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**SECTION 2200**

**WATER SYSTEMS**

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**SECTION 2200**

**WATER SYSTEMS**

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**2201 GENERAL REQUIREMENTS**

**2201.1 Scope**

This specification is to govern the furnishing of all materials, labor, equipment, tools, superintendence, and other services necessary to construct water mains, complete with appurtenances including extensions and relocations at the locations shown on the plans or specified. This section governs materials for water mains having a diameter of 2 inches through 64 inches.

**2201.2 Abbreviations**

Wherever the words, forms, or phrases herein defined or pronouns used in their stead occur in these standards, in the contract or in the Advertisement of any document or instrument herein contemplated or to which these specifications apply, the intent and mean shall be interpreted as defined in the General Conditions of the Construction Contract.

**2201.3 Codes, Specifications, and Standards**

Codes, specifications, and standards referred to by title or number shall form a part of these standards to the extent required by the references thereto. Latest revisions shall apply in all cases. Specific reference standards include:

- A. Title 252. Oklahoma Administrative Code, Chapter 656, Public Supply Construction Standards, ODEQ
- B. Water Supply Operations, Volume 3, AWWA
- C. Backflow and Cross-Connection Manual, AWWA
- D. AWWA Standards
- E. Code of Ordinances, City of Owasso

**2201.4 Submittals**

Materials and products used in the construction described herein shall conform to the standards listed. Before construction, the Contractor is required to submit the following:

- A. Manufacturer's Certificate of Compliance certifying compliance with standards.
- B. Certified copies of test reports of factory tests required by the applicable standards.
- C. Shop drawings with performance data, physical characteristics, and dimensional layouts for piping, fittings, valves, hydrants, and precast concrete units.

**2201.5 Quality Assurance**

- A. The Contractor shall test and disinfect water mains as specified herein.
- B. The City shall collect and submit samples of water from newly constructed water mains. Samples shall be collected after the water mains have been disinfected and flushed. Results of bacteriological tests will be provided to the Contractor.

**2201.6 Water Mains Near Sewers**

- A. Horizontal separation: Water mains shall be laid at least 10 feet horizontally from any sanitary sewer crossing or sanitary manhole. When it is impossible to obtain proper horizontal separation as stipulated above, the sewer pipeline shall be constructed of AWWA C900 water pipe and be tested to assure water tightness before backfilling.
- B. Vertical separation: Whenever water mains must cross sanitary sewers or storm drains, the water main shall be laid at such an elevation that the bottom of the water main is 24 inches above the top of the drain or sewer. A full length of water main pipe shall be centered over the sewer line to be crossed so that the joints will be equally distant from the sewer as possible. This vertical separation shall be maintained for that portion of the water main located within 10 feet, horizontally, or any sewer or drain it crosses.
- C. Unusual conditions: Where a water main must cross under a sewer, a vertical separation of 24-inches between the bottom of the sewer and the top of the water main shall be maintained, with adequate support, especially for the larger sized sewer lines to prevent them from settling on and breaking the water main. The sewer shall be constructed of AWWA C900 water pipe (for a distance of 10 feet on either side of the crossing) or other suitable protection as accepted by the Engineer shall be provided
- D. Manholes: No water line shall pass through or contact a sewer or a sewer manhole.

**2202 PRODUCTS**

**2202.1 Pipe and Fittings**

- A. Ductile iron pipe, fittings and accessories:
  - 1. Ductile iron pipe:
    - a. Ductile iron pipe shall meet the requirements of ANSI A21.51/AWWA C151. Design and manufacture pipe for a working pressure of 150 psi plus 100 psi surge and a safety factor of 2.0. Minimum pressure class shall be as follows:

<u>Size Range</u>	<u>Pressure Class</u>
12 inches and smaller	350
14 inches through 20 inches	250
24 inches	200
30 inches and larger	150

- b. Pipe joints shall be push-on type. Joints shall meet the requirements of ANSI A21.11/AWWA C111. Restrained joints shall be Mega-Lug Lok Ring, Flex-Ring, Lok-Fast, Lok-Tyte, or approved equal.
  - c. Each length of pipe shall be marked with pipe class, casting period, manufacturer's name or trademark, and year of manufacturer. Marking shall meet the requirements of ANSI A21.51/AWWA C151.
2. Ductile iron fittings:
- a. Fittings shall be ductile iron or gray iron. Fittings for standard size fittings shall meet the requirements of ANSI A21.11/AWWA C110. Compact or short body fittings for all pipe sizes shall meet ANSI A21.53/AWWA C153. Design and manufacture fittings for a pressure rating compatible with pipe used.
  - b. Fitting joints shall be mechanical joints or restrained push-on joints. Joints shall meet the requirements of ANSI A21.11/AWWA C111. Concrete thrust blocking shall not be installed unless authorized by the Engineer. Restrained joints may be used instead of mechanical joints. Restrained joints shall be Lok-Ring, Flex-Ring, Lok-Fast, Lok-Tyte, Megalug, or approved equal. Pipe connecting to restrained joint fittings shall also have restrained joints.
  - c. Fitting marking shall conform to ANSI A21.10/AWWA C110 or C153.
  - d. Accepted manufacturers of ductile iron pipe include: U.S. Pipe and Foundry, American Cast Iron Pipe Co., and Griffin Pipe Company.
3. Ductile iron adapters:
- a. Adapters from ductile iron water mains to flange joint valves or fittings shall be gray iron or ductile iron. Adapters shall meet the requirements of ANSI A21.10/AWWA C110, or ANSI A21.53/AWWA C153. Design and manufacture adapters for a pressure rating compatible with pipe used.
  - b. Adapter ends connecting to ductile iron water mains shall have plain ends, push-on joints, mechanical joints, or restrained push-on joints. Adapters with plain ends, push-on joints, or mechanical joints may be used where restrained joints are not required. Adapters shall have restrained push-on joints where restrained joint piping is required as shown on the approved drawings. Mechanical joints and push-on joints shall meet ANSI A21.11/AWWA C111. Restrained joints shall be Lok-Ring, Flex-Ring, Lok-Fast, Lok-Tyte, Megalug, or approved equal.
  - c. Adapter ends connecting to flange joint valves or fittings shall be equipped with interior double cement mortar lining and exterior bituminous seal coat. Cement mortar lining and bituminous seal coat shall meet the requirements of ANSI A21.4/AWWA C104. The outside surfaces of all pipe, fittings, and adapters shall be coated with bituminous coating. Outside coating shall meet the requirements of ANSI A21.51/AWWA C151.
4. Lining and coating: The inside surface of all pipe, fittings, and adapters shall be lined with double cement mortar lining and bituminous seal coat. Cement mortar

lining and bituminous seal coat shall meet the requirements of ANSI A21.4/AWWA C104. The outside surface of all pipe, fittings, and adapters shall be lined with bituminous coating. Outside coating shall meet the requirements of ANSI A21.51/AWWA C151.

5. Gaskets: Gaskets for mechanical joints and push-on joints shall meet the requirements of ANSI A21.11/AWWA C111.
6. Nuts and bolts: Nuts shall be stainless steel conforming to ASTM F 594. Bolts shall be stainless steel conforming to ASTM F 593-02. Nuts and bolts for restrained push-on joints shall meet the requirements of the joint manufacturer.
7. Tapping sleeves: Tapping sleeves shall be standard mechanical joint type for iron pipe and shall comply with all applicable requirements of ANSI A21.10/AWWA C110 for iron fittings. Tapping sleeves shall be furnished with a flanged outlet conforming in dimensions and drilling to ANSI B16.1, Class 125.
8. Polyethylene encasement:
  - a. Polyethylene tube wrap shall be furnished at locations shown when required. It shall be made from virgin polyethylene resin in accordance with ASTM Specification D1248. Thickness shall not be less than 8 mils (0.008 inches). The material shall be chemically inert and moisture resistant to form an effective seal against penetration by water or vapor. Tensile strength shall be 1,800 psi with elongation of 500 percent. The material shall be Polyetube, as manufactured by Polyetube Corporation, Birmingham, Alabama, or approved equal. The tube shall be of such length that a one-foot overlap is provided at each joint in the pipe. Minimum flattened polyethylene tube widths for use with specific pipe sizes and joint types shall be as follows:

<u>Nominal Pipe Sizes</u>	<u>Push-On Joint Flat Tube Width</u>	<u>Mechanical Joint Flat Tube Width</u>
<u>Inches</u>	<u>inches</u>	<u>inches</u>
4	14	16
6	17	20
8	21	24
10	25	27
12	29	30
14	33	34
16	37	37
18	41	41
20	45	45
24	53	53

9. Tape of polyethylene tube shall be plastic-backed adhesive tape, Polykan #900 or Scotchrap #50 or approved equal.

B. Polyvinyl chloride (PVC) pipe, fittings and accessories:

1. PVC pipe:

- a. PVC pipe, 2 to 12 inches in diameter, shall meet the requirements of AWWA C900, pressure Class 150, DR18. PVC pipe larger than 12 inches shall be approved by the Engineer and shall meet AWWA C905, Class 200, DR-21.
- b. PVC pipe shall have ductile-iron pipe-equivalent outside diameter.
- c. Pipe joints shall be push-on type, meeting the requirements of AWWA C900.
- d. Each length of pipe shall be marked in accordance with AWWA C900.

2. PVC Fittings: PVC fittings shall not be used for water line construction. Fittings for PVC pipe shall be ductile or gray iron fittings and be in accordance with Paragraph 2202.1A.2, except that only mechanical joint fittings will be allowed.

3. Adapters:

- a. Adapters from polyvinyl chloride water mains to mechanical or flange joint valves or fittings shall be gray iron or ductile iron. Adapters shall meet the requirements of ANSI A21.10/AWWA C110. Adapters shall be designed and manufactured for a pressure rating compatible with that of the pipe.
- b. Inside surfaces shall be lined of adapters with cement mortar lining and bituminous seal coating. Cement mortar lining and bituminous seal coating shall meet the requirements of ANSI A21.4/AWWA C104. Outside surfaces of adapters shall be coated with bituminous coating. Outside coating shall meet the requirements of ANSI A21.10/AWWA C110.
- c. Adapter ends connecting to polyvinyl chloride water mains shall have plain ends or mechanical joints. Mechanical joints shall meet the requirements of ANSI A21.11/AWWA C111.
- d. Adapter ends connecting to mechanical or flange joint valves or fittings shall have joints complying with the specifications for the applicable valves or fittings.

4. Gaskets: Gaskets for PVC push-on joints shall meet the requirements of AWWA C900.

C. Service line piping:

1. Pipe: Pipe ¾-inch to 2-inch diameter shall be copper tubing, SDR-9; Type K, L and M. The pipe shall conform to ASTM B-88 and ANSI/NSF Standard 61. The pipe shall be homogeneous throughout, free from cracks, inclusions, and other defects. Water supplies with a pH of less than 6.5 may require corrosion control to limit solubility in drinking water.

2. Stops and Cocks:

- a. Stops and cocks shall be brass conforming to ASTM B62 and shall be full size throughout the size specified.
- b. Seating surfaces of the ground key type shall be tapered and shall be accurately fitted together by turning the key and reaming the body. Seating surfaces shall be lapped together using suitable abrasive to insure accurate fit. The large end to the tapered surface of the key shall be reduced in diameter for a distance that shall bring the largest end of the seating surface of the key into the largest diameter of the seating surface of the body, and the taper seat in the body shall be relieved on the small end, so that the small end of the key may extend through, to prevent wearing of a shoulder and to facilitate proper seating of the key. The stem end of the key, key nut and washer shall be designed that if the key nut is tightened to the failure point, the stem of the key shall not fracture. The nut and the stem shall withstand a torque on the nut of at least three times the necessary effort to properly seat the key without failure in any manner.
- c. The ball stop shall have a full-size round-way opening with straight-through flow, Teflon coated bronze ball with a minimum of 0.5 mil thickness coating. The stop must be so constructed that it may be disassembled and the ball removed without special tools.
- d. Plug type stop shall have a full-size round way opening with straight-through flow. Seating surfaces shall be brass (or Teflon coated brass) to rubber O-rings, providing positive pressure seal without mechanical means. The stop must be so constructed that the plug may be removed without special tools. Material for rubber O-rings should conform to requirements of ASTM D450 (test method shall be Rubber O-Rings, ASTM D1414).
- e. Inlet and outlet threads, of the types specified, shall conform to the applicable tables of AWWA C300, and inlet threads shall be protected in shipment by a plastic coating or other equally satisfactory means. If used, coupling nuts shall have a bearing skirt machined to fit the outside diameter of the pipe for a length at least equal to the outside diameter of the pipe.
- f. Corporation stops shall be so designed as to rotate about the axis of the flow passageway within a circle of rotation small enough to properly clear the inside of any standard tapping machine of appropriate size.

**2202.2 Valves**

A. Gate valves:

1. Buried gate valves shall be iron body, non-rising stem resilient seat gate valves. Valves shall meet the requirements of AWWA C509 and shall have mechanical joint ends. Valve opening direction shall be consistent with operation of existing valves in the waterworks in which the valves are installed, unless otherwise directed by the Engineer. The following manufacturers will be permitted: AVK, Mueller Company, American-Darling or American Pipe Company.

B. Butterfly valves:

1. Butterfly valves shall be installed only in special circumstances with prior approval by the Engineer.
2. Butterfly valves shall be of the tight-closing, rubber-seat type, shall have a rated pressure of 200 psig, and shall be bubble-tight at this pressure with flow in either direction. Valves and operators shall meet the requirements of ANSI A21.11/AWWA 504 for "Rubber-Seated Butterfly Valves". The following manufacturers are permitted: American Cast Iron Company, Henry Pratt Company, AVK, Cal-Val, Valmatic, Apco, Crispin and Mueller Company.
3. Buried butterfly valves shall have mechanical joints. Mechanical joints shall meet the requirements of ANSI A21.11/AWWA C111. Butterfly valves installed above ground or in structures shall have flange joints as specified in AWWA C504. Nuts, bolts, and gaskets for flange joints shall meet the requirements of ANSI A21.10/C110. Nuts and bolts shall be cadmium plated. Gaskets shall be full face and shall be red rubber, or equal.
4. Each buried butterfly valve shall have a manual operator and a 2-inch operating nut. Valve opening direction shall be consistent with operation of existing valves in the waterworks in which the valves are installed, unless otherwise directed by the Engineer.
5. Each butterfly valve installed above ground or in a structure shall have a manual operator and handwheel.
6. The valve surfaces, except for seating, shall be evenly coated with asphalt varnish (for buried service) or with a rust inhibitive primer. Exterior valve surfaces for buried or submerged service shall receive two coats of tar epoxy paint.

C. Pressure-reducing valves:

1. Pressure-reducing valves shall be designed to provide tight shutoff under conditions of no flow and shall not "hunt" under ordinary flow conditions.
2. Pressure-reducing valves shall be suitable for operation under the pressure and flow conditions as shown on the approved plans.

D. Combination air valves:

1. Combination air-release and vacuum-relief valves shall be installed at the locations indicated on the approved plans. Each valve assembly shall be installed complete with appropriate piping and valves as shown on the approved plans. All piping and isolation valves shall be bronze except for the air outlet from the valve and tapping saddle, which shall be brass or copper tubing.
2. The following valves, or equal, shall be used: Cla-Val, Valmatic, or Crispin.

E. Tapping valves:

1. Tapping valves shall be 200 psi, iron body, resilient-seated gate valves with non-rising stems conforming with all applicable requirements of ANSI/AWWA C500 and C509, except that the outlet end shall be standard mechanical joint end conforming to ANSI A21.11/AWWA C111 and the inlet end shall have an inlet flange conforming to ANSI B16.1 for cast iron flanges, Class 125.

F. Check valves:

1. Swing check valves 3 inches and larger shall conform to and be tested in accordance with the AWWA Standard for Swing-Check Valves for Ordinary Water Works Service, AWWA C508. They shall be horizontally mounted, single disc, swing type with a full diameter passage providing minimum pressure loss.
2. Valves shall be of the non-slamming type designed for the future installation of outside lever and weight. Disc faces and seat rings shall be bronze. Ends shall fit the pipe or fitting to which attached (push-on, mechanical, bell and spigot, or flanged).
3. The following makes will be permitted: Crane, Darling, Ludlow-Rensselaer, Mueller, A.P. Smith or approved equal.
4. Check valves 2.5-inches in size and smaller shall conform to the requirements of Federal Specification WW-V-51a for Class "A" 125 Pound Bronze Check Valves (for land use), Type IV.
5. Backflow preventers shall be installed to isolate fire protection and irrigation systems from potable water lines.

G. Valve appurtenances:

1. Valve ends:

- a. Valve ends of the mechanical joint type shall conform to ANSI A21.11/AWWA C111.
- b. The end flanges of flanged valves shall conform in dimensions and drilling to ANSI B16.1 for cast-iron flanges and flanged fittings, Class 125. The laying lengths of the flanged valves shall conform to the dimensions of ANSI B16.10.

2. Coating: All exterior surfaces of each valve shall be factory cleaned and painted with two (2) coats of asphalt varnish conforming to Federal Specifications TT-V-51-E or be epoxy coated. The interior surfaces of resilient-seated gate valves shall have a protective coating of fusion-bonded, nontoxic epoxy which is safe for potable water.

3. Valve operation:

- a. Gate valves shall be equipped with a 2-inch square wrench nut and the direction of rotation to open the valve shall be to the left (counterclockwise).

- b. Operators for non-buried service butterfly valves shall be of the enclosed gear-type furnished with a handwheel and 2-inch operating nut. Operators for buried service shall be equipped with mechanical stop-limiting devices to prevent over travel of the disc in the open and closed positions.
  - c. Valve position indicators shall be furnished for buried butterfly valves. The valve indicator shall be hermetically sealed for installation inside a cast-iron valve box and shall show valve-disc position, direction of rotation, and number of turns from full-open to full-close.
4. Extension stems: When the distance from the top of the valve cover to the valve operating nut exceeds 36 inches, each buried valve shall be provided with an extension stem and 2 inch operating nut. Extension stems shall be permanently attached to the valve stems.
- H. Curb stops: Buried valves 2 inches and smaller shall be curb stops. Curb stops shall meet the applicable requirements of AWWA C800, ASTM B-62 for 85-5-5-5 composition bronze, and USAS B2.1. Curb stops shall be Mueller H-10283 or equal.

### **2202.3 Valve Boxes**

- A. Valve boxes for butterfly valves and gate valves shall be cast iron. Valve boxes shall be two-piece or three-piece type. Each two-piece box shall be complete with bottom section, top section, and cover. Each three-piece box shall be complete with base, center section, top section, and cover. Valve boxes shall be extension type with slide or screw type adjustment. Each base and bottom section shall be the proper length for the valve served. The minimum thickness of metal shall be 3/16 inches. The word "WATER" shall be cast in each valve box cover.
- B. Valve boxes for curb stops shall be cast iron. Curb boxes shall be extension type. Each curb box shall be complete with foot piece, curb box, and lid.

### **2202.4 Fire Protection Systems**

- A. General: Fire hydrants shall be dry barrel, oil filled, standard compression, two-piece standpipe, break-away design conforming to AWWA C502 and shall comply with the following:
  - 1. Two 2.5-inch hose nozzles, a 4.5-inch minimum mechanical valve opening and a 6-inch inlet connection.
  - 2. Hydrants shall be equipped with two drain holes and provided with an automatic and positively operating non-corrodible drain or dip valve so as to drain the hydrant completely when the main valve is shut.
  - 3. Harnessing lugs shall be furnished with the hydrants.
  - 4. Hydrant shall be AVK, American-Darling or Mueller.

5. Hydrants on the City of Owasso water system shall be factory painted (baked enamel) New Federal yellow. Hydrants in any other water system shall be factory painted red.
- B. Nut dimensions: Operating stem and nozzle cap nuts shall be 1-1/2 inches point to flat of pentagon.
- C. Nozzle threads and caps: Hydrant nozzles shall meet NFPA standard thread requirements. All nozzle caps shall be equipped with chains attached to the hydrants and shall be furnished with long life rubber gaskets meeting rubber products in automotive application, ASTM D2000 requirements.
- D. Fire Protection Lines – Fire protection lines within the City shall include a double check valve assembly or backflow preventer.

**2202.5 Valve Vaults**

- A. Air release, meter, and pressure-reducing valve vaults shall be precast concrete conforming to ASTM C478. Access lid castings shall be as shown on the Standard Detail.
- B. Vaults which, by their special nature, shall conform to the approved plans and specifications in Section 3100, Concrete Structures.

**2202.6 Pipe Embedment Materials**

- A. Fine aggregate bedding: Fine aggregate bedding shall consist of natural sand or screenings having hard, strong, durable particles free from deleterious substances and meeting the following gradation requirements:

<u>Sieve</u>	<u>Percent Passing</u>
3/8 inch	100
No.4	95-100
No. 16	45-80
No. 50	10-30
No. 100	2-10

- B. Coarse aggregate bedding: Coarse aggregate bedding shall consist of crushed rock having hard, strong, durable particles free from deleterious substances and meeting the following gradation requirements, for ODOT Type A aggregate base:

<u>Sieve</u>	<u>Percent Passing</u>
3/4 inch	40-100
3/8 inch	30-75
No. 4	25-60
No. 40	8-26

- C. Flowable fill: Flowable fill shall be a sand-cement slurry consisting of 2,970 pounds of sand, 100 pounds of cement and approximately 458 pounds of water per cubic yard. The slurry will be mixed to a pourable soupy mix in a ready mix truck. When the flowable fill is to be a quick-set flowable fill, the cement shall be replaced with a rapid set cement and the slurry shall have a strength of 65 to 75 psi in 1 to 1.5 hours.
- D. Concrete embedment: Concrete for embedment and encasement shall be Class C and have a compressive strength of 2,400 psi at 28 days.

## **2203 SITE PREPARATION**

### **2203.1 General Information**

- A. Contractor shall do all cleaning necessary for performance of his work and shall confine his operations to that area provided through easements, licenses, agreements and right-of-way. The Contractor's entrance upon any lands outside of that area provided by easements, licenses, agreements, or public rights-of-way, shall be at the Contractor's sole liability.
- B. The Contractor shall not occupy any portion of the project site prior to the date established in the Notice to Proceed without prior permission of the Engineer.

### **2203.2 Obstructions**

- A. General: Natural obstructions, existing facilities and improvements encountered during site preparation shall be removed, relocated, reconstructed or worked around as herein specified. Care shall be used while performing site preparation work adjacent to any facilities intended to remain in place. Except as otherwise specified, the Contractor shall be responsible for any damage to existing facilities and improvements and any repairs required shall be promptly made at the Contractor's expense. Waste materials shall be disposed of in a satisfactory manner off the work site. Restoration of utilities damaged by the Contractor shall be restored as directed by the utility company at no additional cost to the Owner. Unless otherwise provided in any Special Conditions or Proposal, no separate or additional payment will be made for any work in connection with removal, relocation or restoration of obstructions and existing facilities.
- B. Surface obstructions:
  - 1. Sidewalks, pavements, curb and gutter, drainage structures and similar obstructions shall be bored as per Section 3200. If special circumstances do not allow boring of an obstruction, the Contractor shall inform the Engineer of the problem. Open cut

items shall be cut in straight lines or removed to the nearest construction joint. Line of cut shall be less than one foot outside the edge of the trench. Surface obstructions removed to permit construction shall be reconstructed as specified and to the dimensions, lines and grades of original construction.

2. Mailboxes shall be maintained in the manner that the United States Postal Service requires to prevent interruption of mail delivery.
3. Site preparation shall include the removal of trees, shrubs, brush, crops, and other vegetation within the limits of the easements or right-of-way as required with the approval of the Engineer. The following procedures for protection of existing greenery are required.
  - a. Trees:
    - (1) All reasonable effort shall be made to save as many trees as possible. Trees are defined as six inches in diameter and greater when measured at a point three feet above the ground surface. Any trimming necessary to save a tree shall be in accordance with acceptable pruning practices.
    - (2) All trees within easements or right-of-way provided, which are specifically to be removed or saved have been marked on the plans. Trees to be removed shall be completely removed, including stump and large roots, unless such removal may result in damage to existing pipelines. In that event, trees shall be sawn off not more than 4 inches above the ground and the stump shall be removed to 12 inches below finish grade. Any tree replaced shall be outside the permanent sewer right-of-way and shall be like species of nursery stock.
  - b. Small plants and flowers: At least two weeks prior to the start of construction, property owners shall be notified by the Contractor of the proposed starting date. The purpose of this notification is so that the property owners, may relocate the plants they desire to save.
  - c. Topsoil: Topsoil shall be removed from the trench line and stockpiled on-site so that replacement can occur as soon as possible after the compacted trench backfill has stabilized to the point that no more subsidence is expected.
4. Fences interfering with construction, and located within public rights-of-way may be removed by the Contractor only if the opening is provided with a temporary gate that will be maintained in a closed position except to permit passage of equipment and vehicles unless otherwise herein specified. Fences within temporary construction easements may be removed by the Contractor provided that temporary fencing is installed in such a manner as to serve the purpose of the fencing removed. The Contractor shall locate and record all fence corners prior to removal. All fencing removed shall be restored by the Contractor to the condition existing before construction unless otherwise specified in any Special Conditions. The Contractor is solely liable for the straying of any animals protected or corralled or other damage caused by any removed fences.

5. The Contractor shall preserve all property corners, pins or markers. In the event any property corners, pins, or markers are removed by the Contractor, such property points shall be replaced at the Contractor's expense and shall be reset by competent surveyors properly licensed to do such work. In the event such points are section corners of federal land corners, they shall be referenced and filed with the appropriate authority.
6. Sodded and/or landscaped thoroughfares and areas on or adjacent to improved property shall be disturbed only to the extent required to permit construction. Such areas shall not be used as storage sites for construction supplies and insofar as practicable shall be kept free from stockpiles or excavated materials.

C. Subsurface obstructions:

1. Where existing utilities and service lines are to be encountered, the Owner shall be notified by the Contractor at least 48 hours (not including weekends and/or holidays) in advance of performing any work in the vicinity. All excavation, pipeline installation and backfilling work in the vicinity of such utilities shall be accomplished in the manner required by the respective Owner and, if requested, under their direct supervision. The Contractor shall be responsible for any and all damages to a public or private utility that may occur as the result of the construction.
2. The Contractor shall make a reasonable effort to ascertain the existence of obstructions and shall locate obstructions by digging in advance of machine excavation where definite information is not available as to their exact location. Where such facilities are unexpectedly encountered and damaged, responsible officials and other affected parties shall be notified and arrangements made for the prompt repair and restoration of service.
3. The Contractor shall make every reasonable effort to protect private water and sewer facilities. When these facilities are disturbed or damaged by the work, the Contractor shall make necessary repairs to the facilities for continuous service prior to the close of the work day.

## **2204 WATER LINE CONSTRUCTION**

### **2204.1 Scope**

- A. Water line construction shall include the necessary clearing, grubbing, and preparation of the site; removal and disposal of all debris; excavation and trenching as required; the handling, storage, transportation, and disposal of all excavated material; all necessary sheeting, shoring, and protection; preparation of subgrades; pumping and dewatering as necessary or required; protection of adjacent property; handling and installation of water line; and other appurtenant work.

### **2204.2 General:**

- A. Supervision: All pipeline excavation work shall be accomplished under supervision of a person experienced with the materials and procedures which will provide protection to existing improvements, including utilities and the proposed pipeline.

- B. Trench excavation in fill material: When pipe is to be installed in embankment or fill, the embankment shall be constructed in accordance with Section 2100 and shall be built up to a plane at least 18 inches above the top of the pipe prior to the excavation of the water line trench.
- C. Open trench: The Contractor shall not open more trench in advance of pipe laying than is necessary. The maximum length of open trench allowed on any line under construction shall be 300 feet. All open trenches shall be adequately isolated with barriers.
- D. Hazardous waste: In the event hazardous wastes as defined by the Resource Conservation and Recovery Act of 1976 (PL94-580) are encountered, work shall be halted and the Engineer shall be notified. Work shall be resumed only after the Engineer notifies the Contractor. Regulation of removal, handling and disposal of hazardous wastes is the responsibility of federal and state agencies.
- E. Classification of excavated material: No classification of excavated materials will be made. Excavation and trenching work shall include the removal and subsequent handling regardless of the type, character, composition, or condition thereof.

### **2204.3 Trench Excavation**

- A. Excavations for pipelines, except where boring or jacking is specified, shall be accomplished by the open-cut method (trenching) except as specified or accepted by the Engineer.
- B. All trenches shall be excavated to the alignment and depths as shown on the plans, accounting for proper pipe embedment. Over excavation shall be required when the subgrade is unstable. Over excavations shall be backfilled with granular pipe embedment material unless otherwise directed by the Engineer.
- C. Excavated material shall be stockpiled adjacent to the trench in a location not to endanger the work by overloading the banks and causing slides or cave-ins. The Contractor shall sort and stockpile select excavated material so proper material is available for backfill. Stockpiles shall not obstruct adjacent streets, walks or driveways.
- D. Excavated material not required or stable for backfill shall be removed and wasted in an area designated by the Owner.
- E. Undercutting of trench walls is not permitted.
- F. Trench walls shall be vertical from the bottom of the trench to the top of the pipe. The remainder of the trench shall be sloped or benched in order to prevent collapse of the trench.
- G. Trench width shall be constructed with sufficient working room to properly and safely place and compact embedment materials. The space between the pipe and trench wall must be wider than the compaction equipment used in the pipe zone. The trench widths required for construction shall be as shown on Standard Detail WAT-01.

#### **2204.4 Trench Shoring and Bracing**

- A. All shoring, bracing or blocking shall be furnished and installed as necessary to preserve and maintain exposed excavation faces, to protect existing improvements, to protect the proposed pipeline and to provide for safety.
- B. Shoring or other methods for support of trench wall support is the responsibility of the Contractor and shall be accomplished by methods that will not adversely affect pipeline alignment, grade and/or structural integrity.
- C. All bracing, sheeting and/or shoring installed below top of proposed pipe shall not be removed after pipe and/or pipe embedment has been installed. The Contractor shall back fill around the equipment.
- D. All movable bracing, sheeting and/or shoring shall be installed only where frame supports and not the actual frame extend below the top of pipe.
- E. Movable shoring where the frame rests on a shelf above the pipe with the pipe installed in a narrow, vertical walled sub-trench is allowed. Any voids left in the embedment material by the supports shall be filled and compacted with a granular material. Movable shoring shall be operated as to prevent longitudinal movement or disjoints of the pipe.
- F. Removal of shoring shall be performed so that removal of equipment does not relax the trench support.

#### **2204.5 Trench Dewatering**

- A. Contractor shall maintain a dry and stable trench at all times. Contractor shall obtain necessary permits, and provide for the proper method of discharging such water from the work site at all times until pipeline installation is completed to the extent that hydrostatic pressure flotation or other adverse effects will not result in damage to the pipeline.
- B. Proper dewatering techniques are the Contractor's responsibility. All work performed by the Contractor, which is adversely affected by his failure to adequately dewater trenches, will be subject to rejection by the Engineer. The Contractor shall repair and/or replace the affected pipeline without additional compensation.
- C. The Contractor shall form all dams, flumes or other works necessary to keep the excavation clear of water while the water lines are being constructed. All water shall be removed from such excavation in a manner that will not damage property or soften pipe bedding.

### **2205 INSTALLATION OF WATER PIPE**

#### **2205.1 General**

- A. This section governs construction methods and procedures for the installation of water lines and appurtenances. All pipe shall be installed in accordance with the pipe manufacturer's recommendations, except as modified herein.

1. Maximum trench width: Pipe laying shall not proceed if the trench width as measured at the top of pipe exceeds the maximum allowable trench width. If this occurs, the Contractor shall submit to the Engineer for review an alternate plan for the pipe or pipe of sufficient strength to provide safe supporting strength.
  2. Minimum cover:
    - a. Except where otherwise shown, trenches shall be excavated to a depth sufficient to provide a minimum depth of backfill cover over the top of the pipe of 36 inches as indicated on the drawings. Greater pipe cover depths may be necessary on existing pipe, conduits, drains, drainage structures, or other obstructions encountered at normal pipe grades.
    - b. Measurement of pipe cover depth shall be made vertically from the outside top of pipe to finish grade or pavement surface elevations.
- B. All water pipe located under paved areas shall be sleeved.
- C. Pipe handling:
1. All pipe and fittings shall be stored and handled with care in order to prevent damage. Hooks, chains or cables shall not be used to transport or handle pipe or fittings. Pipe or fittings shall not be dropped into the ditches, but lowered either by hand or mechanical means. Pipe ends shall be covered while being lowered in to the trenches to prevent entrance of foreign matter. Caution shall be taken when handling pipe during freezing weather.
  2. Pipe storage: All pipe shall be stored on pallets or racks to prevent damage. Pipe shall be covered while in storage with an opaque material. Gaskets shall be kept out of direct sunlight and from being exposed to heat, oil and grease.
  3. Pipe inspection: All rejected pipe and fittings shall be marked and removed from the project site at no cost to the City. All pipe and fittings shall be examined for soundness and specification compliance prior to placement in the trench, and rejected pipe or fittings shall not be incorporated into the pipeline. Pipe class or strength shall be checked to assure that proper pipe is installed.
  4. Pipe laying: All pipe laying shall begin at the existing water main and proceed upstream. Pipe bells shall be laid upstream, with the spigots being inserted into the bells.
  5. Alignment: Unless otherwise required, all water lines shall be laid in the designated right-of-way. Pipe joint deflection shall not exceed the maximum allowable deflection per joint according to ASTM C425, ASTM C594 and AWWA C600 and as long as no more than 0.06% of ellipsing or diametric pipe deflection occurs. To assure this, the maximum angle of deflection of any line shall be five (5) degrees.
  6. Covering pipe ends: All pipelines shall be plugged at the end of each day's progress. Plugs or other positive methods of sealing shall be utilized at all times to protect any existing system from entrance of storm water or other foreign matter. During installation no material shall be placed in the pipes.

7. Pipe placement preparation: The Contractor shall unload pipe as close to the installation as possible. Pipe shall be located on the opposite side of the trench as the excavated material. Pipe shall be located as not to interfere with construction. Pipe shall not be strung out in areas where damage could occur due to construction or other activities.
- D. Pipe lengths: Full lengths of pipe shall be used wherever possible. Short lengths of pipe with couplings shall not be permitted, except as approved by the Engineer. Full lengths and cut pipe shall be installed without forcing or springing the pipe, causing excessive bending moments.
- E. Connection to structure: Pipe connecting to a structure shall be supported with concrete embedment, cradle or encasement to the first joint outside the structure excavation. If flexible wall connections are used, standard bedding may be used in lieu of concrete embedment provided the height of backfill does not exceed the covers depths, which would result in loads exceeding the pipe's safe supporting strength.
- F. Drainage course crossing encasement: Any pipeline crossing a well-defined drainage course having less than 4 feet of cover over the pipe shall be sleeved restrained joint or encased in concrete. The length of encasement sleeve shall be as shown on the plans or if not shown as specified by the Engineer.
- G. Cutting pipe: All pipe shall be cut with a saw or special cutting tool. Cutting shall be done in a neat manner without damage to the pipe. Cuts shall be smooth, straight and at right angles to the pipe axis. After cutting, the end of the pipe shall be dressed and beveled. Beveling shall be done with a specifically designed beveling tool. Hand beveling will not be permitted. When cutting pipe with couplings, mark the field cut pipe end the same distance in as the mark appeared on the original full-length pipe section.
- H. Cleaning: The interior of all pipe and fittings shall be thoroughly cleaned of foreign matter before being installed and shall be kept clean until the work has been accepted.
- I. Tracer wire and warning tape: A #12 copper tracer wire shall be placed on top of all PVC pipe and connected to all fire hydrants and valves. A mylar tape shall be placed atop the initial fill for the entire length of line.
- J. Conduit Pipe: Conduit (casing) pipe shall be used where required at railroad or highway crossings. The conduit pipe shall be in accordance with Construction Standards Section 3200 and the requirements of the railroad or highway authority with regard to type of material, wall thickness, and coating. No conduit will be installed without the approval of the involved highway or railroad authority.

## **2205.2 Jointing Pipe**

- A. Push-on Joints:
  1. The Contractor shall inspect each pipe joint for gaskets, deformations and cracks before installation.

2. The Contractor shall clean gasket, bell, groove area, and spigot with a clean rag, brush or paper towel to remove any foreign matter before assembling.
  3. Pipe spigot and bell shall be coated with a manufacturer recommended lubricant for jointing the PVC pipe.
  4. The Contractor shall align the spigot and bell and insert the spigot into the bell until it contacts the gasket uniformly. Steady pressure shall be applied by hand, bar and block assembly or by mechanical assistance until the spigot easily slips into through the gasket. The spigot shall be inserted up to the insertion line marked on the pipe.
  5. The Contractor shall not stab the joint by swinging the spigot into the bell or hammer the pipe.
  6. The Contractor shall backfill the joints as soon as they have been made and inspected. Material shall be placed on each side of the joint to offset conditions that might move the pipe offline and grade. No pipe shall be brought into position until the proceeding length has been secured in place.
  7. The gasket seat in the bell shall be wiped clean after which the gasket shall be placed. A thick film of lubricant shall be applied to all of the inner surfaces of the gasket and on the spigot end of the pipe. The lubricant and the gaskets shall be as recommended and supplied by the manufacturer of the pipe being used. The lubricant shall be odorless, tasteless, nontoxic, and suitable for use in potable water.
  8. Field-cut pipe shall be bevel filed to remove any sharp or rough edges which might otherwise damage the gasket.
- B. Mechanical joints: The mechanical joints shall be as shown on the approved plans.
- C. Flanged joints: When bolting flanged joints, care shall be taken to ensure that there is no restraint on the opposite end of the pipe or fitting which would prevent uniform gasket compression or which would cause unnecessary stress in the flanges. One flange shall be free to move in any direction while the flange bolts are being tightened. Bell- and spigot joints shall not be packed or assembled until all flanged joints affected thereby have been tightened. Bolts shall be tightened gradually and at a uniform rate so that gasket compression is uniform.
- D. Restrained joints: Restrained joints and anchoring joints shall be installed in strict accordance with the pipe manufacturer's recommendations.

### **2205.3 Connection to Existing Mains**

- A. The Contractor shall furnish and install all fittings necessary to join existing and new water mains.
- B. The Public Works Department shall be given at least seven (7) days notice prior to connecting to any water supply mains. The Contractor shall coordinate tie-ins with the City to minimize down time. In no instance shall the Contractor operate City water valves for the purpose of installing connections or repairing water lines. This action will be done only by Public Works Department personnel. In addition, the Contractor shall

hang door knockers in the work area 48 hours in advance to advise citizens of work to be performed.

#### **2205.4 Pipe Bedding Installation**

##### **A. Bedding:**

1. The trench subgrade and bedding material shall be prepared to provide a uniform and continuous pipe support between pipe bells and joints. Bedding material shall conform to Standard Detail WAT-01.
2. Bedding shall be hand or mechanically tamped to compact the bedding materials.
3. The surface of the bedding shall be carefully brought to grade after compaction.
4. Bell holes shall be excavated prior to pipe installation to allow for unobstructed assembly of the joint and to assure a fully bedded pipe for the entire pipe length.
5. Additional excavation to the depth determined by the Engineer shall be required if unstable subgrade conditions are encountered and it is determined by the Engineer that the bedding specified will not provide suitable support for the pipe. This additional excavation shall be backfilled with material accepted by the Engineer.
6. Before concrete embedment, the pipe shall be placed in proper position on temporary supports consisting of wood blocks or bricks with wood wedges. When necessary, anchor or weight the pipe to prevent flotation when the concrete is placed.

##### **B. Haunching:**

1. Proper bedding material shall be placed to the spring line of the pipe, in lifts not to exceed six (6) inches. Compaction shall be by hand or mechanical tamping as long as machinery does not come in contact with the pipe.
2. Sufficient material shall be worked under the haunches of the pipe to provide adequate side support. Movement of the pipe shall be prevented to during the bedding placement.

##### **C. Initial backfill:**

1. The screenings, sand (or flowable fill in special cases) material shall be placed from the bedding material to a minimum of 6 inches above the pipe. Six (6)-inch lifts shall be placed and compacted by hand or mechanical tamping.
2. Backfill shall be placed simultaneously on both sides of the pipe to prevent displacement.

3. Concrete embedment shall be placed uniformly on each side of the pipe and continually deposited to the final position.

#### **2205.5 Polyethylene Encasement**

- A. General: Polyethylene encasement shall be installed on ductile iron pipe and fittings when indicated on the plans and/or called for in the Proposal.
- B. Installation: The polyethylene encasement shall be installed as specified in "Method A" or "Method B" below.
  1. Method A: Polyethylene tubing shall be approximately 24 inches longer than the length of the pipe section to provide a 12-inch overlap on each adjacent pipe section. Tube ends shall be taped in place.
  2. Method B: Polyethylene tubing shall be 1-foot shorter than the length of the pipe section with a 36-inch length of polyethylene tube centered over pipe joint and lapped over pipe section and its tubing. Tube ends shall be taped in place.
  3. Repairs: Any rips, punctures, or other damages to the polyethylene shall be repaired with adhesive tape or with a short length of polyethylene tube cut open, wrapped around the pipe, and secured with adhesive tape.

#### **2205.6 Setting Valves, Fittings, and Hydrants**

- A. Valves and fittings:
  1. All valves, fittings, plugs, and caps shall be set and joined to the pipe in the manner heretofore specified for cleaning, laying, and joining pipe, except that large valves may require special support so that the pipe will not be required to support the valve weight.
  2. Each valve shall be inspected before installation to ensure that all foreign substances have been removed from within the valve body, and shall be opened and closed to see that all parts are in first-class working condition. Gate valves shall be set vertical in the horizontal pipeline. Valves and pipe shall be supported in such a manner as to prevent stress in either with no deflection in the valve/pipe joint.
  3. Valve boxes and lids shall be installed at each valve and shall be supported and maintained centered and plumb over the operating nut of the valve. The valve box shaft shall not transmit shock or stress to the valve. Install valve box covers flush with the surface of the finished area.
  4. All dead ends on new mains shall be closed with plugs or caps suitably restrained to prevent blowing off under test pressure.
- B. Fire hydrants:
  1. All new hydrant installations shall be as shown on the plans or Standard Details and shall include all necessary excavation and backfill to make the installation complete.

2. Each hydrant shall be inspected before installation for direction of opening, nozzle size and threading, nozzle caps and chains, operating nut, and cap nut dimensions, tightness of pressure-containing bolting, cleanliness of inlet elbow and weep hole openings, and handling damage and cracks. Defective hydrants shall be corrected or replaced.
3. All hydrants shall stand plumb. The weep holes of the hydrant shall be kept clear and free to drain. The areas around each hydrant and hydrant valve shall be thoroughly compacted to prevent settlement of these areas. Weep holes shall be surrounded by washed rock as shown on Standard Detail WAT-02.
4. Hydrants shall be set to a grade that allows their proper operation. Traffic hydrants with breakaway joint must be set with the joint above the ground line. Hydrants behind curbs shall be placed with the hydrant centerline 6'-4" from the face of curb or fire lanes and streets. Hydrants shall be rotated so as to have the pumper nozzle facing the street or rotated to face any direction as required by the Engineer or Fire Marshal.

#### **2205.7 Thrust Restraint**

- A. Fire hydrants: Restrained joints shall be utilized with a valve and hydrant tee as shown on the Standard Details. Concrete thrust blocking is not permissible, unless anchored couplings in the opinion of the Engineer cannot be used.
- B. Fittings: All plugs, caps, tees, bends, and other fittings, unless otherwise specified, shall be provided with suitably restrained joints per the manufacturer's recommendations.
- C. Restrained joints: Restrained push-on or mechanical joints, mechanical joint anchoring fittings(MegaLugs), and mechanical joints utilizing set screw ductile iron retainer glands shall be used in lieu of concrete thrust blocking. Thrust blocking will be allowed only under special circumstances as approved by the Engineer.

### **2206 BACKFILL**

#### **2206.1 General**

- A. All trash and debris shall be removed from the pipeline excavation prior to backfilling.
- B. A all water line trenches and excavation around structures shall be backfilled from the initial backfill layer to the original surface of the ground with suitable earth or earth and rock. When an earth and rock mixture is used, it shall be placed and thoroughly consolidated with sufficient earth to completely fill all voids between the rocks. No rock whose greatest dimension exceeds two inches shall be placed within 12 inches of the initial backfill. No rock greater than 6 inches in its largest axis shall be placed in any trench excavation as backfill.
- C. Backfill compaction: The backfill material shall be placed and compacted in lifts not to exceed 12 inches in depth. Each lift shall be compacted to the required density prior to the next lift being placed. Requirements for various materials are as follows:
  1. Cohesionless soils:

- a. Each lift of backfill to support equipment slabs, building slabs on grade or other structures shall be compacted to not less than 95% of maximum standard density.
  - b. Poorly-graded gravel (GP) and sands (SW or SP) shall be placed fully saturated to prevent bulking.
  - c. Well graded gravels (GW) shall be placed at optimum moisture content.
2. Other soils:
- a. Select and final backfill to be under pavements, driveways, curbs and gutters, sidewalks or other similar areas shall consist of ODOT Type A aggregate and be compacted to no less than 95% relative density at maximum moisture content. The backfill shall extend from the bedding layer to the roadway or structure base.
  - b. Under grassed or landscaped areas, each lift (except for topsoil) shall be compacted to 90% of standard density.
  - c. Cohesive soils shall be placed at a moisture content of one (1) percent below to three (3) percent above optimum moisture content.
- D. Commercial sand backfill shall not be used for water lines.
- E. In areas marked "garden" or "flower garden", the original topsoil shall be replaced to original elevation and depth. (Minimum depth shall be 12 inches).
- F. Backfill material shall be carefully placed to avoid damage to or displacement of the pipe and other exposed utilities or structures. Rolling equipment shall not be used until a minimum of two (2) feet of backfill has been placed over the pipe. Three (3) feet of cover shall be placed over the pipe before a hydro hammer is used.
- G. Backfill shall not be placed when material contains frost, is frozen, or when a blanket of snow prevents proper compaction. Contractor shall remove waste material, trees, organic material, rubbish, or other deleterious substances.

### **2206.2 Backfilling Under Pavement**

Under areas to be paved, the aggregate fill from the top of the initial backfill shall be compacted so as to obtain 95% of maximum density at optimum moisture as determined by ASTM D698. Required compaction and percentage of maximum density must be obtained before pavement is placed.

### **2206.3 Backfilling in Unpaved Areas**

From the top of the initial backfill to finished grade, the backfill material shall be compacted to no less than 95% of maximum density at optimum moisture as determined by ASTM 698.

#### **2206.4 Backfill Around Structures**

- A. No backfill shall be placed over or around any structure until the concrete or mortar has attained a minimum strength of 2,000 psi and can sufficiently support the loads imposed by the backfill without damage.
- B. The Contractor shall use utmost care to avoid any wedging action between the side of the excavation and the structure that would cause any movement of the structure. Any damage caused by premature or unbalanced backfill or by the use of equipment on or near a structure will be the responsibility of the Contractor.
- C. No rock larger than 4 inches maximum dimension shall be placed within 12 inches of the exterior surface of any structure.

#### **2207 RESTORATION**

##### **2207.1 General**

- A. The Contractor shall restore the project site to conditions equal to or better than those existing prior to entry unless otherwise specified.
- B. Maintain adequate safety signs, barricades and lights until final restoration of work area is completed.
- C. Public property shall be restored to the requirements of Section 2100.

##### **2207.2 Clean-Up**

- A. The Contractor, upon completion of installation and backfill operations, shall prepare the area for final grading including but not limited to the following items:
  - 1. Clean-up shall follow the backfilling operations as closely as possible.
  - 2. Excess material shall be removed from the site including material that has washed into the stream beds, storm water facilities, streets, etc.
  - 3. Tools, equipment and construction material shall be removed except for in designated storage areas along the pipeline route.
  - 4. Restore surface and sub-surface drainage and provide temporary wash checks where necessary.

##### **2207.3 Finish Grading**

- A. The Contractor shall finish grade the area to lines and grades shown on the plans or if not shown to those that existed prior to the area being disturbed. Special attention shall be directed to assure surface drainage. The area shall be smoothed by raking or dragging.

#### **2207.4 Surface Restoration**

- A. Seeding and sodding: All unpaved areas cut by the line of trench or excavation or damaged during the work shall be seeded or sodded when specifically indicated on the plans. Seeding and sodding shall conform to the requirements of Subsection 2104.
- B. Sidewalks and driveways: All paved sidewalk and driveway areas cut by the line of trench or excavation or damaged during the work shall be replaced. Sidewalk and driveway replacement shall conform to the requirements of Paragraph 2403.5.
- C. Streets and curbing: All paved street, shoulder, and curbing areas cut by the line of trench or excavation or damaged during the work shall be replaced to conform to the lines and grades of the original pavement and shall be of equal quality, thickness, and appearance to that removed. Paving and curb replacement shall conform to the requirements of Paragraph 2403.6.

#### **2207.5 Fences**

All fencing damaged and/or removed existing prior to construction shall be restored to a condition not less than that which existed prior to construction.

#### **2207.6 Walls**

Retaining and architectural walls, if disturbed or damaged, shall be restored architecturally and structurally to conditions not less than that which existed prior to construction.

#### **2207.7 Trees, Shrubs, and Bushes**

- A. Any tree, shrub or bush replaced shall be planted outside the permanent easement and shall be of the same species as the removed tree, shrub or bush. Any tree, shrub or bush species that is prohibited by local restrictions shall be substituted with a related species. The Contractor shall notify the property owners at least two weeks prior to the start of construction so property owners can remove small plants and flowers.
  - 1. Pipe Embedment: Embedment for pipe shall be in accordance with these standards and details of the laying condition as indicated on the plans.
  - 2. Trench fill: Backfill for the entire length of the pipeline shall be compacted full depth of the trench above the initial backfill.
    - a. Compacted backfill shall be finely divided job-excavated material free from debris, organic material, frozen materials, and stones larger than 2 inches in greatest dimension. Masses of moist, stiff clay shall not be used.
    - b. Whenever, in the opinion of the Engineer, the material excavated from the trenches is not suitable for backfilling, or there is a deficiency of material suitable for backfilling, the Contractor shall provide suitable material. The Contractor shall remove all excess excavated materials and shall dispose of them at locations provided by the Contractor.

- c. At the option of the Contractor, compacted backfill may be either approved job-excavated material or standard bedding material.

**B. Placement and compaction:**

1. Job-excavated materials shall be placed in uniform layers not exceeding 12 inches in uncompacted thickness. Increased layer thickness may be permitted for non-cohesive material if the Contractor demonstrates to the satisfaction of the Engineer that the specified compacted density will be obtained. The method of compaction and the equipment used shall be appropriate for the material to be compacted and shall not transmit damaging shocks to the pipe.
2. Granular bedding used for backfill shall be placed in uniform layers not exceeding 6 inches and compacted by slicing with a shovel or vibrating.
3. Compaction of trench backfill shall be the following percent of maximum density at optimum moisture content as determined by the Standard Proctor Test, ASTM D698:

<u>Area</u>	<u>Cohesive Materials</u>	<u>Cohesion less Materials</u>
Non-Paved	95%	95%
Paved	Not Allowed (Refer to Standard Details)	95%

4. Backfill failing to meet required densities shall be removed or scarified and re-compacted as necessary to achieve specified results.

**2208 TESTING**

**2208.1 Preparation**

The Contractor shall pressure test the distribution line without the taps installed. Prior to starting the test, the Contractor will flush the line of all dirt and air and disinfect by chlorination. This procedure will be coordinated with the City project Inspector and/or a Water Division representative of the Public Works Department. In no case is the Contractor authorized to operate City water valves. Pressure tests shall conform to AWWA C605 latest revision.

**2208.2 Flushing**

- A. Flushing: The Contractor shall fill the lines slowly with potable water at a maximum velocity of 1 foot per second while venting the air so that the air will not be entrapped. Lines shall be flushed with a minimum of three changes of treated water. Valves on the new lines shall be closed slowly to prevent excessive surges while maintaining positive pressure at all times. Flushing water shall be discharged without causing erosion damage, nuisance or interruption of traffic.
- B. Damage prevention: The Contractor shall backfill the line as necessary to prevent pipe movement.

- C. Contamination: Existing water mains used to supply water for testing shall be protected from backflow contamination by temporarily installing a double check valve assembly between the test and supply main. After flushing and prior to testing, the back flow prevention device shall be removed so the supply main is visibly isolated from the supply main.

**2208.3 Pressure Test**

After flushing, fill the line with water and bring the line up to the test pressure of 150 psi. All fittings, pipe, valves and hydrants shall be inspected for leaks and repaired accordingly. All defective elements shall be replaced until the allowable leakage requirement is met. The line must maintain that pressure for a two (2)-hour period with less than 5 psi pressure drop. No air testing is allowed.

**2208.4 Leakage Testing**

- A. Leakage is the quantity of water that must be supplied into the pipe section being tested to maintain a pressure within 5 psi of the specified leakage test pressure after the pipe has been filed with water and the air in the pipeline has been expelled. It is also defined as the water needed to fill the full pipeline after the line is tested with air pressure for the same duration above. No installation will be accepted if the leakage in gallons per hour is greater than that determined by the following formula and table:

$$L = \frac{SD(P)^2}{133,200}$$

Where: L = leakage in gallons per hour      D=nominal pipe dia (inches)  
           S = length of pipe in feet                P=average pressure during test (psi)

<u>Avg. Test Pressure</u>	<u>Nominal Pipe Diameter, Inches</u>									
	<u>4</u>	<u>6</u>	<u>8</u>	<u>10</u>	<u>12</u>	<u>14</u>	<u>16</u>	<u>18</u>	<u>20</u>	<u>24</u>
150	0.33	0.50	0.66	0.83	0.99	1.16	1.32	1.49	1.66	1.99
125	0.30	0.45	0.60	0.76	0.91	1.06	1.21	1.36	1.51	1.81
100	0.27	0.41	0.54	0.68	0.81	0.95	1.08	1.22	1.35	1.62
75	0.23	0.35	0.47	0.59	0.70	0.82	0.94	1.05	1.17	1.40
50	0.19	0.29	0.38	0.48	0.57	0.67	0.76	0.86	0.96	1.15

**2208.5 Disinfecting**

- A. Following completion of the pressure and leakage tests, the Contractor shall disinfect the water line by adding chlorine to elevate the concentration to at least 50 mg/l but no more than 200 mg/l. The chlorine shall be allowed to stand in the pipe for 24 hours, as per AWWA specification C651, latest revision. The following table lists the amounts of 65 percent calcium hypochlorite (H.T.H.) powder needed for various lengths of pipe at various diameters to achieve the 50 mg/l concentration needed:

<u>Diameter</u>	<u>Length of Pipe, Feet</u>									
	<u>100</u>	<u>200</u>	<u>300</u>	<u>400</u>	<u>500</u>	<u>600</u>	<u>700</u>	<u>800</u>	<u>900</u>	<u>1000</u>
<u>Inches</u>										

<u>Diameter</u>	<u>Length of Pipe, Feet</u>									
	<u>Inches</u>	<u>100</u>	<u>200</u>	<u>300</u>	<u>400</u>	<u>500</u>	<u>600</u>	<u>700</u>	<u>800</u>	<u>900</u>
2	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.10
4	0.04	0.08	0.13	0.17	0.21	0.25	0.29	0.34	0.38	0.43
6	0.10	0.19	0.28	0.38	0.47	0.57	0.66	0.75	0.85	0.94
8	0.17	0.34	0.50	0.67	0.84	1.00	1.17	1.34	1.51	1.68
10	0.26	0.52	0.79	1.05	1.31	1.57	1.83	2.09	2.36	2.62
12	0.38	0.75	1.13	1.51	1.89	2.26	2.64	3.02	3.39	3.77
16	0.67	1.34	2.01	2.68	3.35	4.02	4.69	5.36	6.03	6.70
18	0.85	1.70	2.55	3.39	4.24	5.09	5.94	6.79	7.63	8.48
20	1.05	2.09	3.13	4.19	5.24	6.28	7.33	8.38	9.42	10.5
24	1.45	2.90	4.35	5.80	7.25	8.70	10.2	11.6	13.1	14.5

- B. Disinfection shall be by adding calcium hypochlorite granules. This process consists of placing calcium hypochlorite granules in the pipe sections as they are constructed. The pipe shall be filled with water to remove all air and flushed to remove particulates.
- C. After 24 hours, the residual chlorine shall be at least 100 mg/l or the Contractor shall re-chlorinate the line. Once the test passes, the Contractor shall flush the chlorine out of the line at a rate not less than 2.5 feet per second. Once the line is flushed, the City will check the chlorine residual to insure that it is in the range from 1.0 to 2.0 mg/l.
- D. The Contractor shall allow the line to set for a period of 48 hours without adding additional chlorine or flushing water through the system.
- E. The City shall take water samples after the 48-hour period for two (2) consecutive days and test for bacteriological quality in conformance with Oklahoma Department of Environmental Quality (ODEQ) criteria.
- F. If the samples from the line do not pass, the Contractor will flush the line and add additional chlorine.
- G. If the samples in the line pass then the Contractor will flush the line completely and make sure that all valves are open. Once opened, the Contractor shall not operate any valve without authorization of the Engineer.

**2208.6 Required Results**

- A. Pressure: A drop of 5 psi or less after 2 hours.
- B. Leakage: Meet the requirements of Section 2208.4.
- C. Bacteria: All samples must meet the required Oklahoma Department of Environmental Quality (ODEQ) criteria.

**2208.7 Inspection Requirements**

- A. The City project inspector shall be given five (5) day notice in order to be on-site to observe all pressure testing. The project inspector or Water Division representative will take samples for testing. Any cost for testing will be paid by the Contractor or Developer.

**2209 APPLICABLE STANDARD DETAILS**

WAT-01	Water Pipe Installation
WAT-02	Installation of 3-Way Fire Hydrant
WAT-03	Short Water Service
WAT-04	Long Water Service (Single)
WAT-05	Long Water Service (Double)
WAT-06	Water Service Line Street Crossing
WAT-11	Water Line at Cul-de-Sac
WAT-12	Blowoff Hydrant
WAT-13	Air Relief Valve and Vault
WAT-14	Valve Box Detail
WAT-15	Pipe Encasement & Cradles
WAT-16	Restrained Joint Detail

END OF SECTION