall conform to the requirements of Section 333100, "Reinforced Concrete Pipe (PVC-lined)." The interiors of all other manholes shall be coated per Section 099100, "Protective Coatings for Concrete Sanitary Sewer Manholes".
- C. **Castings:** Castings for maintenance holes frames and covers shall be non-rocking and shall conform to the requirements of ASTM A 48, Class 30B. Cast iron covers and frames shall be heavy duty traffic type, 24 inches in diameter, with a curved blind pickhole, and embossed lettering for "Storm Sewer" or "Sanitary Sewer," as applicable. Frame and cover shall be designed for HS-20 traffic loading. For installations in unimproved areas, cover and frames shall be bolted. All castings shall be thoroughly cleaned and subject to a hammer inspection after which they shall be twice dipped with an asphalt or coal tar coating applied at a temperature of not less than 290 degrees F. nor more than 310 degrees F.
- D. **Castings Suppliers, or Equal:**
 - 1. **Phoenix P-1002** for field installations.
Phoenix P-1090 for street and paved installations.
 - 2. **D & L Supply Company A-1024.**
- E. **Water Stops:** Plastic pipe connections to precast concrete maintenance holes and cast-in-place bases shall also be sealed using a premolded elastomeric waterstop material.
- F. All connections to precast concrete maintenance holes shall be made with non-shrink grout.

PART 3 -- EXECUTION

3.1 INSTALLATION

- A. All precast concrete maintenance holes shall be installed in strict conformance with the manufacturer's printed instructions on a well compacted foundation as specified in Section 312300, "Utility Earthwork."
- B. Maintenance hole frames and covers shall not be set to final grade until the pavement has been completed. Frame and cover shall be set and adjusted to grade after final paving. The street cut in asphalt concrete pavement shall be circular and paving around the maintenance hole shall be in accordance with the Drawings. Openings in maintenance holes shall be protected from construction loads, debris, and unauthorized entry.
- C. Maintenance hole sections shall be set so as to be vertical with sections in true alignment. The joint of the previously set section shall be clean and covered with preformed joint sealant before the next section is placed. The joint material shall be installed in accordance with manufacturer's printed recommendations.
- D. No pipe ends shall protrude into the maintenance hole. No bell section of the pipe shall be placed into the maintenance hole wall.
- E. Structure backfill and compaction shall be as specified in Section 312300, "Utility Earthwork."

3.2 TESTING

- A. Testing of precast concrete maintenance holes shall conform to the requirements of Section 330130, "Sanitary Sewer and Storm Drain System Leakage Testing."

- END OF SECTION -

**SECTION 334100 - CORRUGATED POLYETHYLENE
NONPRESSURE PIPE (HDPE)**

PART 1 -- GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall provide all materials, equipment, and labor necessary to furnish and install 12 inch to 36 inch corrugated polyethylene non-pressure pipe with all necessary fittings and coupling systems and all appurtenant work, complete and operable, including all connections as shown on the Drawings and as specified herein.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 312300 Utility Earthwork.
- B. Section 330130 Sanitary Sewer and Storm Drain System Leakage Testing.
- C. Section 333900 Precast Concrete Maintenance Holes.
- D. Section 033050 Utility Cast-in-Place Concrete.
- E. Section 034800 Precast Concrete Vaults, Utility Boxes, and Storm Water Inlets.
- F. Section 331100 Piping, General.
- G. Division 1 General Requirements.

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. **State of California (Caltrans) Standards:**

- Section 61 Culvert and Drainage Pipe Joints.
- Section 64 Plastic Pipe.

B. **Commercial Standards:**

- AASHTO M 294 Specification for Corrugated Polyethylene Pipe, 36 in. Diameter.
- ASTM D 2412 Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel - Plate Loading.
- ASTM D 2584 Test Method for Ignition Loss of Cured Reinforced Resins (R 1985).
- ASTM D 3350 Specification for Polyethylene Plastics Pipe and Fittings Materials.

1.4 CONTRACTOR SUBMITTALS

- A. **Certificates of Compliance:** Certificates of Compliance shall be provided for all products and materials proposed to be used under this Section.

1.5 QUALITY ASSURANCE

- A. **Testing:** All materials testing shall be based upon applicable ASTM Test Methods referenced herein for the materials specified. All costs of such manufacturing inspections and tests shall be borne by the CONTRACTOR.

PART 2 -- PRODUCTS

2.1 GENERAL

- A. Corrugated polyethylene pipe shall be smooth interior wall Type S and shall be as specified in AASHTO M 294, except as otherwise specified herein. Corrugated polyethylene pipe shall be manufactured from high density polyethylene (HDPE) virgin compounds.

- 1. HDPE compounds used in the manufacture of corrugated polyethylene pipes shall conform to the following cell classifications as provided in ASTM D 3350:

<u>Property</u>	<u>Cell Classification</u>
Density	3
Melt index	2 ^(a) , 3 or 4
Flexural modulus	4, 5 or 6
Tensile strength	4, 5 or 6
Environmental stress crack resistance	1, 2, or 3
Hydrostatic design basis	0, 1, 2, 3, or 4
Ultraviolet stabilizer.....	C ^(b)

- (a) The melt index for cell class factory 2 material used to manufacture pipe shall not be greater than 0.6. Rotationally-molded couplings and end fittings may be produced from material compounds having a melt index cell classification of one.
- (b) HDPE resin shall contain not less than 2 +/- 1/2 percent carbon black ultraviolet stabilizer.

- B. The residue from ignition of the HDPE compounds shall not exceed 30 percent as determined by ASTM D 2584, except that the muffle furnace temperature shall be 450 +/- 25 degrees C. (840 +/- 45 degrees F.)

2.2 PIPE THICKNESS, STIFFNESS AND UNIT WEIGHT

- A. Wall thickness of Type S corrugated polyethylene pipe shall be the thickness of the inner liner measured between corrugation valleys.
- B. The pipe stiffness shall be determined in accordance with ASTM D 2412. Pipe stiffness shall be determined for 3 test specimens for each manufactured run. Minimum pipe stiffness and wall thickness shall be as follows:

Pipe Diameter (in.)	Minimum Wall Thickness (in.)	Minimum Pipe Stiffness (psi)
12"	0.035	50
15"	0.035	42
18"	0.050	40
24"	0.050	34
30"	0.050	28
36"	0.050	22

The minimum pipe unit weight shall meet the requirements of Table 2 of Section 64-1.03 "Pipe Thickness, Stiffness and Unit Weight" of the Caltrans Standard Specifications.

- C. The pipe unit weight shall be computed as the average weight per foot of length determined from 3 test specimens, taken from each manufactured run. Each test specimen for pipes 24 inches in diameter and less shall be a minimum length of 2 diameters. The length of each test specimen for pipes larger than 24 inches in diameter shall be one diameter or a maximum of 36 inches, whichever is less. The weight of pipe specimens shall be determined with any suitable weighing device accurate to 0.10 pound.

2.3 JOINTS

- A. The joint shall be bell and spigot design and shall include a rubber gasket meeting the requirements of ASTM F-47.

Fittings used in the system shall not reduce or impair the overall integrity or function of the pipe line. Fittings may be either molded or fabricated Common Corrugated fittings including in-line joint such as tees, wyes, and end caps. Unless otherwise specified, fittings shall be installed using a joint configuration meeting the requirements of cell Class 335420C as defined and described in ASTM D3350. Only fittings supplied or recommended by the manufacturer shall be used.

- B. Water tightness shall be attained by the use of approved durable, high quality, resilient joint materials designed to perform the intended function. These materials shall be neoprene expanded rubber or sheet rubber gaskets, "O" ring rubber gaskets, butyl rubber base joint sealant, or other approved resilient materials. Watertight joints shall be tested in accordance with Section 330130, "Sanitary Sewer and Storm Drain System Leakage Testing."

PART 3 -- EXECUTION

3.1 GENERAL

- A. All laying, jointing, testing for defects and for leakage, shall be performed in the presence of the ENGINEER. All material found during the progress to have defects will be rejected and the CONTRACTOR shall promptly remove such defective material from the site of the WORK.

3.2 PIPE HANDLING

- A. Pipe, fittings, and accessories shall be carefully inspected before and after installation and those found defective shall be rejected. Pipe and fittings shall be free from fins and burrs. Before being placed in position, pipe, fittings, and accessories shall be cleaned and shall be maintained in a clean condition. Proper facilities shall be provided for lowering sections of pipe into trenches. Under no circumstances shall pipe, fittings, or any other material be dropped or dumped into trenches.

3.3 INSTALLATION

- A. Pipe shall be laid and jointed in accordance with the manufacturer's printed recommendations and the following provisions in order to be suitable for the purpose intended.
- B. Necessary facilities shall be provided for lowering and properly placing the sections of pipe in the trench.
- C. The pipe shall be laid to line and grade with the sections closely jointed.
- D. Every precaution shall be taken to prevent flooding the pipe trench before backfilling operations.
- E. New pipe shall be connected to existing or new drainage facilities as shown on the Drawings.

3.4 CONNECTIONS

- A. Connections of HDPE to existing structures and pipes shall be as follows:
 - 1. Connections to cast-in-place structures shall include a water-stop at mid-wall of the structure.
 - 2. Connections to pre-cast structures shall include a water-stop at mid-wall of the structure, and opening shall be filled with cement grout in conformance with Section 036000 "Grout."
 - 3. Connections to existing HDPE pipe shall be made with a premium split-coupling saddle tee.
 - 4. Connections to existing PVC shall be made with a PVC saddle with a HDPE/SDR 35 PVC adaptor.
 - 5. Connections to existing DIP shall be made with a DIP tap and heat shrink material around the joint. Heat shrink material shall be supplied by the HDPE pipe manufacturer.
 - 6. Connections to existing RCP shall be as shown on the Drawings, except that the PCC concrete encasement around the RCP shall be extended to cover the HDPE a point 6 inches to 12 inches beyond the RCP sleeve.

3.5 TESTING

- A. Testing of corrugated polyethylene non-pressure pipe shall conform to the requirements of Section 330130 "Sanitary Sewer and Storm Drain System Leakage Testing."

- END OF SECTION -

SECTION 334102 - REINFORCED CONCRETE PIPE

PART 1 -- GENERAL

1.1 THE REQUIREMENT

- A. The CONTRACTOR shall provide all materials, equipment, and labor necessary to furnish and install all reinforced concrete pipe and all appurtenant work, complete and operable, including all connections as shown on the Drawings and as specified herein.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 312300 Utility Earthwork.
- B. Section 330130 Sanitary Sewer and Storm Drain System Leakage Testing.
- C. Section 333900 Precast Concrete Maintenance Holes.
- D. Section 033050 Utility Cast-in-Place Concrete.
- E. Section 034800 Precast Concrete Vaults, Utility Boxes, and Storm Water Field Drop Inlets.
- F. Section 331100 Piping, General.
- G. Division 1 General Requirements.

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards:

- ASTM C 76 Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
- ASTM C 150 Specification for Portland Cement.
- ASTM C 443 Specification for Joints for Circular Concrete Sewer and Culvert Pipe Using Rubber Gaskets.
- ASTM C 596 Test Method for Drying Shrinkage of Mortar Containing Portland Cement.

1.4 CONTRACTOR SUBMITTALS

- A. **Certificates of Compliance:** Certificates of Compliance shall be provided for all products and materials proposed to be used in this Section.

PART 2 -- PRODUCTS

2.1 PIPE MATERIALS

- A. **Reinforced Concrete Pipe:** Reinforced concrete pipe shall conform to the requirements of ASTM Designation C 76. Cement shall conform to ASTM C150, Type II. Pipe shall be bell and spigot having O-ring rubber gaskets conforming to ASTM C 443 retained in a groove on the spigot end. All reinforcement shall be circular. **Elliptical reinforcing will not be allowed.**
- B. **Cement Mortar:** Cement mortar for structures or pipe connections shall consist of a mixture of Portland Cement, sand, and water. Mortar shall be composed of one part of cement and 2 parts of

clean, well-graded sand of such size that will pass a No. 8 sieve. Cement and sand shall first be combined in the proper proportions, and then thoroughly mixed with the required amount of water.

- C. Mortar shall be used as soon as possible after mixing and shall show no visible signs of setting prior to use. Retempering of mortar will not be allowed.
 - D. Concrete material shall conform to the requirements of Section 033050, "Utility Cast-in-Place Concrete."
 - E. **Admixtures:** No admixture shall be used in mortar unless otherwise specified or accepted in writing by the ENGINEER.
- 2.2 PIPE DESIGN
- A. Reinforced concrete pipe shall be manufactured and provided to meet the pipe strength classifications as shown on the Drawings and in accordance with ASTM C 76, but in no case shall be less than Class III for Wall "B" or Wall "C." Class I and II pipe will not be allowed.
 - B. Wall "A" pipe will not be allowed

PART 3 -- EXECUTION

3.1 PIPE LAYING

- A. Installation of pipes in prepared trenches shall start at the lowest point, with the spigot ends pointing in the direction of flow.
- B. Pipe shall have a minimum laying length of approximately 8 feet, except for closure and other special pieces as approved by the Engineer. The length of the incoming and outgoing concrete pipe at each structure shall not exceed 4 feet.
- C. Care shall be used to make sure that the bottom of the pipe is in contact with the bottom of the trench for the full length of each section.
- D. **Excavation:** Bell holes shall be excavated at each joint to provide full length barrel support of the pipe and to prevent point loading at the bells.
- E. **Pipe Laying:** Unless otherwise required, all pipe shall be laid straight between the changes in alignment and at uniform grade between changes in grade.
- F. **Rubber Gasket Joints:** The rubber gasket joint shall be made by properly lubricating the rubber gasket with a suitable vegetable compound soap before it is placed in the groove at the spigot end. The gasket shall be stretched over the spigot end of the pipe and carefully seated in the groove, with care taken to equalize the stress in the gasket around the circumference of the joint. The gasket shall not be twisted, rolled, cut, crimped, or otherwise injured or forced out of position during the closure of the joint. A feeler gauge shall be used to check the position of the rubber gasket after the joint has been assembled. Where a joint placement is found to be improper, the tested pipe section shall be removed, the gasket checked for damage, a new gasket installed, if necessary, the pipe re-laid and the gasket placement rechecked.
- G. Pointing and bonding mortar at pipe connections to structures shall be plastic and of such consistency that it will readily adhere to the pipe and structure.

3.2 TESTING

- A. Testing shall conform to the requirements of Section 330130, "Sanitary Sewer and Storm Drain System Leakage Testing."

- END OF SECTION -