

SECTION 02660
WATER SYSTEMS

PART 1 - GENERAL

1.01 WORK INCLUDED

- A.** See Section 02202 for trenching, groundwater control, pipe bedding, backfill and compaction of backfill, dust alleviation and control, and cleanup/restoration.
- B.** Installation of domestic water lines and appurtenances.
- C.** Disinfection and testing.
- D.** Supplying all labor, materials, equipment and apparatus not specifically mentioned herein or noted on the plans, but which are incidental and necessary to complete the work specified.

1.02 APPLICABLE PUBLICATIONS

- A.** The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text only by their general designation.
- B.** American Society for Testing and Materials (ASTM) Publications:
 - A – 276 Standard Specification for Stainless and Heat-Resisting Steel Bars and Shapes.
 - A – 536 Standard Specifications for Ductile Iron Castings.
 - D - 638 Standard Test Method for Tensile Properties of Plastics.
 - D - 790 Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
 - D - 1248 Specifications for Polyethylene Plastics Molding and Extrusion Materials.
 - D - 1505 Test Methods for Density of Plastics by Density Gradient Technique.
 - D - 1603 Test Method for Carbon Black in Olefin Plastics.
 - D - 1693 Test Methods for Environmental Stress Cracking Ethylene Plastics.
 - D - 2737 Specification for Polyurethane (PE) Plastic Tubing
 - D – 2774 Standard Recommended Practice for Underground Installation of Thermoplastic Pipe
 - D - 3015 Standard Practice for Microscopical Examination of Pigment Dispersion in Plastic Compounds.
 - D - 3035 Standard Specification for Polyethylene (PE) Plastic Pipe. (SDRPR) Based on Controlled Outside Diameter.
 - D - 3261 Standard Specifications for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
 - D - 3350 Specifications for Polyethylene Plastic Pipe and Fittings Materials.
 - F - 477 Elastomeric Seals (Gaskets) for joining Plastic Pipe.

C. American Water Works Association (AWWA) Publications:

- C - 153 Ductile-Iron Fittings 3" through 48" for Water and Other Liquids.
- C - 111 Rubber Gasket Joints for Ductile Iron and Gray-Iron Pressure Pipe and Fittings.
- C - 219 Bolted, Sleeve-Type Couplings for Plain-End Pipe.
- C - 502 Dry Barrel Fire Hydrants.
- C - 503 Standard for Wet-Barrel Fire Hydrant.
- C - 504 Rubber-sealed Butterfly Valves.
- C - 509 Resilient Seated Gate Valves, 3 through 12 NPS for Water and Sewage Systems.
- C - 550 Protective Epoxy Interior Coatings for Valves and Hydrants.
- C - 651 Disinfecting Water Mains.
- C - 900 Polyvinyl Chloride (PVC) Pressure Pipe, 4" through 12" for Water.
- C - 905 Polyvinyl Chloride (PVC) Water Transmission Pipe, Nominal Diameters 14" through 36".
- M – 23 PVC Pipe Design and Installation.

D. National Fire Protection Association (NFPA) Publications:

- Code 24 "Standard for Installation of Private Fire Service Mains and Their Appurtenances".

1.03 QUALITY ASSURANCE

- A.** All Work shall be done to the satisfaction of the representative of the Geotechnical Consultant and shall meet the approval of the City Engineer.
- B.** Class of pipe requirements shown or called for on the plans shall be the minimum acceptable.
- C.** Water mains, services and appurtenances shall be subject to hydrostatic and leakage tests.
- D.** Water mains, services, and appurtenances shall be disinfected by the Contractor prior to connecting to existing systems.
- E.** Submit manufacturer's data on the pipe material, fittings, restrained joints, valves, fire hydrants, and service material prior to beginning of any pipe installation.
- F.** Submit a plan showing the locations of all restrained joints and thrust blocks prior to installation of these devices.
- G.** The maximum allowable deflection (out of roundness) of PVC pipe under superimposed loads shall be 5%, or 75% of the manufacturers recommended maximum, whichever is smaller.

- H. The City Engineer may require manufacturer's certificates showing conformance with this specification for any of the pipe materials, fittings, valves and appurtenances delivered to the job site.
- I. For Fire Service lines, the lines shall be subject to a high velocity flushing test. Methods of flushing shall be approved in advance by the City Engineer.

1.04 JOB CONDITIONS

- A. Comply with all conditions and requirements indicated and specified under Section 02202 "Trenching and Backfill" of these specifications.
- B. Contractor shall conduct operations and schedule cleanup in a manner to cause the least possible obstruction and inconvenience to traffic, pedestrians and to adjacent property owners or tenants.

PART 2 – PRODUCTS

2.01 PVC PIPE MATERIALS

- A. PVC water mains 12" in diameter or less shall be PVC pressure pipe conforming to the applicable requirements of AWWA C900 for class 305 pipe having a dimension ratio (DR) of 14 and a ductile iron pipe equivalent outside diameter.
- B. Pipes 14" in diameter or larger shall be PVC transmission pipe conforming to AWWA C905. Pipe shall be Class 235 psi, having a DR of 18 and ductile iron pipe equivalent outside diameter.
- C. Maximum length of each section of pipe between elastomeric rings shall be twenty (20) feet.
- D. Each length of pipe shall have the words "DOMESTIC WATER" stenciled with 1-5/8" high lettering in permanent ink, at 2-foot spacing along its length.
- E. The Contractor may substitute pressure-sensitive tape in lieu of stenciling. Adhesive Backed Pipe Labeling Tape shall be PVC Plastic tape manufactured specifically for direct placement onto pipe, cable or conduit for warning and identification. Tape shall be a minimum of 2.2 mils, an adhesive strength of 26 psi, and with tensile strength of 32 lb. per inch of width. Tape shall be of the type provided in rolls, color coded for the utility involved with warning and identification imprinted in bold letters continuously and repeatedly over entire tape length. Code and letter coloring shall be permanent, unaffected by moisture or other substances contained in trench material.
- F. Gaskets: Nitrile Butadiene Rubber (NBR or BUNA-N), conforming to National Sanitation Foundation (NSF) Standard No. 61 when pipe is located in a potential hydrocarbon contaminated area.

2.02 DI PIPE MATERIALS

- A. Ductile Iron (DI):
 - 1. Pipe: Ductile iron, pressure class 250, AWWA C151.
 - 2. Joints: Push-on, AWWA C111 as modified.
 - a. Gaskets: Styrene Butadiene Rubber (SBR). Fluoroelastomer Rubber (FKM) when pipe is located in a potential hydrocarbon contaminated areas.

3. Fittings: Ductile iron mechanical joints, AWWA C110 or C153.
4. Lining: Standard thickness cement mortar lining for pipe and fittings, AWWA C104, except where noted otherwise in the Drawings. Cement mortar linings shall be seal coated. Alternatively, fittings may be fusion epoxy lined and coated per AWWA C116.
5. Protection: Polyethylene encasement, AWWA C105, black. Wrap pipe, wrap flanged fittings, mechanical joints, or other appurtenances with significantly different outside diameters from the pipe. Tape to seal seams and overlaps shall be plastic adhesive tape at least 4 mils thick and at least 2 inches wide.
6. Flanged pipe: Where flanges are necessary, thickness shall be Class 53, AWWA C115.
7. Field closure connections for restrained joints: Pipe cut in the field where necessary and when favorably reviewed by the City shall be connected by Series 1100 MEGALUG mechanical joint restraint by EBAA Iron Inc., or equal.

2.03 COUPLINGS AND RESTRAINING DEVICES

A. Solid Sleeve Couplings:

1. Solid sleeves: Shall be long type, mechanical joint, manufactured from ductile iron in accordance with and meet all applicable terms and provisions of standards ANSI/AWWA C153/A21.53. Ductile iron solid sleeves 2" through 24" shall be rated for 350 psi; 30" through 48" shall be rated for 250 psi. Solid sleeves shall be installed with Series 1100 MEGALUG mechanical joint restraints by EBAA Iron Inc., or approved equal.
2. Bolts: Shall be Type 316 Stainless Steel for direct buried solid sleeve couplings. Whenever Petrolatum Wax Tape System is installed per Project Drawings, Cor-Ten T-Bolts/Thrust Bolts, rods and nuts shall be used.
3. Gaskets: Shall be in accordance with and meet all applicable terms and provisions of standards ANSI/AWWA C111/A21.11. And shall be Nitrile Butadiene Rubber (NBR or BUNA-N), conforming to National Sanitation Foundation (NSF) Standard No. 61 when pipe is located in a potential hydrocarbon contaminated area.
4. Coating: Fusion epoxy lined and coated sleeves, mechanical joints and bolts assembly shall be cathodically protected using the Petrolatum Wax Tape System. See Technical Specifications Section 02661.
5. Solid Sleeves shall be Tyler/Union or approved equal.

B. PVC couplings:

1. Couplings manufactured from PVC shall not be used.
2. Slip couplings shall not be used.

C. Flexible Couplings and Flange Coupling Adaptors:

1. Conform to AWWA C-219 Standard.
2. Sleeve: Ductile iron, conforming to ASTM A-536 Standard for flange coupling adaptors and flexible couplings.
3. Followers: Ductile iron, conforming to ASTM A-536 Standard for flange coupling adaptors and flexible couplings.

4. Sleeve bolts and nuts: Type 316 stainless steel bolts and nuts shall be used on direct buried flexible coupling adaptors. Whenever Petrolatum Wax Tape System is installed per project Drawings, ASTM, Type 3, malleable iron or equivalent bolts and nuts shall be used.
5. Coating: Fusion epoxy lined and coat, sleeve and followers for flange coupling adaptors. The flange coupling adaptors including bolt assembly shall be cathodically protected using the Petrolatum Wax Tape System. See Technical Specifications Section 02661.
6. Pressure rating: Greater than or equal to the associated pipe rating, but not less than 150 psi.
7. Buried flexible coupling sleeve: Long barrel. For pipes 12" and larger, minimum sleeve length shall be 12".
8. Gaskets: Nitrile Butadiene Rubber (NBR or BUNA-N), conforming to National Sanitation Foundation (NSF) Standard No. 61.
9. Manufacturers:
 - a. Flexible couplings:
 - 1) Connecting pipe with identical outside diameters: Smith-Blair 411 or approved equal. With the longest sleeve length available.
 - 2) Connecting pipe with slightly different outside diameters: Smith-Blair 441, or approved equal. With the longest sleeve length available.
 - 3) Connecting pipe with outside diameter differences up to 2-3/4": Smith-Blair R441 Reducing Couplings or approved equal. With the longest sleeve length available.
 - b. Flange coupling adaptors:
 - 1) Connecting plain end pipe to flanged fittings: Series 2100 by EBBA Iron; or approved equal.

D. Restraining Devices:

1. Conforming to ANSI/AWWA C111/A21.11 or ANSI/AWWA C153/A21.53.
2. Ductile iron castings shall conform to ASTM A-536 Standard.
3. Bolts, nuts, washers and rods shall be Type 316 Stainless Steel for direct buried restraining devices. Whenever Petrolatum Wax Tape System is installed per Project Drawings, Cor-Ten T-Bolts/Thrust Bolts, rods and nuts shall be used.
4. Pressure rating of greater than or equal to the associated pipe pressure rating, but no less than 150 psi.
5. Metallic portion shall have a factory-applied fusion epoxy coating per AWWA C213.
6. Entire restraining device, including associated adjacent fitting and valves, shall be cathodically protected with Petrolatum Wax Tape System. See Section 02661.
7. Series 1500 by EBAA Iron (4" to 12"); Series 2800 by EBAA Iron (14" to 48"); with two (2) serrated spigot rings; or approved equal for PVC pipe bell and spigot joints.
8. Series 2000 PV by EBAA Iron; or approved equal for PVC pipe mechanical joints restraints at pipe fittings.

9. For Ductile Iron Pipe, mechanical joint restraints shall be EBAA Iron Series 1100 MEGALUG.
10. The restraint length requirements are shown on the Drawings.
11. Gaskets: Nitrile Butadiene Rubber (NBR or BUNA-N), conforming to National Sanitation Foundation (NSF) Standard No. 61 when pipe is located in a potential hydrocarbon contaminated area.

2.04 FITTINGS FOR PVC PIPE

- A. Fittings for use on PVC pressure pipe shall be ductile iron castings conforming to the applicable requirements of AWWA Standard C153 for two-hundred fifty (250) psi working pressure. Joints shall be rubber gasketed per AWWA C-111. Fittings for use on PVC pipe shall be Tyler Union or approved equal.
- B. Tapping sleeves shall be type 316L stainless steel, Smith Blair 663, JMC 432 or approved equal, with full circumference gasket, flat-faced flange to mate with standard flange x mechanical joint tapping valves; and with 3/4" NPT 316 stainless steel test plug.
- C. Fittings shall be fusion-epoxy lined and coated as specified in Section 02661 of these Specifications.
- D. All bolt-up sets (nuts, bolts and washers) and tie rods for buried valves and fittings shall be stainless steel, ASTM A-276 type 316.
- E. Isolated fitting and associate adjacent restraints shall be cathodically protected with a Petrolatum Wax Tap System. See Section 02661.
- F. Gaskets: Styrene Butadiene Rubber (SBR). Fluoroelastomer Rubber (FKM) when the pipe is located in a potential hydrocarbon contaminated areas.

2.05 VALVES AND VALVE BOXES

- A. Gate valves shall conform to the requirements of AWWA C509 for resilient-seated valves. Stems shall be, fitted with a 2" x 2" square wrench **bronze** nut and shall be manufactured to open counter-clockwise. Stem extensions shall be installed to bring the operating nut to within two (2) feet of finish grade where the depth from finished grade to operating nut exceeds four (4) feet. Gate valves shall be used for all valves ten (10) inches and smaller and shall be FUSION EPOXY lined and coated in conformance with the requirements of Section 02661 of these Specifications. Gate valves shall be as manufactured by Mueller Company, or approved equal.
- B. Butterfly valves shall be used for all valves 12 inches and larger and shall comply with the latest revision of AWWA Standard C504, Class 150-B having Cast Iron Bodies, Cast or Ductile Iron discs, Stainless Steel Shafts, adjustable field replaceable rubber seats mating against Stainless Steel seat rings, and field-replaceable seals. Butterfly valves shall be flange x flange; and flange x mechanical joint adapters shall be used to connect butterfly valves to plain end pipes. Wafer type valves shall not be allowed. Valve actuators shall be of the traveling nut type designed for buried service, sized to operate the valves against 150 psi unbalanced line pressure, with field adjustable and stops capable of withstanding input torque of 450 ft. lbs. All internal and external surfaces of butterfly valves shall be covered with a factory applied 2-part, polyamide cured, epoxy coating applied over a sand blasted "near white" metal surface per SSPC-SP10 to a minimum of 8 mils and a maximum of 12 mils, in compliance with AWWA Standard

C550. Butterfly valves shall be as manufactured by Mueller Company, or approved equal.

- C. Combination Air Valves: Combination air release valves, Cla-Val Series 36; equivalent by APCO; or approved equal.
 - 1. Materials: Cast iron body, Buna-N seat, stainless steel float and plug, and stainless steel operating parts. Fusion bonded epoxy coated and lined, 8 to 10 mils minimum.
 - 2. Operating pressure: 20 to 150 psi.
- D. All bolts, nuts and washers throughout the bodies of the gate and butterfly valves shall be stainless steel, ASTM A276, Type 316. The square wrench nut and valve stem shall be bronze, ASTM B62, containing not more than 5% zinc and 2% aluminum. The wrench nut cap screw attaching the square wrench nut to the stem shall be stainless steel, ASTM A276, Type 316. The valve stem shall be forged bronze.
- E. Valves shall be provided with traffic valve boxes and risers and circular cast iron traffic covers labeled "water", set in a concrete base as shown on the Drawings.
- F. All domestic services 1.5-inch in diameter or larger shall be provided with a check valve; or as directed by the California Code of Regulations.

2.06 WATER SERVICES

- A. Commercial water service lines four (4) inches in diameter and larger shall be PVC pressure pipe and couplings conforming to the requirements of AWWA Standard C900 for Class conforming to the applicable requirements of AWWA C900 for class 305 pipe having a dimension ratio (DR) of 14 and a ductile iron pipe equivalent outside diameter, and couplings as herein specified for PVC pressure water mains.
- B. Commercial, irrigation, and residential water service lines two (2) inches in diameter or less, shall be Polyethylene Plastic Tubing (CTS), PE 4710, pressure rating of 250 psi, and conforming to the requirements of ASTM Designation D2737 for the size indicated on the plans. Alternative pipe materials such as PVC or DI with NBR or FKM rubber gaskets will be used if pipe is located in a potential hydrocarbon contaminated area.
- C. Fittings, couplings and water service material 2 inches in diameter or less shall be bronze and all nipples shall be brass of the size and type called for on the plans.
- D. Tapping for water service connections shall be performed using Corporation Stops and double strap bronze Service Saddles as manufactured by Mueller Company or approved equal.
- E. All new water meters will be provided by the City of Redwood City, and installed by the Contractor. Existing water meters shall be left in the new water meter box after removal, for the City to pick-up.
- F. Meter box and cover assembly shall be provided by the Contractor for each water meter as shown on the plans, and shall conform to the size and type shown on the Engineering Standard Details.
- G. Meter box and cover assembly shall be made of solid fiberglass reinforced polymer concrete (RPC) material, in color of "concrete gray". The meter box and cover shall be manufactured by Armorcast Products Company or approved equal. Cover shall have "WATER" logo showing on top; and shall be recessed with a 2-inch diameter hole to allow radio transmitter installation. The RPC material shall be resistant to chemicals

commonly found in the soil or in the operating environment, and shall be tested in accordance with ASTM D-543. The polymer concrete material shall be resistant to sunlight and any climatic condition and shall be tested in accordance with ASTM D-756, procedure "E". Each meter box and cover assembly shall withstand a vertical test load of 20,800 lbs. (16,000 lbs. Plus 30% impact factor) load over a 10"x20"x1" thick steel plate centered on the cover area and baked with a 10"x20"x1/2" rubber plate. The test loading shall not cause any failure to the box per cover. Traffic rating cover shall be used in traffic area.

2.07 FIRE HYDRANTS

- A.** All fire hydrant service runs shall be PVC pressure pipe as herein specified and shall be six (6) inches in diameter.
- B.** Fire hydrant assemblies shall consist of a six (6) inch gate valve, the run of six (6) inch pipe, cast-iron bury, and the hydrant. Use break away bolts to fasten the hydrant to the bury.
- C.** Fire Hydrants shall be one of the four (4) different types depending on location and the size of the watermain.
 - 1. Type A - Mueller A-423 dry barrel or approved equal fusion epoxy lined and coated; provided with two 2-1/2" and one 4-1/2" outlets, conforming to AWWA C502.
 - 2. Type B – Clow 92 low silhouette, wet barrel or approved equal fusion epoxy lined and coated; provided with two 2-1/2" and one 4-1/2" outlets, conforming to AWWA C503.
 - 3. Type C – Clow 76 wet barrel or approved equal fusion epoxy lined and coated; provided with two 2-1/2" and one 4-1/2" outlets, conforming to AWWA C503.
 - 4. Type D – Clow 865 wet barrel or approved equal fusion epoxy lined and coated; provided with one 2-1/2" and two 4-1/2" outlets, conforming to AWWA C503.
- D.** All exterior metal parts of the hydrants from the ground up shall be painted with two coats of paint, or one coat of primer and one coat of paint. The finish coat color shall be 2064-20 "PATRIOT BLUE" in Redwood Shores area; or "CITY OF REDWOOD CITY LIME GREEN FIRE HYDRANT" at all other locations. Both paint colors are available from Benjamin Moore Paints. Substitution with other paint brands shall match these colors and quality; and shall be submitted to the City Engineer for approval.
- E.** Wet barrel fire hydrants, burys and extension spools shall be epoxy lined and coated as herein specified for fittings.
- F.** All fire hydrant heads, burys and extension spools shall be bolted with stainless steel bolts, and washers, as herein specified for fittings.

2.08 LOCATOR WIRE

- A.** Locator wire for use with plastic pipe installations shall be stranded copper, eight (8) gauge types TW or THHN electrical wire with solid blue jacket.
- B.** Connect locator wire to metallic fittings with Caldwell exothermic welding process and cover with Royston Handy Cap, or equal. Splice locator wires with brass wire split nuts.

All exposed metallic wires and fittings shall be protected with Skotchkote 3M Electrical Coating or equal; and covered with Skotchkote 3M Electrical Tape or equal.

2.09 CONCRETE FOR THRUST BLOCKING

- A.** Reinforcement for concrete thrust blocking shall be deformed steel bars conforming to Section 02550 of these Specifications.
- B.** Concrete for thrust blocking shall be Portland Cement Concrete conforming to the applicable requirements of Section 02550 of these Specifications.

2.10 PIPE BEDDING AND BACKFILL MATERIAL

- A.** Shall conform to Section 02202 of these Specifications.

PART 3 – EXECUTION

3.01 TRENCHING, BACKFILLING AND SHORING

- A.** Shall conform to Section 02202 of these Specifications.

3.02 PVC PIPE INSTALLATION

- A.** Installation: Install pipe, valves, fittings and appurtenances in accordance with manufacturer's instructions, and in conformance with the applicable requirements of the AWWA Standards. Rotate each length of PVC pipe so that the stenciled or taped words "DOMESTIC WATER" will be located on the top of the pipe. Where pipe lengths of 3 feet or less are needed, ductile iron pipe shall be used. Provide corrosion protection per Project Drawings, or as directed by the City Inspector.
- B.** Handling: Handle pipe, valves, and fittings carefully during hauling, unloading, and placing operations, so as to avoid breakage or damage. Use strap-type slings for lifting and placing; no chains or hooks will be permitted. Broken or damaged pipe or appurtenances will be rejected by the City Engineer and shall thereupon be removed by the Contractor from the work and replaced. Repair damaged coating in accordance with coating manufacturer's recommendations.
- C.** Alignment: All pipes shall be accurately laid in conformity with the prescribed lines and grades as established by the City Engineer. Joint each length to the preceding section as specified, and after said jointing has been completed; there shall be no movement of the pipe in subsequent operations.
- D.** Pipe Deflections: The laying of pipe on curved alignment will be permitted up to one-half the deflection as recommended by the respective pipe manufacturer. Pipe shall not be bent against the trench side wall.
- E.** Cleaning: Before each new length of pipe is placed, carefully clean the interior of the preceding pipe of all dirt and debris. When pipe laying is not in progress, close all open pipe ends with watertight plugs in a satisfactory manner.
- F.** Bearing: Provide continuous uniform bearing of pipe in the trench along its bottom, except at bell holes. Place blocking used to support the pipe during laying at the end of the section and remove before laying the next section. Before lowering pipe into the

trench, the Contractor shall remove all stakes, debris, loose rock and other hard material from the bottom of the trench. If the Contractor installs the pipe on uneven, humpy, or concave bedding, it will be required to remove the pipe and uniformly grade the pipe bedding before continuing the work.

- G.** Positioning: After the final positioning, hold the pipe in place in the trench with compacted backfill material placed equally on both sides of the pipe at as many locations as are required to hold the pipe section in place. After joints are completed, redistribute the backfill material and compact as herein required.
- H.** Closure: At the end of each day and when work is not in progress, close the open ends of pipe installed in the line with watertight plugs or caps.
- I.** Thrust Blocking: Concrete thrust blocks of the form and dimensions shown or noted on the plans shall be provided by the Contractor at all changes in horizontal or vertical alignment and at such other points as may be called for on the plans. Thrust blocks shall be installed by the Contractor in strict conformance with the details shown or noted on the plans.
- J.** Restrained Joint: Install per manufacturer's instructions. Length of restraint as shown on Drawings. Install Petrolatum Wax Tape System per Section 02661.
- K.** System Connections: Unless separately listed on the bid schedule, Contractor shall make all required connections to existing facilities and improvements at no additional cost; and compensation for such work shall be deemed as included in the bid price for pipe installation. Straight pipe connections shall be done using ductile iron mechanical joint solid sleeve couplings, long type; with Series 1100 MEGALUG mechanical joint restraints by EBAA Iron Inc., or approved equal; as specified in paragraph 2.03.A "Solid Sleeve Couplings" of this section.

3.03 SERVICE INSTALLATION

- A.** Tapping for water service connections shall be performed using Corporation Stops threaded on double strap bronze Service Saddles. No direct threaded connection of Corporation Stops on pipe shall be permitted; regardless the type of mainline pipe material. Minimum distances required when tapping are: 18 inch between taps (staggered at 45 degrees); 24 inch from back of bell; and 24 inch from spigot insertion line; or per manufacturer recommendations, whichever is greater. Contractor shall consult the City's Inspector on these critical distance situations, and shall not backfill without inspection. Contractor shall submit the tapping bit to the City's Inspector/Engineer for approval, before starting the tapping work.
- B.** Contractor shall not bend the service pipe in a manner that might affect pipe roundness and/or integrity. The minimum bending radius shall never be lesser than the manufacturer's minimum radius recommended.
- C.** The installation depth of service line shall provide a minimum cover of 24 inch within Redwood City's right of way and Town of Woodside's right of way; and 30 inch within San Mateo County's right of way.

3.04 COUPLING INSTALLATION

- A.** Flexible Couplings, Rigid Couplings and Flange Coupling Adaptors: Prior to installation, thoroughly clean oil, scale, rust, and dirt from the pipe to provide a clean seat for the gasket. Take care that the gaskets are wiped clean before they are installed. If

necessary, lubricate flexible couplings and flanged coupling adapter gaskets with manufacturer's standard lubricant before installation on the pipe ends. Install in accordance with the manufacturer's recommendations. Tighten bolts progressively, drawing up bolt on opposite sides a little at a time until all bolts have a uniform tightness. Workers tightening bolts shall be equipped with torque-limiting wrenches or other favorably reviewed type. Install anchor studs on restrained flanged coupling adapters so as to lock into holes drilled through pipe wall in accordance with manufacturer's recommendation.

- B. Flexible Expansion Joints: Install in accordance with manufacturer's instructions.

3.05 CONNECTIONS TO EXISTING SYSTEMS

- A. Do not make connections to existing systems until the new mains have been satisfactorily disinfected and have passed all tests specified herein.
- B. Perform connection of new water main to existing distribution system no later than 48 hours after Bacteriological Examination Results have been received and approved by the City Engineer. If the system connection is not performed within this period of time, repeat Disinfection and Bacteriological Examination processes.
- C. Before cutting the existing main the Contractor shall be prepared with a dewatering pump to keep the trench dewatered to prevent muddy water from reaching the pipes. Dewatering operations shall be lawfully performed.
- D. If the total length of the connection from the end of the new watermain to the existing watermain is equal to one pipe length (20 feet) or less, the Contractor shall disinfect the new pipes, fittings and valves by means of spraying or swabbing the interior with a minimum 1-5% solution of chlorine just prior to be installed.
- E. If the total length of the connection from the end of the new watermain to the existing watermain is greater than one pipe length (20 feet), the Contractor shall set the pipe aboveground, and perform disinfection and bacteriological test as outlined in paragraph 3.06 of this specification section. Between the time the satisfactory bacteriological results are receipt and the time that the connection piping is installed, the ends of the piping must be sealed with watertight plugs or caps.
- F. Straight pipe connections shall be done with ductile iron mechanical joint solid sleeve couplings, long type; with Series 1100 MEGALUG mechanical joint restraints by EBAA Iron Inc., or approved equal, as specified in paragraph 2.03.A "Solid Sleeve Couplings" of this section.

3.06 PRESSURE AND LEAKAGE TESTS

- A. Preparation:
 1. The Contractor shall install temporary blow-offs as necessary for testing purposes and provide all necessary material and equipment, and shall perform all work required in connection with the testing of the water system, as specified herein.
 2. Hydrostatic and leakage tests shall be made by the Contractor only after the trenches have been backfilled sufficiently to hold the pipe firmly in position; and thrust blocks have given time to cure. Allow seven (7) days for Type I Portland Cement Concrete and three (3) days for Type III Portland Cement Concrete.

3. The Contractor shall provide all water necessary for filling, flushing, disinfection and any required tests including all labor and equipment required.

B. Initial Pipe Filling:

1. Contractor shall fill the new water main with water at the lowest elevation making sure that air is being released at all high points, including curb stops at domestic services, hydrants and blow-offs. If chlorine tablets have been attached inside the pipe as work progresses, the main line shall be filled very slowly in order to avoid dislodging the tablets. Pipes shall not be filled at a rate greater than one (1) foot of pipe length per second.
2. The Contractor shall connect a pressure pump at the lowest elevation of the main to be tested. The pump must have a pressure gauge and connection to a small tank of makeup water that would facilitate pumped water measurement.
3. Apply partial pressure and verify that all air has been released. Allow the pipe to stand with a pressure not to exceed the local water system pressure for at least 24 hours to stabilize, moisturize gaskets and allow air bubbles to travel to the highest points to be released previous to the Pressure Test.

C. Hydrostatic Pressure Test and Leakage Test:

1. The Contractor shall notify the Engineer at least 24 hours in advance to allow proper scheduling. The Contractor shall supply and install pressure gages at the discretion of the Engineer. Approximately three (3) gauges are required for an average size block. Ensure that all air bubbles have been expelled from the pipe before starting the pressure test. Subject all water pipe to a hydrostatic test of at least fifty percent higher than the normal expected operating pressure or one hundred and fifty (150) pounds per square inch (psi), whichever is larger, unless otherwise specified or directed. This test pressure shall be measured at the lowest elevation; therefore, pressure may be lesser at higher elevations. The expected difference in pressures due to difference in elevation shall be estimated by the Engineer to ensure that all gauges are working properly. Faulty gauges shall be replaced by the Contractor. If the slope of the pipe is greater than five percent (5%) the pipe shall be tested in sections no greater than seven hundred (700) linear feet.
2. The minimum hydrostatic and leakage pressure for fire service lines is 200 psi.
3. The duration of the pressure test shall not be less than two (2) hours. If no pressure drop is observed, the pressure test is considered passed and no leakage test is necessary. If during these two hours, the pressure drops more than five (5) psi, a leakage test is required as follows: The Contractor shall pump more water into the pipe to recuperate the required test pressure. The amount of water pumped into the pipe to maintain the test pressure during these two hours shall be measured. The measured water shall not exceed the allowable leakage as described below.
4. Upon completion of the pressure and leakage tests, the pressure in the pipe shall be lowered to match the local system pressure. The Contractor shall release the pressure at the outlets selected by the Engineer.

D. Allowable Leakage:

1. For domestic water and fire service lines, the duration of each leakage test shall not be less than two (2) hours, unless otherwise specified, and during the test the pipe shall be continuously subject to hydrostatic pressure, as specified, and measured at the lowest elevation.
2. Satisfactorily apply the specified test pressure by means of a pump connected to the pipe. Maintain the test pressure for the specified time and do not allow to drop more than 5 psi during which all exposed pipe, couplings, fittings, valves and hydrants shall be examined carefully.
3. No PVC pipe installation will be accepted if the leakage for the section of tested line is more than the amount determined by the formula below:

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

Where: L = allowable leakage, gph
N = number of joints in the length of pipeline tested
D = nominal diameter of pipe, in.
P = average test pressure during the leakage test, psig

4. When test results indicate leakage beyond that allowed, Contractor shall conduct a leak survey of the line and repair any leaks found. The method used for leak survey shall be approved by the City Engineer. If the Contractor does not have the appropriate leak detection equipment, a specialized firm shall be hired. After all leaks have been repaired, the leakage test shall be repeated by the Contractor until satisfactory conformance to this specification is demonstrated.
5. Any flaw disclosed by any of the above-referenced tests shall be repaired and satisfactorily retested by Contractor, even if the test is passed.

3.07 DISINFECTION AND BACTERIOLOGICAL TEST

A. Following the Pressure and Leakage Tests and before being placed in service, all new water lines shall be chlorinated, flushed and tested by Contractor in accordance with the requirements of AWWA Standard C651-05, and as directed. If a later edition is available it will supersede the 05 edition.

1. Disinfection: The Contractor shall have the option of applying chlorine with tablet method, continuous-feed method or slug method to the entire water content of the line, including services, fire hydrants and stubs, in sufficient quantity as stipulated in the above mentioned AWWA Standard.
 - a. If the Contractor elects to employ the use of the "Tablet" form of chlorination by mounting tablets into the pipe sections as they are installed, he shall determine the minimum number of tablets per AWWA C651-05 or later Standard requirement. This method may be used only if the pipes and appurtenances are left clean and dry during construction. The tablets shall be attached to the ceiling of the pipe by a food-grade adhesive. In the event that adequate disinfection is not obtained using said minimum number of tablets, it shall be the Contractor's responsibility for re-chlorination until a satisfactory result is obtained.

- b. The tablet method and the continuous feed method shall be applied at an average chlorine dose of 25 mg/L and provide a minimum residual of 10mg/L after 24 hours retention.
 - c. If liquid chlorination is to be used, the Contractor shall flush the pipe to remove any impurities, sediment or other materials that may be present in the pipe before starting the disinfection process. If colored or cloudy water is noticed, flushing shall continue until clear water is observed.
2. Final Flushing: After chlorination has been satisfactorily completed, thoroughly flush the lines until the chlorine content in all parts of the system has been proven by test to be comparable to the chlorine content of the City Water System. Contractor shall provide and use test paper or other means approved by the Engineer to measure chlorine residual to a precision of one (1) part per million (ppm) and PH to increments of 0.5.
 - a. Prior to flushing, the Contractor shall thoroughly neutralize the free and combined chlorine residuals. The chemical product used for dechlorination shall provide consistent elimination of residual chlorine without affecting water quality. Sulfur Dioxide gas or Liquid Sodium Metabisulfite systems shall not be allowed. The product used by Contractor for this purpose shall be Bio-Neutralizer, with 35% concentration Sodium Sulfite dechlorination tablets as produced by NORWECO, or approved equal. The Contractor shall submit product information sheet for review and approval by the City before performing any flushing.
 - b. Before discharge, the pH of the water shall be within the range of 6.5 to 8.5. Neutralized water may be discharged into the storm drainage system upon satisfactory testing.
 - c. Disposal of flushed water shall comply with the National Pollution Discharge Elimination System (NPDES). See Specification Section 02133 "Stormwater Pollution Prevention" of these specifications.
 - d. Contractor shall use caution to avoid flooding or damage to adjacent properties or facilities.
3. Bacteriological Test: After flushing the chlorine from the water system and prior to placing line in service, the Contractor shall engage the services of an approved Commercial Testing Laboratory, approved by the State of California Department of Health Services, to gather an approved number of representative water samples, the location and number of which shall be determined by the City Engineer. Bacteriological testing shall be in accordance with requirement of AWWA Standard C651-05.
 - a. Samples shall be taken of water that has stood in the watermain for at least 16 hours after Final Flushing.
 - b. Two consecutive sets of acceptable samples taken at least 24 hours apart shall be collected from the new watermain. The Contractor shall install temporary blow-off assemblies at each end of the new watermain and at each branch of it to allow sampling. One set of samples shall be taken at

each end and at each branch of the main line; at the discretion of the City Engineer, samples can be requested from any one domestic service per block. The number of samples taken will never be less than one set of samples for every one thousand two hundred (1,200) linear foot of main line.

- c. No section of water systems will be allowed to be connected to the City's existing water system when any sample of water tests indicate coliform bacteria as tested by the 24 Hour Membrane Filtration Method. Should the laboratory report show that any sample taken was not acceptable (Heterotrophic plate count greater than 0), Contractor shall re-chlorinate and test the water again as herein before specified. This process shall be repeated by Contractor until a satisfactory disinfection has been accomplished.
- d. Contractor shall direct the laboratory to send the original report of Bacteriological Examination to the City Engineer.
- e. Special Conditions: If trench water has entered the new watermain during construction or if in the opinion of the City Engineer, excessive quantities of dirt or debris have entered the new main, bacteriological samples shall be taken at intervals of approximately two hundred (200) feet, and the location of samples shall be identified. Samples shall be taken of water that has been stood in the new pipe with an initial chlorine residual comparable to that in the existing local water system for at least 16 hours.

3.08 HIGH VELOCITY FLUSH TEST

- A.** This test is required for individual, dedicated fire service lines only in compliance with the National Fire Protection Association (NFPA) Code 24 "Standard for Installation of Private Fire Service Mains and Their Appurtenances". The purpose of the test is to clean the pipe of debris and sediment.
- B.** The test shall be performed by the Contractor in the presence of the City Inspector. The test shall be done under maximum flow conditions, and the flushed water shall be filtered to collect any debris in the line. Underground pipe shall be tested from the connection at the City's main to the riser. The flushing operation shall be continued for a sufficient time to ensure thorough cleaning; and the debris shall be collected using a filter fabric pouch such as "Hydrant Sock" brand, or similar approved. Dechlorinator tablets shall be placed in the pouch before flushing. If sediments continue to be trapped in the filter, then the test shall be re-done as directed by the City Inspector, until the water is free of sediments.
- C.** The Fire Service shall not be connected to the building fire suppression system until the flushing test is completed and approved by the City inspector.
- D.** Upon completion and approval of all testing, the Contractor shall provide an Underground Piping Test Certificate to be signed by both witnesses: Contractor and City Inspector. The Test Certificate shall be provided to the City's Fire Prevention Officer for the project file.
- E.** The test may be combined with other flushing of the water main following disinfection.

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