

TRENCHING, BACKFILLING AND COMPACTION

PART 1 GENERAL

1.01 SUMMARY

- A. Work to be performed under this section shall include all labor, equipment, materials and miscellaneous items necessary to perform all excavation, backfilling and compaction of underground pipelines, conduits, cables and appurtenances as specified herein for the City of Glenwood Springs
- B. All work within the rights-of-way of the Federal Government of the Colorado Division of Highways, County Governments or Municipal Governments shall be done in compliance with requirements issued by those agencies. All such requirements shall take precedence over these Specifications. It shall be the Contractor's responsibility to secure all required excavation permits and pay all costs thereof. Contractor will be required to obtain necessary road cut permits.

1.02 PROTECTION OF WORK

- A. Safety. All excavation shall be protected by barricades, lights, signs, etc., as required by governing federal, state and local safety codes and regulations.
- B. Sheeting, Shoring and Bracing. Where trench walls are not excavated at a stable slope, the Contractor shall provide and maintain support sufficient to prevent caving, sliding or failure and property or bodily damage. Any damage due to inadequate support shall be repaired at the sole expense of the Contractor.
 - 1. Under normal construction conditions, support shall be removed as work progresses. Support shall remain installed if directed by the City or if pipe does not have sufficient strength to support backfill based on trench width as defined by the sheeting.
 - 2. Use of a movable trench shield or coffin box will not be allowed where pipe strength is insufficient to support backfill as defined by the trench width after the trench shield is removed.
 - 3. The Contractor shall be held solely responsible for any violation of applicable safety standards. Particular attention is called to minimum requirements of OSHA and State of Colorado Occupational Safety and Health laws.
- C. Site Drainage. Excavation to be protected from surface water at all times. At no time shall excavated area be allowed to fill with storm water runoff. Contractor shall provide proper, temporary drainage structures at their cost to detour runoff from excavated areas.

1.03 CONSTRUCTION IN STREETS

- A. When construction operations are located within streets make provisions at cross streets and walks for free passage of vehicles and pedestrians. Do not block streets or walks without prior approval.

PART 2 PRODUCTS

2.01 EMBEDMENT MATERIAL

- A. Pipeline embedment material shall comply with the appropriate classes as listed below and as illustrated in the Construction Drawings:
 - 1. Class A - Use where improper trenching or unexpected trench conditions require its use as determined by the Engineer.
 - a. Characteristics - Concrete cradle foundation with densely compacted Class 6 aggregate base backfill to 12" above top of pipe, or densely compacted Class 6 aggregate granular foundation with concrete arch cover to 6" above top of pipe.
 - 2. Class B - Use for all PVC, DIP, CMP and concrete pipe under normal construction conditions.
 - a. Characteristics - Densely compacted Class 6 aggregate granular foundation of depth shown on Typical Details with densely compacted Class 6 aggregate 12" above top of pipe.

2.02 CONCRETE FOR EMBEDMENT

- A. Shall be 2000 psi concrete (28-day compressive strength).

2.03 BACKFILL MATERIAL

- A. Characteristics – Class 6 aggregate base course. Uniformly graded sufficient to allow proper compaction.

PART 3 EXECUTION

3.01 SITE PREPARATION

- A. Clearing. Remove all vegetation, stumps, roots, organic matter, debris and other miscellaneous structures and materials from project site. Dispose of off site.
- B. Topsoil Removal. Strip existing topsoil from all areas to be disturbed by construction. Topsoil to be stockpiled separately from excavated materials.
- C. Pavement Removal. Asphalt and bituminous pavements to be cut to full depth of pavement. The vertical face of the cut shall be a straight-line parallel to the limit of excavation. Cuts shall be made with a concrete saw, or as approved by the City. The method used should provide a straight, true cut. All asphalt located within trench limits to be hauled off site.
- D. Concrete pavements, including curbs, gutters and sidewalks, to be saw cut to the full depth of pavement at the nearest construction joint. The vertical face of the cut shall be a straight-line parallel to the limit of excavation.
- E. All pavement removal shall be disposed of off site. Broken pavement shall not be used in backfill material.

3.02 TRENCH EXCAVATION

- A. Limits of Excavation. Trenches to be excavated along lines and grades as approved by the City. Trench widths for pipe loading to be measured 12 inches above top of pipe.
 - 1. Minimum trench width to be the outside diameter of the pipe or conduit plus 16 inches.
 - 2. Maximum trench width to be the outside diameter of the pipe or conduit plus 24 inches for all pipes or conduits with outside diameter of 24 inches or less, and plus 30 inches for all pipes or conduits with outside diameters greater than 24 inches.
 - 3. If maximum trench width is exceeded, Contractor will provide at his expense, higher strength pipe or special bedding including concrete at the direction of the Engineer.
 - 4. Trench excavation not to be completed more than 100 feet in advance of pipe installation. Backfill to be completed within 100 feet of pipe installation.
- B. Groundwater Control. Contractor to maintain facilities on-site to remove all groundwater from trench and keep water at least 12 inches below the trench bottom to a point such that a firm base for pipe or conduit installation exists. Facilities shall be maintained until all concrete is cured and backfilling is in place at least 24 inches above anticipated water levels before water removal is discontinued; all water removal shall be subject to approval by the City.
- C. Stockpile Excavated Material. Excavated material to be stockpiled so as not to endanger the work or public safety. Maintain existing vehicular and pedestrian traffic with minimum disruption. Maintain emergency access and access to existing fire hydrants and water valves. Maintain natural drainage courses and street gutters.
- D. Excavation for Appurtenances. Adequate working clearances to be maintained around appurtenances. Provisions for base and bottom preparations shall apply to all appurtenances. Precautions to be taken to maintain trench widths in the vicinity of adjacent pipelines and conduits.

3.03 BOTTOM PREPARATION

- A. Undisturbed Foundation. Where soils are suitable and have adequate strength, bottom to be graded and hand-shaped such that pipe barrel rests uniformly on undisturbed soil. All rocks or stones, which may result in a point bearing on the pipe, shall be removed.
 - 1. Undisturbed grades shall be within 0.1 feet \pm tolerance. Soils for final pipe grade placed within these limits shall be fine granular (100% passing No. 4 sieve) or may be native materials, hand compacted to 95% maximum density.
- B. Bell Holes. Material to be removed to allow installation of all fitting and joint projections without affecting placement of pipe.
- C. Over-excavation. Whenever trench is over-excavated to eliminate point bearing by rocks or stones or when undisturbed grade tolerances of 0.1' are exceeded, the Contractor is to re-establish grade using Class 6 aggregate bedding material. Compaction shall be 95% maximum density. All work to re-establish grade shall be at the Contractor's expense.

- D. Unstable Materials. Materials incapable of supporting superimposed loadings are defined as unstable materials. Should unstable materials be encountered during excavation, immediately notify the City. If, unstable materials are encountered, the trench bottom shall be over-excavated (minimum 6 inches) and backfilled with clean 2-inch to 6-inch rock with filter fabric installed around it to prevent migration of fines. The rock backfill provides increased water movement and helps stabilize the trench bottom.
- E. Rock Excavation. Rock shall be removed to a 4" depth below grade. Additionally, all rock loosened during jacking, blasting, etc., shall be removed from the trench.

3.04 BACKFILLING

- A. Tamping Equipment. Except immediately next to the pipe, mechanical or air operated tamping equipment to be used. Hand equipment, such as T-bar, to be used to pipe if necessary. Care to be taken when compacting under, alongside and immediately above pipe to prevent crushing, fracturing or shifting of the pipe. The Contractor is to note densities required for materials being backfilled and shall use appropriate approved equipment to obtain those densities.
- B. Moisture Control. Generally maintain moisture of backfill material with $\pm 2\%$ of optimum moisture content as determined by ASTM D698. Maintain closer tolerances as needed to obtain densities required.
- C. Compaction. Maximum density (100%) based on ASTM D698 or AASHTO T99.
 - 1. Bedding Material, including material used for over-excavation of any kind: 95%.
 - 2. Select Material: 95%.
 - 3. Backfill beneath existing or proposed pavement, roadways, sidewalks, curbs, utility lines and other improvements or within 5' horizontally of such improvements: 95%.
 - 4. Backfill within public or designated right-of-way: 90% or as shown on the Drawings.
 - 5. Backfill within undeveloped, green or undesignated area: 85%.
 - 6. Backfill for any fill over over-cut grading in areas of lot/home construction: 95%.
- D. Placing Backfill. The maximum loose lifts of backfill material to be placed in the reverse order as removed and as follows: use smaller lifts where necessary to obtain required densities:
 - 1. Bedding and select material: 6"
 - 2. Backfill Material: 12" where 95% compaction required; 24" where less than 95% compaction required.
- E. Backfilling Appurtenances. Backfilling to be done generally at the same time as adjacent pipelines. Backfilling procedure to conform to this section. Use special techniques or materials as shown on drawings.
- F. Disposal of Excess Excavation. Contractor to dispose of excess excavation off site. Disposal in any case shall be the sole responsibility of the Contractor.
- G. Maintenance of Backfill. Contractor to maintain all backfill in a satisfactory condition during the extent of the contract and warranty period. All surface deterioration determined to be the responsibility of the Contractor and all settlement shall be repaired

at once by the Contractor upon notice by the Owner. All costs for repair and all liability as a result of surface deterioration or settlement shall be the responsibility of the Contractor.

3.05 SURFACE RESTORATION

- A. All existing surface improvements and site conditions disturbed or damaged during construction to be restored to a condition equal to pre-construction condition. All restoration costs are considered incidental to excavation and backfill.
 - 1. Improvements. Replace, repair or reconstruct all improvements as required. Work will not be accepted until City and all affected property owners accepts restoration. Improvements include, by example, other utilities, culverts, structures, curb and gutter, mailboxes, signs, sprinkler systems, etc.
 - 2. Roadways. All roadways to be restored to original condition with material types removed.
 - a. Minimum base course material on gravel roadways or minimum depth gravel on hard surface roadways to be 12 inches.
 - b. Minimum bituminous surfacing to be 3 inches.
 - c. Minimum concrete pavement surfacing to be 6 inches.

3.06 COMPACTION

- A. It should be fully understood that it will be the sole responsibility of the Contractor to achieve the specified densities for all embedment and backfill material placed. Contractor will be responsible for ensuring that correct methods are being used for the placement and compaction of said materials. Correct backfill methods include, but are not limited to:
 - 1. Use of proper equipment for existing soil condition encountered.
 - 2. Moisture content of existing soils; determination if water should be added or if soil should be air dried to reduce moisture content.
 - 3. Thickness of backfill lift.
- B. Contractor may, at his own expense, have an approved geotechnical engineer monitor the methods of backfill and compaction used to ensure that the desired densities are being obtained.

3.07 INSPECTION AND TESTING

- A. Inspection and testing to be performed at the direction of the City. Contractor to cooperate fully with all persons engaged in testing. Contractor to excavate as required to allow testing. Contractor to backfill all test excavations in accordance with these Specifications.

3.08 DENSITY TESTING AND CONTROL

- A. Reference Standards. Density/moisture relationships to be developed for all soil types encountered according to ASTM D698 or AASHTO T99.
- B. Field Testing. Testing for density during compaction operations to be done in accordance with ASTM D2922 using nuclear density methods

- C. Frequency of Testing. Minimum of one (1) test every 100' trench per lift or as directed by City. Contractor to excavate to depths required by Engineer for testing and backfill test holes to density specified. Testing to be paid for by Contractor.

END OF SECTION

SANITARY SEWERLINES

PART 1 GENERAL

1.01 SUMMARY

- A. Work under this section shall include furnishing all materials, labor and tools necessary to perform all installation, cleaning and testing of all sanitary sewerlines and appurtenances as specified herein and shown on the Drawings.

1.02 PROTECTION OF WORK

- A. All pipe, fittings and equipment shall be carefully handled, stored and protected in such a manner as to prevent damage to materials. At no time shall such materials be dropped or dumped into trench.
- B. Precaution shall be taken to prevent foreign matter from entering the pipe and fittings prior to and during installation. Place no debris, tools, clothing or other materials in the pipe during installation.
- C. At such time as pipe installation is suspended, either temporarily or overnight, the open end of the pipe shall be sealed with a watertight plug to prevent entrance of trench water, debris or foreign matter. A mechanical-type fitting shall be used for this seal. At no time shall duct tape or any other tape be used for this seal.
- D. Under no circumstances shall trench water be allowed to enter the pipeline. When water is present in the trench, the seal shall remain in place until such time the trench is pumped dry. Whenever trench water becomes evident, adequate measures shall be taken to prevent pipe flotation. Contractor shall bear all costs associated with keeping trench free of liquids.
- E. If, in the opinion of the City, the Contractor is incapable of keeping the pipe free of foreign matter during installation, the City shall require the Contractor to cover the pipe ends with close woven bags until the start of the jointing operation.

PART 2 PRODUCTS

- A. This item covers the types of materials that will be allowed for the construction and installation of sewerlines. All materials used shall be new, of the best quality available and conform to applicable standards as indicated herein.

2.01 DUCTILE IRON PIPE AND FITTINGS

- A. Ductile Iron Pipe
 1. Reference Standard - ANSI 21.51/AWWA C151, latest edition.
 2. Thickness Class – 52.
 3. Pipe joints shall be push on, restrained joints, except where specifically shown or detailed otherwise.

4. Pressure Rating - 350 psi.
 5. Restrained Joint (Snap-Lok or Approved Equal).
- B. Fittings
1. Type - All fittings shall be mechanical joint, except where specifically shown or detailed otherwise.
 2. Reference Standard - ANSI/AWWA C153, latest edition, for mechanical "compact" joints.
 3. Material - Ductile iron, DIP fittings, sleeves and valves shall be polyethylene encased.
 4. Pressure Rating - 350 psi.
- C. Joints
1. Mechanical, Reference Standard - ANSI A. 21.53/AWWA C153, latest edition.
 2. Push-on, Reference Standard - ANSI A 21.15/AWWA C115, Class 125.
 3. Flanged, Reference Standard - ANSI B 16.1, Class 125
- D. Gaskets
1. Gasket shall be suitable for the specified pipe sizes, pressure and temperature.
 2. Reference Standard - AWWA C111, latest edition.
 3. Lubricant - A non-toxic vegetable soap lubricant shall be supplied with the pipe.
- E. Protective Coating
1. Underground Service - Manufacturer's standard bituminous coating
 2. Polyethylene Film Envelope - Polyethylene encasement shall conform to AWWA C105, latest edition, or ANSI A.21.5. Film shall be Class C with a nominal thickness of 8 mils. Tape for securing the film shall have a minimum thickness of 8 mils and a minimum width of 2 inches. The polyethylene film shall be free of streaks, pinholes, tears or blisters.
- F. Protective Lining
1. Type – "Epoxy lined"
 2. Reference Standard - ANSI A 21.4/AWWA C104, latest edition.
 3. Thickness – Standard.
- 2.02 POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS (GRAVITY MAIN)
- A. PVC Pipe, through 15" diameter.
1. Material Reference Standard - ASTM D1784.
 2. Pipe Reference Standard - ASTM D3034.
 3. Class - SDR35.
 4. Markings - Manufacturer's name, nominal size, PVC classification, Type PSM, SDR-35, PVC gravity sewer pipe, ASTM D3034 and code number, green coloring dyed into PVC.
- B. PVC Pipe, 18" to 48" diameter.
1. Material Reference Standard - ASTM D1784.
 2. Pipe Reference Standard - ASTM F679
 3. Markings - Manufacturer's name, nominal size, PVC cell classification, PS 46 PVC Sewer Pipe and ASTM F679. Green coloring dyed into PVC.

4. Variance - PVC piping meeting the stiffness requirement of ASTM F679, but not meeting wall thickness requirement will be allowed under this specification. Manufacturers will be required to provide a list of at least five (5) similar projects with references in which pipe has been successfully used and laboratory testing data showing the pipe meets the structural requirements of ASTM F679.

C. Fittings

1. Type - PVC push-joint.
2. Materials - ASTM D1784.
3. Reference Standard - ASTM D3034 or ASTM F679.

D. Joints

1. Type - push-on rubber gasket.
2. Gasket reference standard - ASTM F477

E. Restraint-type Glands

F. Repair Couplings

1. Manufacturer Reference – Smith Blair Quantum.

2.03 FORCE MAIN

A. PVC Pipe

1. Materials - ASTM D 1784, Type 1, Grade 1, PVC 1120
2. Reference Standard - AWWA C900 and C905.
3. Thickness: (DR18).
4. Markings - Manufacturer's name, nominal size, AWWA pressure rating
5. Size - Shall conform to outside diameter of DIP.

B. Fittings

1. DIP Restrained mechanical joints except where specifically shown or detailed otherwise.
2. Reference Standard - AWWA/ANSI C153/A 21.53.
3. Pressure Rating - 250 psi.
4. Gasket Reference Standard - AWWA C-111.

C. HDPE Pipe

1. HDPE pipe shall conform to the requirements of ASTM F714, and shall be of the nominal size diameter shown on the Drawings.
2. HDPE pipe provided shall comply with NSF-61 and AWWA C906. HDPE pipe shall be either all PE3608 or all PE4710. It shall meet the following minimum criteria.
3. The SDR number shall be marked on the pipe at intervals not exceeding 10 feet.
4. Pipe and fittings from different manufacturers shall not be interchanged. All pipes and fittings shall use the same resin.
5. The manufacturer shall be listed with the Plastic Pipe Institute as meeting the recipe and mixing requirements of the resin manufacturer for the resin used to manufacture the pipe and fittings for this project.
6. The HDPE pipe and fittings shall conform to Cell Classification 345434C or 355434C for PE3608 or 445474C for PE4710 (ASTM D 3350). This material shall have a compressive yield strength of 1,600 psi when tested and analyzed

by ASTM D2837. This material shall have minimum tensile yield strength of 3,200 psi when tested and analyzed by ASTM D638.

7. The PE compound shall be suitably protected against degradation by ultraviolet light by means of carbon black, well dispersed by precompounding in a concentration of not less than 2 percent.
8. HDPE products shall contain no recycled compounds except that generated in the manufacturer's own plant from resin of the same specifications from the same raw material supplier.
9. The PE pipe shall be homogenous throughout and free of visible cracks, holes, foreign inclusions, or other injurious defects. Any pipe with nicks, scrapes, or gouges deeper than 5 percent of the nominal wall thickness shall be rejected. The pipe shall be uniform in color, opacity, density, and other physical properties.

D. HDPE Fittings

1. HDPE fittings shall be from the same material and manufacturer as the pipe, molded or fabricated from HDPE pipe and shall have the same or numerically smaller SDR than pipe connecting to the fitting. HDPE fittings shall be molded, for sizes 6-inch and smaller, if manufactured as a standard item. All other HDPE fittings shall be fabricated from HDPE pipe by means of thermal butt-fusion unless otherwise noted.
2. All reducing tees shall be factory-molded if available as a standard item by the manufacturer. If not available as a standard item, branch saddle reducing tees shall be used. Reducers shall be shop-manufactured. Field fabricated branch saddle connections will not be allowed, except where shown on the Drawings.
3. All molded HDPE fittings shall have the same or higher pressure rating as the pipe when installed in accordance with the latest technical specifications. All fabricated HDPE fittings shall have the same or higher pressure rating as the adjoining pipe and installed in accordance with the manufacturer's recommendations.

E. HDPE Joints

1. Joints and pipe connections shall be by thermal butt-fusion, except where shown on the Drawings or approved by the City.

F. Flanges

1. Flange backup rings shall be stainless steel with 150-pound 304 stainless steel, ANSI B16.5 standard dimensions unless specified otherwise. Flanges shall be complete with one-piece, PE molded flange adapter. Flanged connections shall have the same or greater pressure rating as the pipe. All fasteners shall be 304 stainless steel and shall be assembled with anti-seize compound as recommended by the manufacturer. Gaskets shall be installed at all flanged connections.
2. Blind flanges shall be made of HDPE.
3. Gaskets shall be flat ring, 1/8-inch Viton.

G. Electrofusion Couplings

1. Joints and pipe connections shall be by thermal butt-fusion, except where shown on the Drawings or approved by the City.
2. Electrofusion couplings shall be used where shown on the Drawings, in situations where welding machine access is impossible and upon approval of the City.

3. Electrofusion couplings shall be a rigid straight coupler constructed from injection-molded PE with embedded heating coils. Electrofusion couplings shall be manufactured in accordance with ASTM F1055.

2.04 CONCRETE FOR THRUST BLOCKS AND ENCASING OF PIPE

- A. Concrete for thrust blocks and for encasing the sewer pipeline shall have 28 day compressive strength of not less than 4000 psi.

2.05 MANHOLES

A. Concrete Rings/Cones

1. Type – Precast.
2. Reference Standard - ASTM C478.
3. Size - Four-foot or five-foot inside diameter

B. Manhole Bases

1. Shall be precast or cast-in-place, depending upon local jurisdiction standards with integrally cast-in water stops. The tops of base shall be at least 12 inches above top of pipe.
2. Reference Concrete Standard - ASTM C150 Type II modified or Type V.

C. Manhole Steps

1. Manhole steps shall conform to ASTM C-478-94 and shall be steel reinforced copolymer polypropylene with materials conforming to the following:
 - a. The deformed steel reinforcing bar shall be 1/2" conforming to ASTM A-615 Grade 60.
 - b. The copolymer polypropylene shall conform to ASTM D4101-92b PP0344B33534Z02.
 - c. Manufacturer's Reference: M.A. Industries Model PS2-PFDF, or approved equal.

D. Joints

1. Type - Rub'r Nek preformed gasket as manufactured by K.T. Snyder Co., Inc., Houston, Texas or equal.
2. Cement Mortar Material Reference Standard - One part Portland Cement, Type II, modified with three parts of sand. Cement mortar to be used with concrete grade rings only.

E. Grade Adjustment Rings

1. Type - Precast ASTM C150 Type II modified concrete.
2. Size - Not less than 6" wide x heights to allow for two-inch adjustments.
3. Manufacturer's reference: Ludtech, Inc., or approved equal.

F. Frame and Cover

1. Material Reference - Grey Iron, ASTM A48-83, Class 35B.
2. Cover - Stamped with "SEWER", machined bearing surface with ring.
3. Type - Heavy, weight of cover greater than 140 pounds.
4. The minimum clear opening in the manhole frame shall be 24 inches.
5. Manufacturer Reference - Castings MH-400-24CI.

2.06 SEWER SERVICE LINE MATERIAL

- A. Wyes - Required for all new sewer line construction
 - 1. Material - ASTM D3034 PVC.
 - 2. Strength - for use with SDR-35.
 - 3. Joint - Slip-on rubber gasket.
- B. Saddles (Required for tapping existing mains)
 - 1. Material - ASTM D3034 PVC.
 - 2. Joint - Rubber seal to main with stainless steel compression bands. Slip-on service joint with rubber gasket.
 - 3. Glue on Joint??
 - 4. Armor Core??

2.07 MAGNETIC TAPE

- A. Detectable marking tape shall consist of a minimum of 5 mil (0.0005") overall thickness; five-ply composition; ultra-high molecular weight' 100% virgin polyethylene; acid alkaline and corrosion resistant.
- B. Elongation properties shall be in accordance with ASTM D882-80A and shall be less than 150% at break. The tape shall have a 20 gauge (0.0020") solid aluminum foil core, encapsulated within 2.55 mil (0.00255") polyethylene backing.
- C. Tape color and legend combination shall be in accordance with APWA or local requirements. The color shall be green. The legend shall read "CAUTION - SEWERLINE BELOW".
 - 1. The tape tensile strength shall be in accordance with ASTM D882-80A and be not less than 7800 psi.
 - 2. Tape width shall be 3/4 of the diameter of the pipeline being protected

Tape Width	2"	3"	6"	12" or wider
Tape Bury Depth	6"- 18"	6"- 28"	6"- 36"	6"- 36"
 - 3. The tape shall be as manufactured by T. Christy Enterprises, or equal.
 - 4. Magnetic tape is required for all pipe and shall be 2 feet above the top of pipe.

PART 3 EXECUTION

3.01 CLEANING AND INSPECTION

- A. Clean all pipe, fittings and related materials thoroughly of all foreign material and inspect for cracks, flaws or other defects prior to installation. Mark all defective, damaged or unsound materials with bright marking crayon or paint and remove from job site.
- B. The Contractor shall take all necessary precautions to prevent any construction debris from entering the sewerlines during construction. If this debris should enter the pipeline system, the Contractor shall furnish all labor and materials necessary to clean the system. Under no circumstances will the Contractor flush the debris into an existing sanitary sewer system.

3.02 PLACEMENT OF PIPE

- A. All sanitary sewer pipe must be installed with a laser. If bending of the beam due to air temperature variations becomes apparent with "in pipe" units, a fan shall be provided to circulate air in the pipe. Air velocity shall not be so excessive as to cause pulsating or vibrating of the beam. If, in the opinion of the City, the beam cannot be accurately controlled, this method of setting line and grade shall be abandoned.

3.03 PIPE EMBEDMENT

- A. Placing embedment material - Refer to Section Trenching, Backfilling, and Compaction for placement methods.
- B. Embedment Classes - Refer to Section Trenching, Backfilling, and Compaction and Construction Drawings for embedment materials for each class listed below:
 - 1. Pipe shall be embedded according to applicable details within the specifications and on the Construction Drawings.

3.04 PIPE INSTALLATION

- A. Installation of Ductile Iron Pipe Lines.
- B. Installation of PVC Pipe.
 - 1. Pipe Handling. Pipe should be carefully lowered into the trench to avoid pipe falling into trench
 - 2. Pipe Laying. Pipe shall be laid true to line and grade, in an uphill direction, with bell ends facing in the direction of laying. When pipe laying is not in progress, the open end of the pipe shall be closed by a watertight plug.
 - 3. Jointing the Pipe. The outside of the spigot and the inside of the bell shall be thoroughly wiped clean. Set the rubber ring in the bell with the marked edge facing toward the end of the bell. Lubricate the spigot end using a thin film of the manufacturer-supplied lubricant. Push the pipe spigot into the bell. Position the completed joint so that the mark on the pipe end is in line with the end of the bell.
 - 4. Pipe Cutting. The cutting of pipe for manholes or for fittings, or closure pieces shall be done in a neat and workmanlike manner without damage to the pipe or lining and so as to leave a smooth end at right angles to the axis of the pipe. Bevel the end of the pipe with a beveling tool after the pipe is field cut. Place a clearly visible position mark at the correct distance from the end of the field-cut pipe.
- C. Installation of Slipline Pipe. Not applicable.

3.05 SEWER MANHOLE INSTALLATION

- A. General. Manholes shall be furnished and installed to depths and dimensions shown on the Construction Drawings and/or staked in the field. Manholes shall be constructed of precast concrete rings in accordance with details shown on the Construction Drawings.
- B. Connections to Manholes. Connection of manhole with pipe shall be made with flexible connector. In addition, extra care shall be taken by grouting or other means of sealing to assure positive watertight manholes around the inlet or outlet pipes.

- C. Manhole Floor and Inverts. Invert channels shall be smooth and semi-circular in shape, conforming to the inside of the incoming and outgoing sewer pipelines. Changes in direction of flow shall be made with a smooth curve of as large a radius as the size of the manhole will permit. Changes in size and grade of the channels shall be made gradually and evenly. Where large differences in invert elevations exist, sloped flow channels shall be formed so the wastewater does not undergo a vertical drop. The invert channels may be formed directly in the concrete of the manhole base. The floor of the manhole outside the channel shall be smooth and shall slope toward the channels.
- D. Finish Grade and Adjustment. To bring the manhole cover to the correct elevation, the top section of each manhole shall be constructed of pre-cast concrete grade adjustment rings. These rings shall be not less than six inches (6") wide and furnished in heights to allow for two-inch (2") adjustments. Grade adjustment with rings shall be eight inches (8") maximum and two inches (2") minimum. All rings shall be grouted in place.
- E. Manhole Stubs. Pipe stubs shall be a full stick of pipe and extend approximately 20' from the outside face of the manhole and shall be capped or plugged with manufactured fittings to form a watertight installation.
- F. Manhole Cone/Opening. Eccentric manhole cone/opening shall be offset so as not to be located in the tire track or traveled lane and shall be in line with the manhole steps.

3.06 CONNECTION TO EXISTING SEWER FACILITIES

- A. Connections to existing sewer facilities where live flows exist shall be made only after prior consultation with and receipt of written permission from the City. No bypass of sewage to the surface will be allowed in the completion of this connection. Connections shall be made as shown on the Drawings. All connections between pipes of different materials shall be made with approved manufactured connectors.

3.07 SERVICE CONNECTIONS

- A. Customer service connections shall be installed in accordance with the details set forth on the construction Drawings. After the service connection is installed, the end shall be plugged watertight with a manufactured plug and marked with a stake except as shown otherwise on the Drawings.

3.08 ALIGNMENT AND GRADE (LAMPING)

- A. Sewer pipelines will be checked by the City to determine whether any displacement of the pipe has occurred after the trench has been backfilled. The test will be as follows:
- B. A light will be flashed between manholes, or if the manholes have not as yet been constructed, between the locations of the manholes, by means of a flashlight. If the illuminated interior of the pipeline shows poor alignment, displaced pipe, earth or other debris in the pipe, or any other kind of defect, the defects determined by the City shall be remedied by the Contractor at his own expense. Test will be repeated after completion of backfilling and any poor alignment, displaced pipe, or other defects determined by the City, shall be corrected.

3.09 LEAKAGE TEST

- A. Sewerlines shall be tested using a low-pressure air test only; water tests will not be allowed. Only after the sanitary sewers, including appurtenances and sanitary laterals have been installed, backfilled and cleaned, shall the Contractor proceed with an air test on the installed facilities.
1. Low Pressure Air Test Procedure. The section of sewer line to be tested should be flushed and cleaned prior to conducting the low-pressure air test. This serves to clean out any debris, wet the pipe, and produce more consistent results. Isolate the section of sewer line to be tested by means of inflatable stoppers or other suitable test plugs. One of the plugs should have an inlet tap, or other provision for connecting a hose to a portable air control source.
 2. If the test section is below the groundwater level, determine the height of the ground water above the spring line of the pipe at each end of the test section and compute the average. For every foot of groundwater above the pipe spring line, increase the gauge test pressure by 0.43 pounds per square inch. Connect the air hose to the inlet tap and a portable air control source. The air equipment should consist of necessary valves and pressure gauges to control the rate at which air flows into the test section and to enable monitoring of the air pressure within the test section. Also, the testing apparatus should be equipped with a pressure relief device to avoid the possibility of loading the test section with the full capacity of the compressor. Locate valves and gauges above ground.
 3. Add air slowly to the test section until the pressure inside the pipe is raised to 5.0 psig greater than the average backpressure of any groundwater that may be over the pipe. After a pressure of 5.0 psig is obtained, regulate the air supply so that the pressure is maintained between 4.5 and 5.0 psig (above the average ground water back pressure) for a period of two minutes. This allows the air temperature to stabilize in equilibrium with the temperature of the pipe walls. The pressure will normally drop slightly until temperature equilibrium is obtained.
 4. Determine the rate of air loss by the time/pressure drop method. After the two-minute air stabilization period, the air supply is disconnected and the test pressure allowed to decrease to 4.5 psig. The time required for the test pressure to drop from 4.5 psig to 4.0 psig is determined by means of a stopwatch and this time interval is then compared to the required time in the attached table to determine if the rate of air loss is within the allowable time limit. If the time is equal to or greater than the times indicated in the tables, the pipeline shall be deemed acceptable.

Nominal Pipe Size (Inches)	Minimum Test Time (min/100 feet)
3	0.2
4	0.3
6	0.7
8	1.2
10	1.5
12	1.8
15	2.1
18	2.4
21	3.0
24	3.6
27	4.2
30	4.8
33	5.4
36	6.0

5. Upon completion of the test, open the bleeder valve to allow air to escape. Plugs should not be removed until all air pressure in the test section has been released. During this time, no one should be allowed in the trench or manhole while the pipe is being decompressed. Air test shall also include service lines and appurtenances.

3.10 MANHOLE INSPECTION

- A. During the construction of the manholes, the Contractor shall, in accordance with good practice, ensure that no earth, sand, rocks or other foreign material exists on the joint surfaces during assembly of the section. The City shall check each manhole to determine whether the manhole fulfills the requirements of the Drawings and Specifications.
 1. Visual Examination. The City shall visually check each manhole, both exterior and interior, for flaws, cracks, holes, or other inadequacies which might affect the operation or watertight integrity of the manhole. Should any inadequacies be found, the Contractor, at his own expense, shall make any repairs deemed necessary by the City.
 2. Leakage Test. All manholes shall be tested for leakage and all tests shall be witnessed by the City. The leakage test shall be conducted prior to backfilling around the manhole and shall be carried out in the following manner:
 - a. Stubouts, manhole boots and pipe plugs shall be secured to prevent movement while the vacuum is drawn.
 - b. Installation and operation of vacuum equipment and indicating devices shall be in accordance with equipment specifications for which performance information has been provided by the manufacturer and approved by the City.
 - c. A measured vacuum of 10" of mercury shall be established in the manhole. The time for the vacuum to drop to 9" of mercury shall be recorded.
 - d. Acceptance standards for leakage shall be established from the elapsed time for a negative pressure change from 10" to 9" of mercury. The

maximum allowable leakage rate for a 4' diameter manhole shall be in accordance with the following:

Manhole Depth	Minimum Elapsed Time for a Pressure Change of 1-inch Mercury
10 feet or less	60 seconds
Greater than 10 feet but less than 15 feet	75 seconds
Greater than 15 feet but less than 25 feet	90 seconds

For manholes 5' in diameter, add an additional 15 seconds and for manholes 6' in diameter, add an additional 30 seconds to the time requirements for 4-foot diameter manholes.

- e. If the manhole fails the test, necessary repairs shall be made and the vacuum test and repairs shall be repeated until the manhole passes the test or the manhole shall be tested in accordance with the standard exfiltration test and rated accordingly.
- f. If a manhole joint mastic is completely pulled out during the vacuum test, the manhole shall be disassembled and the mastic replaced.

3.11 DEFLECTION TEST FOR NON-RIGID PIPE (MANDREL)

- A. The maximum allowable pipe deflection for a completely backfilled, non-rigid sewer pipe shall not exceed five percent (5%) of the nominal internal pipe diameter. Deflections in non-rigid pipe shall be checked by measurement or by pulling a mandrel with the minimum allowable diameter through the pipe. The minimum allowable diameter shall be equal to the minimum interior diameter of the pipe, as specified in the applicable portions of the ASTM Standard Specifications or the pipe manufacturer's recommendations, minus five percent of the minimal interior diameter of the pipe. Those sections of non-rigid pipe with deflections greater than the maximum allowable five percent shall not be acceptable and the Contractor will remove and replace these sections at his own expense.
- B. Deflection tests will be run if in the opinion of the City testing is warranted. The program for testing shall be mutually determined by the City and the Contractor. The Contractor shall furnish all labor, tools and equipment necessary to make the tests and to perform any work incidental thereto.

3.12 TELEVISIONING MAIN

- A. All sewer connection lines eight inches (8") or larger shall be televised.
- B. The Contractor shall televise the entire line as soon as the leakage and manhole tests are satisfactorily completed. Any defects noted shall be repaired immediately. The entire line(s) shall be re-videtaped immediately prior to the warranty period expiring. The City retains the right to televise the line anytime during the warranty period, if conditions warrant such inspection. If defects are present, the developer or contractor

shall complete the repair work immediately. The developer or contractor shall pay to have that section of line re-televised following any required repairs.

- C. Immediately prior to a television inspection, enough water shall be run down the line so it comes out the lower manhole.
- D. The televising system camera shall include pan, tilt, and radial viewing. The full color camera system shall be fully controllable remotely from the operator's vehicle. The pan shall be plus or minus 275 degrees, and rotate 360 degrees. The camera equipment shall include an accurate footage counter, which displays the footage distance from the centerline of the starting manhole on the operators monitor and is recorded on the videotape or CD. The camera shall be equipped with a camera height adjustment to allow the camera lens to always be centered at one-half the inside pipe diameter, or higher, in the pipe being televised. A lighting system for the camera is required to clearly illuminate the features and conditions of the pipe being inspected. A reflector in front of the camera may be required to enhance lighting in large diameter pipes. High quality copies of the videotape or CD, along with a complete log of the operators observations, shall be provide to the City within one week of the completion of the televising activity. The videotape or CD, as well as the operators log, shall clearly show the location in relation from the starting manhole, each item of interest. These shall include, but are not limited to each infiltration point, offset joints, separated joints, service taps, roots, broken pipe and other discernible conditions of interest.

3.13 PRESSURE TESTING OF FORCE MAIN

- A. Make pressure and leakage tests on all newly laid pipe. Furnish all necessary equipment and material, make all taps in the pipe as required, and conduct the tests. The tests shall be conducted between valved sections of the pipeline, or as approved by the City. The City will monitor the tests.

<u>Amount</u>	<u>Description</u>
2	Approved graduated containers.
2	Pressure gauges.
1	Hydraulic force pump approved by the City.
1	Additional 1/2-inch pressure tap for City's test gauge Suitable hose and suction pipe as required.

- B. Conduct the tests after the trench has been partially backfilled with the joints left exposed for inspection, or when completely backfilled, as permitted by the City. Where any section of pipe is provided with concrete reaction blocking, do not make the pressure test until at least 5 days have elapsed after the concrete thrust blocking is installed. If high-early cement is used for the concrete thrust blocking, the time may be cut to 2 days.
- C. Conduct pressure test in the following manner, unless otherwise approved by the City: after the trench has been backfilled or partially backfilled as hereinbefore specified, fill the pipe with water, expelling all air during the filling. The test pressure shall be 1½ times normal working pressure at the point of lowest elevation of the test gauge.
- D. Duration

1. The duration of each pressure test shall be 2 hours, unless otherwise directed by the City.

E. Procedure

1. Slowly fill the pipe with water and allow to stand for 24 hours. Expel all air from the pipe. Allow and maintain the specified test pressure by continuous pumping if necessary for the entire test period. The test pressure shall be calculated for the point of lowest elevation, or as specified by the City. The pump suction shall be in a barrel or similar device, or metered so that the amount of water required to maintain the test pressure may be measured accurately.
2. Before the line is pressurized, the City shall verify that all necessary main line valves are open or closed with regard to the section of line being tested. In addition, the City shall verify that all hydrant valves are open.

F. Leakage

1. Leakage shall be defined as the quantity of water necessary to hold the specified test pressure for the duration of the test period. No pipe installation will be accepted if the leakage is greater than the number of gallons per hour as determined by the following formula:

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

In the above formula:

L = Allowable leakage, in gallons per hour

N = Number of joints in the length of pipe tested

D = Nominal diameter of pipe, in inches

P = Average test pressure during the leakage test, in pounds per square inch gauge.

G. Correction of Excessive Leakage

1. Should any test of pipe laid disclose leakage greater than that allowed, locate and repair the defective joints or pipe until the leakage of a subsequent test is within the specified allowance.

END OF SECTION

WATER TRANSMISSION AND DISTRIBUTION LINES

PART 1 GENERAL

1.01 SUMMARY

- A. Work under this Section shall include furnishing all materials, labor, equipment and miscellaneous items necessary to install, disinfect, and test all potable water, non-potable and yard piping distribution and transmission pipelines and appurtenances as specified herein and shown on the Drawings.

1.02 PROTECTION OF WORK

- A. All pipe fittings, valves and equipment shall be carefully handled, stored and protected in such a manner as to prevent damage to materials and protective coatings and linings. At no time shall such materials be dropped or dumped into trench
- B. Precaution shall be taken to prevent foreign matter from entering the pipe, fittings and valves prior to and during installation. Place no debris, tools, clothing or other materials in the pipe during installation.
- C. At such time as pipe installation is suspended, either temporarily or overnight, the open end of the pipe shall be sealed with a watertight plug to prevent entrance of trench water, debris or foreign matter.
- D. Under no circumstances shall trench water be allowed to enter the pipeline. When water is present in the trench, the seal shall remain in place until such time as the trench is pumped dry. Whenever trench water becomes evident, adequate measures shall be taken to prevent pipe floatation.
- E. If, in the opinion of the City, the Contractor is incapable of keeping the pipe free of foreign matter during installation, the City shall require the Contractor to cover the pipe ends with close woven bags until the start of the joining operation.

PART 2 PRODUCTS

- A. This item covers the types of materials that will be required for the construction and installation of water lines. All materials used shall be new, of the best quality available, and conform to applicable standards as indicated herein.

2.01 DUCTILE IRON PIPE AND FITTINGS

- A. Ductile Iron Pipe
 1. Reference Standard - ANSI 21.51/AWWA C151, latest edition.
 2. Thickness Class – 52.
 3. Pipe joints shall be push on, except where specifically shown or detailed otherwise.
 4. Pressure Rating - 350 psi.

5. Pipe shall be polyethylene encased.
- B. Fittings
1. Type - All fittings shall be mechanical joint, except where specifically shown or detailed otherwise.
 2. Reference Standard - ANSI/AWWA C153, latest edition, for mechanical "compact" joints.
 3. Material - Ductile iron, DIP fittings, sleeves and valves shall be polyethylene encased.
 4. Pressure Rating - 350 psi.
- C. Joints
1. Mechanical, Reference Standard - ANSI A. 21.53/AWWA C153, latest edition.
 2. Push-on, Reference Standard - ANSI A 21.15/AWWA C115, Class 125.
 3. Flanged, Reference Standard - ANSI B 16.1, Class 125.
- D. Gaskets
1. Gasket shall be suitable for the specified pipe sizes, pressure and temperature.
 2. Reference Standard - AWWA C111, latest edition.
 3. Lubricant – A non-toxic vegetable soap lubricant shall be supplied with the pipe.
- E. Protective Coating
1. Underground Service - Manufacturer's standard bituminous coating
 2. Polyethylene Film Envelope - Polyethylene encasement shall conform to AWWA C105, latest edition, or ANSI A.21.5. Film shall be Class C with a nominal thickness of 8 mils. Tape for securing the film shall have a minimum thickness of 8 mils and a minimum width of 2 inches. The polyethylene film shall be free of streaks, pinholes, tears or blisters.
- F. Protective Lining
1. Type – "Standard Cement Mortar Lining"
 2. Reference Standard - ANSI A 21.4/AWWA C104, latest edition.
 3. Thickness – standard

2.02 POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS

- A. PVC Pipe
1. Materials - ASTM D1784, Type 1, Grade 1, PVC 1120, 2000 psi design stress.
 2. Reference Standard - AWWA C900, latest edition, 4" - 12"
 3. Class - 200 (DR-14), 4" - 12".
 4. Reference Standard - AWWA C905, latest edition, 14" - 48".
 5. Class - 235 (DR-18), 14" - 48".
 6. Reference Standard - AWWA C909, latest edition. Use of this pipe requires City approval.
 7. Markings - Manufacturer's name, nominal size, class pressure rating, PVC 1120, NSF logo, identification code.
 8. Size - Shall conform to outside diameter of DIP.
- B. Fittings
1. Type - All fittings shall be mechanical joint except where specifically shown or detailed otherwise.

2. Reference Standard - ANSI/AWWA C110/A.21.10 or C153/A.21.53, latest edition.
3. Pressure Rating - 250 psi for C110; 350 psi for C153.
4. Gasket Reference Standard - AWWA C111, latest edition
5. DIP fittings, sleeves and valves shall be polyethylene encased.

C. Joints

1. Push-on rubber gasket.
2. Gasket Reference Standard - AWWA C111, latest edition.

2.03 HYDRANTS

A. Fire Hydrant - Dry Barrel Type

1. Reference Standard - AWWA C502, latest edition.
2. Outlet Size - one 4½ inch, two 2½ inch.
3. Hydrant Size - 5 ¼ inch.
4. Inlet Size - 6 inch.
5. Operation - 1½-inch pentagonal national standard operating nut, open counter clockwise.
6. Special Features - outlet hydrant shall open when turned to the left (counter clockwise).
7. Depth of Bury - As shown on Drawings
8. Additional Requirements - Furnish hydrant complete with pipe and tee, 6 inch (6") restrained mechanical joint gate valve and thrust blocks.
9. Traffic Model with breakaway bolts and coupling.
10. Manufacturers Reference - Mueller Super Centurion A423, or Kennedy K81D.

B. Yard Hydrant

1. Inlet Size - 1 inch.
2. Overall Bury Depth – As shown on drawings.
3. Operation – freezeless with backflow preventer and hose connection.
4. Manufacturer Reference – Woodford Freezeless Sanitary Yard Hydrant Model S3 or Equal.

2.04 VALVES

A. Gate Valves

1. See gate valve specification.

B. Butterfly Valves

1. See butterfly valve specification.

C. Combination Air Release Valve

1. Size - As recommended by manufacturer for correct application.
2. Inlet - Pipe Thread FNPT.
3. Materials
 - a. Body - Nylon Body or Cast Iron.
 - b. Float - Stainless Steel.
 - c. Seat - Buna-N.
 - d. Lever Frame – Delrin.
4. Pressure Rating - 200 psi.

5. Manufacturer's Reference – ARI 040 Series or Val-Matic 100 Series. Or manufacturers will be considered on a case by case basis.
6. Performance - Permits efficient filling or draining of long pipelines, for protection against vacuum, and will continuously vent pockets of air as they accumulate in pipeline.

2.05 VALVE BOXES

- A. Screw Type - Three Piece
 1. Material - Cast Iron
 2. Size - 5 1/4-inch diameter
 3. Type - Three-piece adjustable screw type
 4. Cover - Deep socket type with the work "water" cast in the top
 5. Base - #160 type with 20.5" bottom opening

2.06 MUD PLUGS & DEBRIS CAP

- A. The City's preference is to use mud plugs, but debris caps will be considered on a case by case basis.
 1. Mud plugs shall be manufactured by Infact Corporation or equal approved by City
 2. Flexible caps shall be manufactured by SW Services, Inc. or equal approved by City.

2.07 MECHANICAL COUPLINGS

- A. Only M.J. ductile iron solid sleeves allowed.

2.08 WATER SERVICE & TAP COMPONENTS

- A. Corporation Stops
 1. Material - Brass or bronze
 2. As shown on Drawings
 3. Reference Standard - AWWA C800, latest edition
 4. Thread inlet - IP
 5. Thread outlet - Compression connection
 6. Manufacturer's Reference - Mueller B-25028N or equivalent if approved by City.
- B. Copper Service Pipe (for sizes up to 2 inch)
 1. Reference Standard - AWWA C800
 2. Material - Type K, ASTM B88
 3. Size - As shown on Drawings
- C. Eagle Pure-Core HDPE Service Pipe (for sizes up to 2 inch)
 1. Reference Standard - AWWA C901
 2. Material – SDR9 CTS, HDPE 3408, ASTM D2239 and ASTM D2737
 3. Size - As shown on Drawings
- D. Curb Box
 1. Material - Cast iron box, complete w/lid and red brass screw, stationary/extension rod shall also be provided.
 2. Type – Mueller H-10308

- E. Curb Stop
 1. Materials - Cast bronze body, resilient O-ring seal, standard tee-head operator Teflon ball valve
 2. Size - As shown on Drawings
 3. Inlet - Copper service thread
 4. Outlet - Copper service thread Manufacturer's Reference - Mueller B-25209N
- F. Service Saddle
 - a. Materials - Bronze service clamp, O-ring gasket, double stainless steel strap, and IP threads.
 - b. Manufacturer's Reference - Mueller BR-2S Series, Smith Blair 317, or equal if approved by City.

2.09 JOINT RESTRAINTS

- A. Mechanical Joint Retainer Glands
 1. For use with ductile iron pipe:
 - a. Materials - Multiple wedge, ductile iron ASTM A536, 60-42-10 minimum.
 - b. Manufacturer's reference - EBAA Iron Series 1100 Megalug
 2. For use with PVC pipe:
 - a. Materials - Multiple wedge ductile iron A536, 60-42-10 minimum.
 - b. Manufacturer's reference - EBAA Iron Series 2000PV Megalug
- B. Push-on Joint Restraints
 1. For use with ductile iron pipe:
 - a. Materials - Ductile iron retainer gland and restraint ring ASTM-536, 60-42-10 minimum, 526 alloy steel tie bolts ANSI/AWWA C111/A21.11.
 - b. Manufacturer's reference - EBAA Iron Series 1700 Megalug restraint harness.
 2. For use with PVC pipe:
 - a. Materials - Ductile iron restraint harness ASTM 536, 60-42-10 minimum.
 - b. Manufacturer's reference - EBAA Iron Series 1600 (C-900) and Series 2800 (C-905) and Series 1900 (C-909).

2.10 REPAIR CLAMP

- A. Stainless steel, full circle, Smith Blair 256 with stainless lugs or equal if approved by City

2.11 TAPPING SLEEVES

- A. Type - Split-body, O-ring sealed with flanged outlet. Stainless Steel body and hardware, full circumference.
- B. Manufacturer's reference - Smith Blair Model 665.

2.12 ENCASEMENT

- A. Mains to be installed inside casings shall be installed with self-restraining casing spacers. Casing spacers shall provide axial thrust restraint to prevent pipe deflection during and after installation.

2.13 CONCRETE FOR THRUST BLOCKS AND ENCASING OF PIPE

- A. Concrete for thrust blocks and for encasing the water pipe line shall have a 28-day compressive strength of not less than 4000 psi.
- B. Concrete pipe encasements are not preferred. Exceptions may be allowed through City on a case by case basis.

2.14 TRACER WIRE

- A. No. 12 gauge insulated, stranded copper. All splices to be watertight, underground type, (Tracer wire is required for all pipes and services).

2.15 MAGNETIC TAPE

- A. Detectable marking tape shall consist of a minimum of 5 mil (0.0005") overall thickness; five-ply composition; ultra-high molecular weight' 100% virgin polyethylene; acid alkaline and corrosion resistant.
 - B. Elongation properties shall be in accordance with ASTM D882-80A and shall be less than 150% at break. The tape shall have a 20 gauge (0.0020") solid aluminum foil core, encapsulated within 2.55 mil (0.00255") polyethylene backing.
 - C. Tape color and legend combination shall be in accordance with APWA. The color shall be blue. The legend shall read "CAUTION - WATERLINE BELOW".
 - 1. The tape tensile strength shall be in accordance with ASTM D882-80A and be not less than 7800 psi.
 - 2. Tape width shall be 3/4 of the diameter of the pipeline being protected
- | | | | | |
|-----------------|---------|---------|---------|--------------|
| Tape Width | 2" | 3" | 6" | 12" or wider |
| Tape Bury Depth | 6"- 18" | 6"- 28" | 6"- 36" | 6"- 36" |
- 3. The tape shall be as manufactured by T. Christy Enterprises, or equal.
 - 4. Magnetic tape is required for all pipe and shall be 2 feet above the top of pipe.

PART 3 EXECUTION

3.01 CLEANING AND INSPECTION

- A. Clean all pipe, fittings, valves and related material thoroughly of all foreign material and inspect for cracks, flaws or other defects prior to installation. Mark all defective, damaged or unsound materials with bright marking crayon or paint and remove from jobsite.
- B. The Contractor shall take all necessary precautions to prevent any construction debris from entering the water lines during construction of water lines and appurtenances. If this debris should enter the distribution system, the Contractor shall furnish all labor and material necessary to clean the system. Under no circumstances will the Contractor flush the debris into an existing distribution system.

3.02 VERIFICATION

- A. Verify dimensions and class of all existing and proposed pipe, valves, fittings and equipment prior to installation to ensure the piping system will fit together properly.

3.03 PIPE EMBEDMENT

- A. Placing Embedment Material - Refer to Section Trenching, Backfilling, and Compaction for placement methods.
- B. Embedment Classes - Refer to Section Trenching, Backfilling, and Compaction and Construction Drawings for embedment materials as listed below:
 - 1. Pipe shall be embedded according to applicable details within the specifications and on the Construction Drawings.

3.04 PIPE INSTALLATION

- A. Methodology. Pipe shall be laid in straight section with bell ends facing the direction of laying unless otherwise directed by the City. Where pipe is laid on a grade of ten percent (10%) or greater, the installation shall proceed uphill with the bell ends facing upgrade. The pipeline shall be installed so that a continuous positive or negative grade is maintained between high and low points to avoid air pockets. Jointing of the pipe shall be made in accordance with the directions of the manufacturer of the pipe and the manufacturer of the coupling.
 - 1. The pipe shall be brought to correct line and grade, and secured in place with the specified bedding material as directed in Section Trenching, Backfilling, and Compaction.
- B. Pipeline Depth. As indicated on Drawings, but always below frost level, 5.5' minimum. Depth shall be based on depth below finished grade of a project and not existing grade. Contractor shall be responsible for keeping pipelines from freezing if fire line is temporarily installed above frost line before fill material is installed.
- C. Pipe Encasement.
 - 1. Water mains to be installed inside casings and be installed with self-restraining casing spacers when separation distances from pollution sources cannot be met.
 - 2. Install concrete encasement only when allowed by the City. Concrete shall have a four thousand (4,000) psi compressive strength. Reinforcing shall consist of four (4) evenly spaced longitudinal No. 4 rebar.
- D. Installation of Ductile Iron Pipelines
 - 1. Pipe Handling. Pipe should be lowered into the trench with ropes, slings or machinery. Under no circumstances should the pipe be pushed off the bank and allowed to fall into the trench.
 - 2. Pipe Laying. Pipe shall be laid in straight sections, in an uphill direction, with bell ends facing in the direction of laying, unless directed otherwise by the City.
 - 3. Jointing of Push-on Joints. In joining the pipe, the exterior four inches of the pipe at the spigot end and the inside of the adjoining bell shall be thoroughly cleaned to remove oil, grit, tar (other than standard coating) and other foreign matter. The gasket shall be placed in the bell as per manufacturer's installation instruction. A thick film of the pipe manufacturer's joint lubricant shall be applied

to the gasket over its entire surface. The spigot end of the pipe shall then be wiped clean and inserted into the bell to contact the gasket. The pipe shall be forced all the way into the bell by crowbar or by jack and choker slings. Check the position of the gasket with a feeler gauge to ensure it is not rolled.

4. Pipe Cutting. The cutting of pipe for fittings or closure pieces shall be done in a neat and workmanlike manner without damage to the pipe or lining and so as to leave a smooth end at right angles to the axis of the pipe. The flame cutting of pipe by means of an oxyacetylene torch will not be allowed.
5. Polyethylene Film Envelope. Encase main and fittings using procedures recommended by manufacturer. Special care shall be used at all overlap joints.

E. Installation of Polyvinyl Chloride (PVC) Pipe.

1. Pipe Handling. Pipe should be carefully lowered into the trench to avoid pipe falling into trench.
2. Pipe Laying. Pipe shall be laid in straight sections with bell ends facing the direction of laying. When pipe laying is not in progress, the open end of the pipe shall be closed by a watertight plug.
3. Jointing the Pipe. The outside of the spigot and the inside of the bell shall be thoroughly wiped clean. Set the rubber ring in the bell with the marked edge facing toward the end of the bell. Lubricate the spigot end using a thin film of the manufacturer-supplied lubricant. Push the pipe spigot into the bell. Position the completed joint so that the mark on the pipe end is in line with the end of the bell.
4. Pipe Cutting. The cutting of pipe for fitting or closure pieces shall be done in a neat and workmanlike manner without damage to the pipe and so as to leave a smooth end at right angles to the axis of the pipe. Bevel the end of the pipe with a beveling tool after the pipe is cut. Place a clearly visible position mark at the correct distance from the end of the field-cut pipe.

3.05 INSTALLATION OF PIPELINE APPURTENANCES

- A. General. Install all valves, meters, manholes, and other equipment appurtenant to pipeline at the locations indicated on the drawings or as otherwise designated by the City to accommodate field conditions. Document "record" measurements prior to backfill referencing all appurtenant equipment to the nearest permanent surface improvement.
- B. Installation of Valves. Install valves in the pipeline in the same manner specified for laying and jointing the pipe and in accordance with details included in drawings.
- C. Valve Boxes. Except where specified otherwise, install valve boxes on all buried valves. Install boxes such that no stress is transmitted to the valve. Set boxes plumb and directly over the valve with the top of the box placed flush with the finished grade. Backfill and thoroughly compact around each box. Provide extended stems on valves where required such that the operating nut is not lower than two feet (2') below finished grade. Extended stems will be handled on a case by case basis.
- D. Mud Plugs & Debris Caps
 1. Mud Plugs and debris caps shall be installed as close under the cast iron cover without interfering with cover operation.
 2. Mud plugs and debris caps shall be trimmed to provide a smooth contact with the interior diameter of the pipe.

- E. Fire Hydrants. Install hydrants in accordance with the standard details on the drawings. Hydrant to be set plumb and true to grade. Contractor to bag or cover the fire hydrant that is not in operation.
- F. Joint Restraint. Concrete thrust blocks shall be provided, as shown in the details included with the Drawings for all tees, elbows, plugs, reducers, valves, fire hydrants and crosses if one or more sides of the cross is plugged. The bearing area of the block shall be at least equal to that stated on the drawings. The bearing surface shall be against undisturbed earth. The block shall be placed normal to the thrust as shown on the drawings. Concrete for thrust blocks shall have four thousand (4,000) psi compressive strength. Concrete support blocks shall be placed under all valves.
 - 1. Contractor will be required to use either plywood forms or plastic to protect the nuts and bolts on the fittings when the concrete reaction block is placed.
 - 2. Mechanical joint retainer glands and push-on joint restraint devices to be used as shown on the Drawings. Contractor to verify prior to construction.
 - 3. Contractor to also use joint restraint or wood blocking as a method of temporary restraint to secure fittings while concrete reaction blocks set up. (Note: Temporary restraint to be used for those cases where a tie-in is being made and the water needs to be turned back on as soon as possible).

3.06 CONNECTION TO EXISTING WATER FACILITIES

- A. All main line connections between existing and proposed piping shall be made during non-business hours or at a time which is acceptable to the Owner. All shut-offs shall be planned 72 hours in advance and all persons affected by the shut-off shall be given a 48-hour notice in the local newspaper, local radio, and/or other methods requested by the City at the Contractor's expense. In addition, the Contractor shall personally warn those affected 1 hour before the water is shut off.
- B. The tie-ins between existing and proposed mains shall be made so that both the proposed main and existing main are in service at the same time. Only after the new main is tested, approved and in service can the individual proposed service lines tie into the existing service line on the building side of the curb valve. The affected property shall be given a minimum of one (1) hour notice before the water is shut off. The new line must have passed the pressure testing and bacteriological test prior to connecting the services to the proposed waterline.
- C. Remove existing curb boxes and locate new curb boxes on property line unless otherwise instructed by the City. Contractor is to provide all necessary fittings needed to reconnect service line on property side of curb box. Contractor shall notify City if existing service line is leaking prior to connection. Contractor shall be responsible for repair of existing service line if it is leaking after connection is made. Contractor shall keep the connection to existing pipe exposed, and notify City, and again approval from City prior to backfilling over connection to existing service line.
- D. Take all precautions to prevent contamination when making connections to existing potable water lines. No trench water, mud or other contaminating substances shall be permitted to enter the pipeline.
- E. Swab the interior of all new pipe, fittings and valves installed in the existing pipeline with a minimum one percent (10,000 ppm) chlorine solution per AWWA standards prior to

installation. After the connection is completed, flush the main to remove all contaminated water.

3.07 SERVICE CONNECTIONS

- A. Customer service connections shall be installed in accordance with the details set forth on the Drawings. Terminate the service with a curb stop and box and mark with a stake except where shown otherwise on the Drawings.

3.08 TRACER WIRE

- A. Tape electrical tracing wire to the top of the pipe at 5-foot intervals to prevent dislocation of the wire during backfilling. Extend wire to ground surface at all valves, fire hydrants, and other locations shown on drawings. The tracing wire shall be brought up on the outside of the valve box. When the wire is within 4" of the top of the lid, the wire shall be brought back inside the box and securely fastened. Provide sufficient slack in the wire outside of the box to compensate for any future adjustment to the valve box. Required on all water mains.

3.09 HYDROSTATIC TESTS

- A. Make pressure and leakage tests on all newly laid pipe. Furnish all necessary equipment and material, make all taps in the pipe as required, and conduct the tests. The tests shall be conducted between valved sections of the pipeline, or as approved by the City. The City will tests but contractor is responsible for the testing. Contractor will be required to submit certification that all tests were performed per the City Rules and Regulations and these Specifications.

- B. Furnish the following equipment and material for the tests:

Amount	Description
2	Approved graduated containers.
2	Pressure gauges.
1	Hydraulic force pump approved by the City.
1	Additional 1/2 inch pressure tap for City's test gauge. Suitable hose and suction pipe as required.

- C. Conduct the tests after the trench has been partially backfilled with the joints left exposed for inspection, or when completely backfilled, as permitted by the City. Where any section of pipe is provided with concrete reaction blocking, do not make the pressure test until at least 5 days have elapsed after the concrete thrust blocking is installed. If high-early cement is used for the concrete thrust blocking, the time may be cut to 2 days.

- D. Conduct pressure test in the following manner, unless otherwise approved by the City: after the trench has been backfilled or partially backfilled as hereinbefore specified, fill the pipe with water, expelling all air during the filling. The test pressure shall be 1 and a half times normal working pressure at the point of lowest elevation of the test gauge. Pressure tests on lines used for fire service shall be pressure tested per NFPA 24 requirements..

- 1. Duration

- a. The duration of each pressure test shall be 2 hours, unless otherwise directed by the City.
- 2. Procedure
 - a. Slowly fill the pipe with water and allow to stand for 24 hours. Expel all air from the pipe. Allow and maintain the specified test pressure by continuous pumping if necessary for the entire test period. The test pressure shall be calculated for the point of lowest elevation, or as specified by the City. The pump suction shall be in a barrel or similar device, or metered so that the amount of water required to maintain the test pressure may be measured accurately.
 - b. Before the line is pressurized, the City shall verify that all necessary main line valves are open or closed with regard to the section of line being tested. In addition, the City shall verify that all hydrant valves are open.
- 3. Leakage
 - a. Leakage shall be defined as the quantity of water necessary to hold the specified test pressure for the duration of the test period. No pipe installation will be accepted if the leakage is greater than the number of gallons per hour as determined by the following formula:

$$L = \frac{SD\sqrt{P}}{148,000}$$

In the above formula:

L = Allowable leakage, in gallons per hour.

S = The length of pipe being tested, in feet.

D = Nominal diameter of pipe, in inches.

P = Average test pressure during the leakage test, in pounds per square inch gauge.

- b. The pressure testing of water service lines shall follow the same procedure as outlined in the section. In all cases, however, the corporation stop, service line and curb stop shall be visually inspected under full test pressure and any leaks fixed.
- 4. Correction of Excessive Leakage
 - a. Should any test of pipe laid disclose leakage greater than that allowed, locate and repair the defective joints or pipe until the leakage of a subsequent test is within the specified allowance.

3.10 DISINFECTION OF POTABLE WATERLINES

- A. General. Flush and disinfect potable waterlines in accordance with the procedure set forth in AWWA C651, latest edition, Disinfecting Water Mains.
- B. Provide all temporary blow-offs, pumps, chlorination equipment, chlorine and all other necessary apparatus required.
- C. Pipe Cleaning. If the pipe contains dirt or heavy encrusted matter that, in the opinion of the City, will not be removed during the flushing operation, the Contractor shall clean and swab the interior of the pipe with a minimum one percent (10,000 ppm) chlorine solution per AWWA standards.

- D. Preliminary Flushing. Flush pipeline prior to disinfection, except when the tablet method is used, to remove all remaining foreign material. The flushing operation shall develop a minimum velocity of 2.5 ft./sec. Flushing of lines used for fire service shall be pressure tested per NFPA 24 requirements.
- E. Chlorine Application. In general, the City's preferred method of chlorine application is the tablet method.
1. Continuous Feed Method. Introduce water into the line at a constant rate while adding chlorine at a minimum concentration of 50 mg/l. Maintain the chlorinated water in the pipeline for a minimum of 24 hours after which period the treated water shall contain no less than 10 mg/l of chlorine throughout the entire length.
 2. Slug Method. Introduce water with a minimum chlorine concentration of 100 mg/l at a constant measured rate into the pipeline. Apply column or slug of chlorinated water that will, as it passes along the line, expose all interior surfaces for a period of three hours. Check the application at the upstream end of the line.
 3. Tablet Method. This method shall not be used if trench water or foreign material has entered the line or if the water is below 5°C (41°F). Because preliminary flushing cannot be used, this method shall only be used when scrupulous cleanliness has been exercised.
 - a. Place tablets in each section of pipe in sufficient number to produce a dose of 50 mg/l initial residual with a 20 mg/l residual after 24 hours.. Refer to Table 2 of AWWA C651, latest edition, for the required minimum number of tablets. All tablets within the main must be attached at the top of the pipe. Introduce water into the pipeline at a rate no greater than 1 ft./sec. and retain the water in the pipeline for a period of 24 hours after which period the treated water shall show detectable chlorine residual at each sampling point.
- F. Final Flushing. After the applicable retention period, heavy chlorinated water should not remain in prolonged contact with pipe. In order to prevent damage to the pipe lining or to prevent corrosion damage to the pipe itself, the heavily chlorinated water shall be flushed from the main fittings, valves, and branches until chlorine measurements show that the concentration in the water leaving the main is no higher than that generally prevailing in the distribution system or that is acceptable for domestic use.
1. The environment to which the chlorinated water is to be discharged shall be inspected. If there is any possibility that the chlorinated discharge will cause damage to the environment, then a neutralizing chemical shall be applied to the water to be wasted to neutralize thoroughly the residual chlorine.
- G. Bacteriologic Tests. Standard conditions. After final flushing and before the new water main is connected to the distribution system, two consecutive sets of acceptable samples, taken at least 24 hours apart, shall be collected from the new main. At least one set of samples shall be collected from every 1,200 feet of the new water main, plus one set from the end of the line and at least one set from each branch. A minimum of two sampling points are required for any segment over 500 feet in length. All samples shall be tested for bacteriological (chemical and physical) quality in accordance with Standard Methods for the Examination of Water and Wastewater, and shall show absence of coliform organisms.
1. Collect samples in sterile bottles from sampling points furnished and installed by the Contractor in the main.

- H. Final Connections to Existing Mains. When connections to existing mains are made without a new valve at the connection point, new water main and appurtenances shall be installed, flushed, disinfected and satisfactory bacteriological sample results received prior to permanent connections being made to the active, existing system.
1. Final connections or those portions of the new system installed that have not been disinfected as part of a previous disinfection procedure, shall be disinfected in accordance with Section 4.6 of AWWA C651.

END OF SECTION

GATE VALVES

PART 1 GENERAL

1.01 SUMMARY

- A. Furnish and install gate valves, and all necessary operators, valve stems, valves and accessories for a complete operable assembly as shown and indicated on the Drawings and as specified herein.

1.02 REFERENCES

- A. Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
 - 1. AWWA C509 – Resilient-Seated Gate Valves for Water Supply Service.
 - 2. AWWA C515 – Reduced Wall Resilient-Seated Gate Valves for Water Supply Service.
 - 3. AWWA C540 – Power-Actuating Devices for Valves and Sluice Gates.
 - 4. AWWA C550 – Protective Interior Coatings for Valves and Hydrants.
 - 5. AWWA C606 – Grooved and Shouldered Joints.
 - 6. NSF 61 – Drinking Water System Components - Health Effects.

1.03 SUBMITTALS

- A. Product Data—Provide complete data on valve accessories sufficient to verify compliance with the specifications:
 - 1. Provide manufacturer's catalog information with size, dimensions, number of turns to open, materials, and assembled weights. Indicate valve pressure temperature rating.
- B. Manufacturer's certificate: Provide Affidavit of Compliance to certify that products meet or exceed specified requirements.
- C. Test reports: Submit reports of shop pressure tests, AWWA C504.

1.04 OPERATION AND MAINTENANCE DATA

- A. Maintenance data: Include installation and maintenance instructions, recommended spare parts lists and exploded assembly views of valves, operators and accessories.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, protect, and handle products to site as specified and in accordance with manufacturer's instructions.
- B. Deliver and store valves and accessories in shipping containers with labeling in place in accordance with AWWA C504, Section 6:
 - 1. Seal valve ends to prevent entry of foreign materials into valve body.

2. Box, crate, or otherwise completely enclose valves, operators and accessories to protect against damage.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Manufacturers:
 1. Mueller.
 2. Kennedy.
 3. Engineer Approved Equal.

2.02 MATERIALS

- A. Valves:
 1. Body, bonnet, and wedge: Cast iron, ASTM A126, Class B or Ductile iron, ASTM A536 Grade 65-45-12.
 2. Stem: Bronze.
 3. Stem O-rings: Nitrile.
 4. Bonnet seal: Nitrile.
 5. Lubrication free, unobstructed port to minimize headloss.
 6. Entire body encapsulated inside and out with epoxy coating.
 7. Upper and lower trunnion bearings: Sleeve type, type 316 stainless steel.
- B. General:
 1. Ends to match connecting piping:
 - a. Flanged, 125 lb, ASME B16.1.
 - b. Mechanical joint, AWWA C111.
 2. Maximum working pressure:
 - a. 250 psig.
 3. Actual length within 1/16 inch \pm of specified or theoretical length.
 4. All internal parts shall be accessible without removing body from valve.
- C. Shop coatings:
 1. Epoxy: Tnemec "Series 66 Hi-Build Epoxoline", or equal.
- D. Valve actuators:
 1. Buried valves as indicated on Drawings: Wrench nuts.
 2. Adequate to seat, unseat, and maintain valve position under all operating conditions.
 3. Counter clockwise (to the left) to open.

2.03 SHOP FINISHING

- A. Shop paint all ferrous metal surfaces of valves and accessories, both interior and exterior for corrosion protection.
- B. Manufacturer's standard paint will be acceptable if it is functionally equivalent to the specified paint and compatible with the specified field painting.
- C. Surfaces to be painted:

1. Unfinished surfaces:
 - a. Interior of valves; Asphalt varnish (2 coats) coat tar, or epoxy for potable water applications.
 - b. Exterior of other valves to be buried, submerged, or located in manholes: Asphalt varnish or coal tar.
 - c. Exterior of other valves: Rust-inhibitive primer.
 - d. Actuators and accessories: Rust-inhibitive primer.
 - e. Flange faces and interior working parts: Rust-preventative compound.

2.04 SOURCE QUALITY CONTROL

- A. Shop test in accordance with AWWA C504.
- B. Valve to be driptight on completion of tests.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install valves and accessories in accordance with the manufacturer's instructions.
- B. Check and adjust valves and accessories for smooth operation in accordance with manufacturer's instructions.

3.02 FIELD QUALITY CONTROL

- A. Coordinate inspection of all valves by manufacturer's representative and instruct plant personnel on their operation and maintenance.

END OF SECTION

BUTTERFLY VALVES

PART 1 GENERAL

1.01 SUMMARY

- A. Furnish and install butterfly valves, and all necessary operators, valve stems, valves and accessories for a complete operable assembly as shown and indicated on the Drawings and as specified herein.

1.02 REFERENCES

- A. Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
 1. AWWA C500 – Metal-Seated Gate Valves for Water Supply Service.
 2. AWWA C504 – Rubber-Seated Butterfly Valves.
 3. AWWA C540 – Power-Actuating Devices for Valves and Sluice Gates.
 4. AWWA C550 – Protective Interior Coatings for Valves and Hydrants.
 5. AWWA C606 – Grooved and Shouldered Joints.
 6. NSF 61 – Drinking Water System Components - Health Effects.

1.03 SUBMITTALS

- A. Product Data—Provide complete data on valve accessories sufficient to verify compliance with the specifications:
 1. Provide manufacturer's catalog information with size, dimensions, number of turns to open, materials, and assembled weights. Indicate valve pressure temperature rating.
- B. Manufacturer's certificate: Provide Affidavit of Compliance to certify that products meet or exceed specified requirements.
- C. Test reports: Submit reports of shop pressure tests, AWWA C504.

1.04 OPERATION AND MAINTENANCE DATA DESCRIPTION

- A. Maintenance data: Include installation and maintenance instructions, recommended spare parts lists and exploded assembly views of valves, operators and accessories.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, protect, and handle products to site as specified and in accordance with manufacturer's instructions.
- B. Deliver and store valves and accessories in shipping containers with labeling in place in accordance with AWWA C504, Section 6:
 1. Seal valve ends to prevent entry of foreign materials into valve body.

2. Box, crate, or otherwise completely enclose valves, operators and accessories to protect against damage.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Manufacturers:
 1. Kennedy
 2. Mueller
 3. DeZurik.
 4. Milliken
 5. Keystone
 6. Engineer Approved Equal

2.02 FABRICATION

- A. General:
 1. Rubber seat, tight closing discs seat at 90 degrees with pipe axis.
 - a. Shaft: Keys and pins for securing disc to shaft to be 18-8 stainless steel.
 2. Valve ends suitable for specified use:
 - a. Wafer, grooved or flanged type for interior piping.
 - b. Mechanical joint type on buried piping.
 3. Materials:
 - a. Body: Cast iron.
 - b. Shaft: Stainless steel, one piece.
 - c. Disc: Bronze or cast iron with corrosion-resistant metal plating.
 - d. Seat: Synthetic rubber or other elastomer with suitable temp rating.
 - e. Shaft bearings: Bronze or Teflon.
 - f. Shaft seal: Suitable synthetic rubber rings.
- B. Valve actuators:
 1. Buried valves as indicated on Drawings: Wrench nuts.
 2. Adequate to seat, unseat, and maintain valve position under all operating conditions.
 3. Counter clockwise (to the left) to open.

2.03 SHOP FINISHING

- A. Shop paint all ferrous metal surfaces of valves and accessories, both interior and exterior for corrosion protection.
- B. Manufacturer's standard paint will be acceptable if it is functionally equivalent to the specified paint and compatible with the specified field painting.
- C. Surfaces to be painted:
 1. Unfinished surfaces:
 - a. Interior of valves; Asphalt varnish (2 coats) coat tar, or epoxy for potable water applications.
 - b. Exterior of other valves to be buried, submerged, or located in manholes: Asphalt varnish or coal tar.

- c. Exterior of other valves: Rust-inhibitive primer.
 - d. Actuators and accessories: Rust-inhibitive primer.
 - e. Flange faces and interior working parts: Rust-preventative compound.
2. Air service:
- a. Interior of valve: Suitable for continuous air service at the rated temperature.
 - b. Exterior of valve: Rust-inhibitive primer suitable for air service at the rated temperature.

2.04 SOURCE QUALITY CONTROL

- A. Shop test in accordance with AWWA C504.
- B. Valve to be driptight on completion of tests.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install valves and accessories in accordance with the manufacturer's instructions.
- B. Check and adjust valves and accessories for smooth operation in accordance with manufacturer's instructions.

3.02 FIELD QUALITY CONTROL

- A. Coordinate inspection of all valves by manufacturer's representative and instruct plant personnel on their operation and maintenance.

END OF SECTION

