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SECTION 2300

SANITARY SEWER SYSTEMS

2301 GENERAL REQUIREMENTS

2301.1 Scope

This specification is to govern all work, materials, and testing for the installation of gravity sanitary sewers, pressure pipelines and related items complete, including manholes, junction chambers, diversion chambers, house services, and miscellaneous concrete structures.

2301.2 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.

2301.3 Codes, Specifications, and Standards

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

- A. Water Pollution Control Construction Standards, Rule No. 655, ODEQ
- B. Wastewater Collection Systems Management, MOP 7, WEF
- C. Code of Ordinances, City of Owasso

2301.4 Submittals

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

- A. Manufacturer's Certificate of Compliance certifying compliance with the applicable specifications and 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, and precast concrete units.

2301.5 Quality Assurance

- A. Performance tests: The Contractor shall test all gravity sewers constructed. The Contractor shall constantly check horizontal and vertical alignment. Testing for horizontal and vertical deflection in the case of non-rigid pipe, sewer water tightness testing in the case of all gravity sewers and hydrostatic testing of pressure pipe (force main) shall be as specified in Subsection 2309.

- B. Line and grade requirements: The Contractor shall provide assurance to the Engineer that the sewer is laid accurately to the required line and grade as shown on the drawings. The Contractor shall utilize a laser beam instrument or another acceptable method to lay and check the alignment and grade between manholes. Before proceeding with the next section of sewer, the last section shall be checked for proper line and grade. Variations from a uniform line and grade as shown on the drawings and described below shall be cause for the line to be rejected.

2301.6 Relation to Water Mains

- A. Sanitary sewer lines shall be constructed at least 10 feet horizontally and 2 feet vertically from any existing or proposed water main. The separation shall be measured from exterior wall of sewer pipe to exterior wall of water pipe.
- B. When it is impossible to obtain proper horizontal and vertical separation as stipulated above, the sewer shall be designed and constructed equal to AWWA C900, DR18, water pipe; SDR 32.5 sewer pipe; ductile iron; or sleeved. The line shall be pressure tested to assure water tightness prior to backfilling.
1. Where sewer lines cross existing lines with less than 2 feet of separation, the pressure rated pipe shall extend 10 feet upstream and downstream of where the sewer line crosses the water lines.
 2. Where sewer lines parallel existing water lines with less than 10 feet of horizontal separation, the pressure rated pipe shall be used until the separation is greater than 10 feet or the vertical separation is greater than 8 feet, with the sewer line being the deeper of the two lines.

2302 PRODUCTS

2302.1 Gravity Sewers 18 Inches and Larger

- A. Ductile iron pipe (DIP):
1. Ductile iron pipe shall only be allowed under special circumstances and require written approval from the Engineer. Pipe and fittings shall conform to the requirements of ANSI/ASTM A746, Ductile Iron Gravity Sewer Pipe.
 - a. Thickness class requirements of ductile iron pipe to be used in conveyance of sanitary sewage by gravity shall be determined by methods specified in ANSI/ASTM A746. The thickness of the pipe shall be determined by the laying conditions and the trench loads.
 - b. Outside surfaces of the pipe and fittings shall be bituminous coated complying with ANSI/AWWA A21.51/C151 and ANSI/AWWA A21.10/C110.
 - c. Inside surfaces of all pipe, fittings and adapters shall be lined with Protecto 401 Ceramic Epoxy Lining. Minimum thickness of coating to be 40 mils.
 - d. Ductile iron pipe joints shall be push-on type conforming to ANSI/AWWA A21.11/C111, latest revision. Fittings shall be cast iron and shall comply with

ANSI Specification A21.10, latest revision, with mechanical joints for 150 psi working pressure.

B. Polyvinyl chloride (PVC) pipe:

1. PVC sewer pipe and fittings shall conform to the current revision of ASTM 3034, ASTM2241 or ASTM F679, Type T-1A and T-2B.
2. The pipe shall be made of PVC plastic having cell classification of 12454-B, 12454-C or 12364-C and fittings shall be made of PVC plastic have cell classifications of 12454-B,12454-C or 13343-C as defined in ASTM Designation D 1784.
3. Ribbed PVC pipe may be used with prior approval of the Engineer. Ribbed pipe shall conform to ASTM F794 and UNI-Bell specification UNI-B-9 or ASTM F949-93a.
4. Pipe shall meet requirements for flattening, impact resistance, stiffness, joint tightness, and extrusion quality as specified in ASTM F679.
5. Joints shall be the integral bell type gasketed joint designed so that when assembled, the elastomeric gasket inside the bell is compressed radially on the pipe spigot to form a positive seal. The joint shall be so designed to avoid displacement of the gasket when installed in accordance with manufacturer's recommendations.
6. Pipe entering a manhole shall be equipped with a manhole waterstop gasket as supplied by the manufacturer firmly clamped around the pipe at the manhole. The exterior penetrations shall be grouted. Manhole systems with flexible entry seals shall not warrant the use of water stop gaskets.

2302.2 Gravity Sewers 15 Inches or Smaller

A. Ductile iron pipe:

1. Ductile iron pipe shall only be allowed under special circumstances and require written approval from the Engineer. Pipe and fittings shall conform to ANSI/AWWA A21.51/C151 or A21.53/C153. Pipe greater than 18 inches in diameter shall be ANSI/AWWA A746.
2. Joints on ductile iron pipe shall be push-on type conforming to ANSI/AWWA A21.51/C151. Fittings shall be gray iron or ductile iron and shall comply with ANSI Specification A21.10, with push-on mechanical joints for 150 psi working pressure.
3. Outside surfaces of the pipe and fittings shall be bituminous coated complying with ANSI/AWWA A21.51/C151 and ANSI/AWWA A21.10/C110.
4. Inside surfaces of all pipe, fittings and adapters shall be lined with Protecto 401 Ceramic Epoxy Lining. Minimum thickness of coating shall be 40 mils.
5. Polyethylene tube encasement shall be as specified in Water System Paragraph 2202.1A.8.

B. Polyvinyl Chloride Pipe:

1. Polyvinyl chloride pipe and fittings shall conform to ASTM D3034 SDR 35, Type PSM. Pipes installed with burial depths exceeding 12 feet shall be SDR 26. For burial depths greater than 22 feet, C900 water pipe is required. See Standard Detail SAN-02. Pipe under commercial/industrial collector streets shall be sleeved.
2. Joints on PVC sewer pipe shall be the integral bell type gasketed joint designed so that when assembled the elastomeric gasket inside the bell is compressed radially on the pipe spigot to form a positive seal. The joint shall be so designed to avoid displacement of the gasket when installed in accordance with manufacturer's recommendations. The joint shall comply with the physical requirements of ASTM D3212, and the gasket shall be the only element depended upon to make the joint flexible and watertight.
3. All PVC pipe entering a manhole shall have a manhole waterstop gasket as supplied by the manufacturer firmly clamped around the pipe at the manhole. The exterior penetrations shall be grouted. If flexible entry type manhole system is used, the waterstop gasket is not required.

2302.3 Fittings

- A. Fittings such as wyes, tees and bends shall be made in such a manner as will provide strength and water tightness at least equal to the class of the adjacent main line pipe to which they are jointed and shall conform to all other requirements specified for pipe of corresponding class and internal diameter. Joints shall be of the same type as used on the adjoining pipe.

2302.4 Force Mains

A. Piping:

1. Force main pipe and fittings shall be PVC or DIP, as described in Water System Subsection 2202, except as follows:
 - a. Inside surfaces of DIP piping shall be lined with Protecto 401 Ceramic Epoxy Lining. Minimum thickness of coating shall be 40 mils.
 - b. PVC pipe shall meet the requirements of AWWA C900, Class 150, DR 18 unless otherwise required by the Engineer.

B. Valves:

1. Exposed valves in vaults or manholes shall be equipped with flanges that conform to the requirements of ANSI/ B16.1, Class 125. Buried valves shall be equipped with mechanical joint ends conforming to the requirements of ANSI C110/A21.10.
2. Eccentric type plug valves:
 - a. Plug valves shall be non-lubricated eccentric type with resilient faced plugs.

- b. Port areas of 4-inch to 20-inch diameter valves shall be at least 80% of full pipe area. Port area for 24-inch and larger valves shall be at least 70% of full pipe area.
 - c. Valve seats, valve plug stem sleeves and plug stem bushings shall be fabricated of materials which are corrosion and abrasive resistant. The corrosion resistance shall be such that exposure over a period of five years to domestic wastewater, industrial wastewater, domestic sludges or industrial sludges containing sulfuric acid, hydrochloric acid, acetic acid, mineral oils, vegetable oils, polymers, esters or acetones shall not result in sufficient corrosion to interfere with the serviceability of the plug valve.
 - d. Seals shall be capable of being replaced while the line and valve remain in service, if under submerged conditions, thereby eliminating the need to take process units out of service.
 - e. All exposed nuts, bolts, springs, and washers shall be stainless steel. Means of actuation shall be by lever, gear actuator, tee wrench, extension stem, or floor stand, as indicated.
 - f. All plug valves shall be equipped with an underground operator.
 - g. Plug valves 10 inches and larger in diameter shall be equipped with gear actuators. All gearing shall be enclosed and lubricated with seals provided on all shafts to prevent entry of dirt and fluid into the actuator. All shaft bearings shall be furnished with permanently lubricated bronze bearing bushings. Actuator shall clearly indicate valve positions, and an adjustable stop shall be provided to set closing torque. Valve stop shall be positive and shall not move due to repeated operation of the valve.
 - h. Plug valves shall be DeZurik Series 100, Homestead Ballcentric, Dresser Style 800, X-Centric, or approved equal.
3. Gate valves:
- a. Gate valves 2 inches and larger in diameter shall be iron body, rising stem, resilient seat gate valves.
 - b. Valves shall meet the requirements of ANSI/AWWA C509.
 - c. Valve opening direction shall be consistent with operation of existing valves in the utility in which the valves are installed, unless otherwise directed by the Engineer.
 - d. Gate valves larger than 12 inches diameter shall be gear actuated. Minimum gear ratio for valves 14 to 24 inches shall be 2:1; 3:1 for valves 30 to 36 inches; and 4:1 for valves 42 to 48 inches. Valve gears installed in the ground shall be enclosed in an extended waterproof grease case attached to the bonnet of the valve. Construction of the valve shall allow re-packing of the stuffing box without disassembly of the grease case. The valve stem, stuffing box and seals

shall be protected by a suitable frame to prevent contact of these three to the surrounding soil.

- e. Gate valves shall be manufactured by Mueller, U.S. Pipe, American-Darling, M&H, Clow or approved equal.

4. Check valves:

- a. Check valves 3 inches and larger in diameter shall conform to and be tested in accordance with the AWWA Standard for Swing-Check Valves for Ordinary Water Works Service, AWWA designation C508. They shall be horizontally mounted, single disc, swing type with a full-diameter passage providing minimum pressure loss.
- b. Buried valves shall be of the non-slamming type with an internal lever and spring. Exposed valves shall be external lever and spring. 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).
- c. Check valves shall be manufactured by Mueller, U.S. Pipe, American-Darling, M&H, Clow or approved equal.
- d. Check valves 2-1/2 inches in diameter and smaller shall conform to the requirements of Federal Specification WW-V-51a for Class "A" 125 pound Bronze Check Valve (for land use), Type IV.

5. Sewage air and vacuum valves:

- a. Sewage combination air and vacuum valves shall be installed at all high points shown on the plans. Air/vacuum valves shall be Apco, Val-Matic, BWA, Crispin or approved equal.

C. Valve boxes:

1. Valve boxes for plug 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 size for the valve served. Each valve box assembly shall be the proper length for the valve served. The minimum thickness of metal shall be 3/16-in. Valve box covers shall have wording, "Sewer", cast in it. Valve box manufactures shall be Tyler or approved equal.

D. Air and vacuum valve chambers:

1. Air and vacuum valve chambers shall be 4-foot diameter precast concrete manhole barrels with precast concrete flat slab tops. Precast manhole barrels shall meet the requirements of ASTM C478.

2. Air and vacuum valve chamber access frames and cover shall be in accordance with Standard Detail WAT-13.
- E. Tracer wire and warning tape: A #12 copper wire shall be placed on top of PVC force mains and attached to manhole/vault rings. A green and silver detection tape with the words "Sanitary Sewer Line" shall be placed 6 inches over all gravity lines.

2302.5 Manholes and Other Structures

- A. Materials for manholes, junction chambers, diversion chambers, and miscellaneous concrete structures shall comply with the following:
 1. Precast manholes: Precast manhole sections shall conform to requirements of ASTM Specification C478.
 2. Concrete: Concrete for precast manhole sections shall be 3,000 psi concrete. Monolithic manholes shall use 4,000 psi concrete. Ready-mix concrete shall conform to ASTM C94 Alternate 2. Maximum size of aggregate shall be 1-1/2 inches. Slump shall be between 2 and 4 inches.
 3. Forms: Forms for chamber and structures shall be plywood or other accepted material. Steel forms shall be used for monolithic concrete manholes.
 4. Reinforcing steel: Reinforcing steel shall conform to ASTM A615, Grade 40 deformed bars, or ASTM A616, Grade 40 deformed bars.
 5. Mortar: The materials for mortar shall conform to the following:
 - a. Sand - ASTM C33, passing a No. 8 Sieve.
 - b. Cement - ASTM C150, Type 1.
 - c. Water - shall be potable.
 - d. Aggregate - ASTM C144
 - e. Hydrated Lime - ASTM C207, Type S
 6. Precast manhole joints: All joints shall be fully sealed and waterproofed. Rubber gaskets for precast concrete manhole sections shall meet the requirements of ASTM C443. The gasket shall be the sole element depended upon to make the joint flexible and watertight. Precast manholes designed not to use rubber gaskets will not be accepted.
 7. Pipe seals: The manufacturer of the precast manholes shall provide core-drilled or formed openings that is a smooth, uniform, cylindrical hole of the proper size to accommodate a resilient connector meeting the requirements of ASTM C923 for all sewer pipes entering and leaving the manhole. The resilient connectors shall be either Press-Seal Gasket Corp., which provides PSX gasket or Press Wedge II; or similar flexible manhole sleeves furnished by Kor-N-Seal by NPG Systems, Inc.; A-Lok or approved equal.

8. Water proofing: After proper curing the interior and exterior surfaces of each manhole shall be thoroughly coated with Kop-Coat Bitumastic 300-M or approved equal. Final dry mils thickness shall be a minimum of 12 mils.
9. Manhole castings: Manhole castings shall be of good quality cast iron and/or ductile iron, conforming to ASTM Designation A48. Castings shall have a total weight of not less than 380 pounds and shall conform to the design of the manhole casting as shown on the standard detail sheet. Castings shall have three bolt holes equally spaced around base of frame and shall be securely anchored to cone section to provide a water tight fit with three 3/8-inch stainless steel bolts and expansion shields. Unless specifically designated otherwise, manhole castings shall be the non-locking type.
10. Manhole ring seal: A bitumastic sealer shall be used to seal manhole rings to the new manhole cones. The material shall meet Federal Specifications SS-S-00210A. Seal shall be "Ram Neck" as manufactured by K. T. Snyder Company, Inc. or approved equal.
11. Non-shrink grout: Non-shrink grout shall be Master Builders "Embeco", Sonneborn "Berrolith G-DS" or approved equal.
12. Rain guards: Rain guards to be installed on each manhole shall be manufactured by Fosroc-Preco Industries, South West Packing and Seals, Inc. or approved equal.
13. Special construction: Any other special manholes, junction chambers, diversion chambers, and miscellaneous concrete structures shall be constructed as detailed on the drawings.

2302.6 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-in	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>
19.0 mm 3/4-in	40-100%
9.5 mm 3/8-in	30-75%
4.75 mm 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 2,500 psi at 28 days.

2303 SITE PREPARATION

2303.1 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.

2303.2 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. Proposed sanitary sewer lines crossing existing roadways, sidewalks, 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 where necessary and permitted the removal of trees, shrubs, brush, crops, and other vegetation within the limits of the easements (right-of-way) or as may be provided for in licenses, permits and agreements. 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 6 inches in diameter and greater when measured at a point 3 feet above the ground surface. If trees can be saved by trimming, this shall be done 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. Notification will allow property owners to salvage any 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 backfill has stabilized.
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 removed fencing. 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 prior to construction unless otherwise specified in any Special Conditions. The Contractor is and shall be solely liable for the straying of any animals protected or corralled or other damage caused by any fence so removed.
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 comers or 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 obstruction:

1. Where existing utilities and service lines are to be encountered, the Owner thereof 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 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.

2304 SEWER LINE CONSTRUCTION

2304.1 General

- A. Scope: Sewer 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 sewer line; and other appurtenant work.
- B. 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.
- C. Sewer alignment: The alignment, depth, and pipe subgrades of all sewer trenches shall be determined by laser beam or other electronic equipment.
- D. 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 sewer trench.
- E. 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.

- F. 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.
- G. 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.

2304.2 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 so 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 SAN-01.

2304.3 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 initial backfill has been installed.
- 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.

2304.4 Trench Dewatering

- A. Contractor shall maintain a dry a 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 sewers are being constructed. All water shall be removed from such excavation in a manner that will not damage property or soften pipe bedding.

2305 INSTALLATION OF SEWER PIPE

2305.1 General

- A. Scope: This section governs construction methods and procedures for the installation of gravity and pressure pipelines and appurtenances. All pipe shall be installed in accordance with the pipe manufacturer's recommendations, except as modified herein. Exceptions between sewer and pressure lines are noted.
- B. All sanitary sewer lines located under commercial/industrial streets shall be sleeved.
- C. 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 an alternate plan to the Engineer for review for the pipe or pipe of sufficient strength to provide safe supporting strength.

- D. Pipe handling: 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.
- E. 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.
- F. Pipe inspection: All rejected pipe and fittings shall be marked and removed from the project site at no cost to the Owner. 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.
- G. 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.
- H. Pipe laying: All pipe laying shall begin at the lowest manhole and proceed upstream. Pipe bells shall be laid upstream, with the spigots being inserted into the bells.
- I. Alignment: Unless otherwise required, all sewer pipe shall be laid straight between manholes, excavating bell holes for each pipe joint. In special cases, curvature shall be allowed. 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.
- J. 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.
- K. 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.
- L. 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.
- M. 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.

- N. 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.

2305.2 Jointing Pipe

- A. The Contractor shall inspect each pipe joint for gaskets, deformations and cracks before installation.
- B. 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.
- C. Pipe spigot and bell shall be coated with a manufacturer recommended lubricant for jointing the PVC pipe.
- D. 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.
- E. The Contractor shall not stab the joint by swinging the spigot into the bell or hammer the pipe.
- F. The Contractor shall backfill the joints as soon as they have been made. 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.

2305.3 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 SAN-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 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 proper bedding material shall be placed from the spring line of the pipe to a minimum of 6 inches above the pipe. Six-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.

2305.4 Tees, Wyes, and Building Service Lines

- A. Tees, wyes and saddles shall be installed as shown on the drawings for pipe sizes 8 inches through 16 inches diameter. Tees, wyes and saddles shall not be installed in pipe sizes greater than or equal to 18 inches in diameter.
- B. Building service lines shall be installed with a straight alignment and at a uniform grade not less than one (1) percent unless otherwise specified and shall be embedded with granular bedding material. Service line depth shall be based on service line stubout 6 inches below surface, 1% minimum grade and a minimum of 26 inches from finished floor elevation to top of service line. When a building service line grade exceeds twenty (20) percent, pipeline anchors shall be installed with the first anchor not more than 12 feet nor less than 3 feet upstream of the tee or wye.
- C. The Contractor shall maintain an accurate record for submittal to the Engineer of location, size and direction of each tee, wye, saddle and/or location, size and length of each building service line. Locations shall use the pipeline stationing as shown on the plans or the distance from the first downstream manhole.

D. Service lines shall be terminated and capped as shown on drawings.

2305.5 Pressure Sewers (Force Main)

- A. All pressure sewers shall be installed with required pipe embedment to depths shown on the plans (to a continuous slope when not shown) and in accordance with Subsection 2205.
- B. Accepted air relief valves shall be installed at all locations shown on the plans or where required by the Engineer.
- C. The Contractor shall install restrained joints to accommodate thrust and testing forces at pipe deflections, bends, tees, and plugs in accordance with Paragraph 2205.7.
- D. All force mains located under paved areas shall be sleeved.

2305.6 Anchors

A. Pipelines shall be anchored in accordance with the following table:

<u>Percent of Grade</u>	<u>Center to Center Max. Spacing (Ft)</u>
20 - 35	36
35 - 50	24
50	16

B. The anchor shall be of concrete or other material accepted by the Engineer. Concrete anchors shall have a minimum thickness of 12 inches. The anchor shall extend not less than 120 inches into undisturbed earth on the sides and bottom and 12 inches above the top of pipe. In incompressible material, the above dimensions may be 6 inches each side and bottom. The anchor shall support a joint fitting.

2305.7 Pipe Coupling of Dissimilar Materials

The connection of pipes of different materials shall be made using accepted transition coupling and shall provide a permanent and watertight connection that will withstand the hydrostatic test pressure.

2306 BACKFILL

2306.1 General

- A. All trash and debris shall be removed from the pipeline excavation prior to backfilling.
- B. All sewer 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 2 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. 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.
- D. 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.
- E. Commercial sand backfill shall not be used for gravity sewer lines.
- F. In areas marked "garden" or "flower garden", the original topsoil shall be replaced to original elevation and depth. Minimum depth shall be 12 inches.
- G. 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 2 feet of backfill has been placed over the pipe. Three feet of cover shall be placed over the pipe before a hydro hammer is used.
- H. Backfill shall not be placed when material contains frost, is frozen, or a blanket of snow prevents proper compaction. Contractor shall remove waste material, trees, organic material, rubbish, or other deleterious substances.

2306.2 Backfilling Under Pavement

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

2306.3 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.

2306.4 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.

2307 RESTORATION

2307.1 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. The Contractor will 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.

2307.2 Clean-Up

The Contractor, upon completion of installation and backfill operations, shall prepare the area for final grading including but not limited to the following items:

- A. Clean-up shall follow the backfilling operations as closely as possible.
- B. Excess material shall be removed from the site including material that has washed into the stream beds, storm water facilities, streets, etc.

- C. Tools, equipment and construction material shall be removed except for in designated storage areas along the pipeline route.
- D. Restore surface and sub-surface drainage and provide temporary wash checks where necessary.

2307.3 Finished 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.
- B. Special attention shall be directed to assure surface drainage. The area shall be smoothed by raking or dragging.

2307.4 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 2403.7A.

2307.5 Fences

All existing fencing damaged and/or removed prior to construction shall be restored to a condition equal to or better than which existed prior to construction.

2307.6 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.

2307.7 Trees, Shrubs, and Bushes

- A. Any tree, shrub or bush replaced shall be planted outside the permanent sanitary sewer 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 conditions 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 in thickness 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 D 698:

<u>Area</u>	<u>Cohesive Materials</u>	<u>Cohesionless Materials</u>
Non-Paved	95%	95%
Paved	Not Allowed	95%

(Refer to Standard Details)

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

2308 MANHOLE CONSTRUCTION

2308.1 Excavation

- A. General: Excavation for manholes and special structures shall be governed by this Section and Subsection 2304. Construction shall proceed in a suitable and orderly manner minimizing disturbances to the general public.

- B. Depth of excavation: Excavation shall be to the depth required for proper installation of the manhole or structure. In unstable subgrade, the Engineer may require over-depth excavation and backfill with crushed rock. If the Contractor over-excavates the trench due to error, the additional backfill costs are the Contractor's responsibility.
- C. Side clearances: Side clearances outside the manhole and/or structures shall be no greater than to allow for forming, connection of piping, proper application of special coatings, if required, and to permit inspection. When concrete is to be placed directly against excavated faces, excavation shall be sufficiently outside of the manhole or structure to provide not less than 3 inches of concrete cover over the steel reinforcement.
- D. Existing structure: Excavation shall extend a sufficient distance from walls and footings to allow for placing and removal of forms, installation of services and for inspection.

2308.2 Manhole Installation

- A. General: Manhole installation shall be governed by this paragraph and Paragraph 2302.5. Construction shall follow a schedule that provides for an orderly progression of work.
 - 1. Precast bases shall be reinforced in accordance with ASTM C478 and have a minimum base thickness of 8 inches.
 - 2. Precast bases shall be installed on a maximum of 6 inches of crushed rock. Depths exceeding this amount shall be filled with concrete.
 - 3. Cast-in-place bases shall have a minimum thickness of 8 inches. When poured-in-place bases are used, the invert shall be poured monolithically with the base. The bottom wall sections shall be embedded in the base section a minimum of 3 inches. The bottom precast wall section shall not be set upon a previously poured base. Solid concrete blocks shall be used for supporting and leveling the wall section prior to pouring the base.
- B. Inside dimensions: The minimum diameter of the manhole barrel shall be 4 feet.
- C. Precast manholes:
 - 1. Delivery: Precast concrete components shall not be delivered to the job until representative concrete control cylinders have attained at least 80 percent of the specified minimum design strength.
 - 2. Inspection: Precast concrete shall be inspected when delivered. Rejection of defective or cracked precast concrete components shall be in accordance with ASTM C478.
 - 3. Construction: Precast sections shall be cleaned of all dirt, grass, and other deleterious matter. Seal each joint (including adjustment rings and castings) with a double bead of performed bitumastic joint sealant. Lift holes shall be patched with non-shrink grout.
- D. Cast-in-place manholes:

1. Wall thickness: Wall thickness shall conform to the dimensions as shown on the drawings.
2. Construction: Reinforcement steel shall be placed as shown on the drawing. Tie-holes shall be patched with non-shrink grout. Wall sleeves, where required, shall be installed as shown on the drawings. Water stops shall be installed at the wall and slab connection and shall be of the size, thickness and material as shown on the drawings.
3. Waterproofing: Interior protective coatings, where required, shall conform to the material specifications. Application shall conform to the manufacturer's recommendation.
4. Top slabs: Thickness shall conform to the dimensions and reinforcement steel shall be placed as shown on the drawings.
5. Pipe stubs: Stubs shall be installed at the locations, angles, elevations and of the materials as shown on the drawings. A water-tight removable stopper shall be installed in each pipe stub. Pipe stubs shall be installed so that a pipe joint will be 24 inches or less from the outside manhole wall.
6. Inverts: Inverts shall be structural concrete and steel-troweled to produce a dense, smooth finish. The invert channel shall be "U" shaped in cross section and extend upward one-half of the inside pipe diameter. Smooth transitions shall be formed for pipes of different sizes, elevation and bends. The invert bench shall be sloped to drain.
7. Top elevation: The finished top elevation of manhole rims shall conform to the following unless otherwise shown on the plans or directed by the Engineer.
 - a. In paved or future paved areas, the top of the rims shall conform to the slope of the pavement and be 1/8 inch below the finished pavement elevation. The top shall have sufficient reinforcement to accommodate anticipated traffic loads.
 - b. In non-pavement areas, the top of the rim shall be not more than 6 inches above the surrounding ground nor less than the sod's upper root limit. The final elevation shall be at a point where water will not pond over the manhole cover.
 - c. In flood prone, non-paved areas, the Contractor shall extend the manhole rims to the elevation shown on the plans (one-foot above the 100-year flood or install bolt-down lids with gaskets and water-proof inserts.
 - d. In flood prone, paved areas, the Contractor shall install bolt-down lids with gaskets and waterproof inserts.
8. Manhole Adjustment: All new manholes requiring adjustment will be provided with adjustment ring(s) underneath the metal rim as shown on the Standard Details. The joints shall be sealed with preformed bitumastic sealant. The maximum allowable adjustment distance between the top of the cone and the bottom of the casting shall be 12 inches. If the top of an existing manhole is required to be raised to an elevation that will exceed the maximum adjustment distance or lowered more than

the adjustment rings will allow, all vertical adjustments shall be made to the barrel of the manhole.

9. Metal rims: Castings shall be installed with the mud ring inserted inside the manhole opening and resting on a minimum of two rows of preformed bitumastic sealer. Bolt-down lids and rims shall be held in place as shown on the plans.

2309 TESTING

2309.1 Sanitary Sewer Force Main Pressure Testing

- A. Preparation: Prior to starting the test the Contractor will flush the line of all dirt and air. This shall be coordinated with the project inspector and/or a Wastewater Division representative of the Public Works Department.
- B. Procedure:
 1. The Contractor shall fill the line with water and bring the line up to test pressure of 100 psi and the line must maintain that pressure for a period of 30 minutes with not more than a 5 psi drop.
 2. If the line does not pass the pressure test, then the Contractor shall repair the lines so that it will met the test requirements.
- C. Inspection requirements: The project inspector shall be given sufficient notification in order to be on site to observe all pressure testing.

2309.2 Sanitary Sewer Gravity Lines Testing

- A. Preparation: The Contractor will ensure that the line is clean and all debris has been removed from manholes. Debris removal shall be by using a sewer cleaning ball or high velocity jet. The Contractor will coordinate with the project inspector to have the lines deflection tested with a mandrel prior to pressure testing.
- B. Deflection test: Deflection tests shall be performed on all PVC sewer lines. After the sewer line has been in place and the backfill has settled for 30 days, the Contractor shall hand pull the appropriate sized mandrel (sized for a 5% deflection) through the line while the project inspector observes. Sewer line sections not passing the mandrel shall be considered deflected and shall be excavated and repaired. The mandrel exterior diameter shall be 95% of the base inside pipe diameter. The sizes of mandrels needed for PVC sewer line 6 inches through 30 inches are listed in the table below:

TEST FOR 5% DEFLECTION

SDR 35

ASTM D 3034 PIPE

ASTM F 679 PIPE

Nominal Size (inches)	Inside Dia. (Inches)	Mandrel Diameter	Nominal Size (Inches)	Inside Dia. (Inches)	Mandrel Diameter
6	5.742	5.46	18	16.976	16.13

TEST FOR 5% DEFLECTION

8	7.665	7.28	21	20.004	19.00
10	9.563	9.08	24	22.480	21.36
12	11.361	10.79	27	25.327	24.06
15	13.898	13.20	-	-	-

TEST FOR 5% DEFLECTION

SDR 26

ASTM D 3034 PIPE

ASTM F 679 PIPE

Nominal Size (inches)	Inside Dia. (Inches)	Mandrel Diameter	Nominal Size (Inches)	Inside Dia. (Inches)	Mandrel Diameter
6	5.612	5.33	18	16.586	15.76
8	7.488	7.11	21	19.545	18.57
10	9.342	8.87	24	21.964	20.87
12	11.102	10.55	27	24.744	23.51
15	13.575	12.90	30	28.763	27.32

C. Air pressure test:

1. The Contractor shall plug both ends of the line and pressure the line to 4.0 psi.
2. When the line is at pressure the project inspector shall observe the pressure gage for the time required in the table below:

Pressure Test

Pipe Dia. (in)	Min. Time (min: sec)	Length for Min. Time (ft)	Time for Longer Length (sec)	100 ft.	200 ft.	300 ft.	400 ft.	500 ft.
4	3:46	597	0.380L	3:46	3:46	3:46	3:46	3:46
6	5:40	398	0.854L	5:40	5:40	5:40	5:42	7:07
8	7:34	298	1.520L	7:34	7:34	7:36	10:08	12:40
10	9:26	239	2.374L	9:26	9:26	11:52	15:49	19:47
12	11:20	199	3.418L	11:20	11:24	17:05	22:47	28:29
15	14:100	159	5.342L	14:100	17:48	26:42	35:36	44:31
18	17:00	133	7.692L	17:00	25:38	38:27	51:16	64:06
21	19:50	114	10.470L	19:50	34:54	52:21	69:48	87:15
24	22:40	99	13.674L	22:47	45:34	68:22	91:10	113:57

3. If the line does not meet test requirements, the Contractor shall make necessary repairs and retest.
4. When the test is completed, the Contractor shall remove all plugs and ensure the line is clear.

D. Required results: The mandrel must pass through the line. The City may test or contract for test of pipe alignment by use of a video camera.

- E. Inspection requirements: The project inspector shall be given sufficient notification in order to be on-site to observe all testing.
- F. Alternative inspections: In special circumstances and with approval by the Engineer, the following alternative tests may be substituted for the pressure test detailed above.
 - 1. Joint testing: Only 24 inches and larger diameter lines.
 - 2. Exfiltration test: In the event a section of line is in dry ground conditions above the water table, an exfiltration test may be used. The line shall be filled with water and pressurized so that the maximum pressure at the lowest end does not exceed 100 psi. The allowable exfiltration is 50 gallons per inch of pipe diameter per mile of pipe per day.
 - 3. Infiltration test: In the event a section of line is below the groundwater table, an infiltration test may be required. The allowable infiltration of a sewer line is 50 gallons per inch of pipe diameter per mile of pipe per day, including manholes.

2309.3 Sanitary Sewer Lines Dye Testing

- A. Requirements: In specific cases determined by the Engineer, this test is used for gravity sanitary sewer line replacement projects. Normally, this test may be required for a City contract or work performed by Public Works Department crews.
- B. Preparation: The Contractor shall ensure that the line is clean and all debris has been removed from manholes. The Contractor will prepare the water source with sufficient sewer line marking dye to give the water a highly visible color.
- C. Procedure:
 - 1. A rigid pipe connected to a water source shall be used to inject dye colored water, under pressure, into the material surrounding the gravity sewer.
 - 2. The dye injection shall start 100 feet upstream of the lowest manhole and will proceed upstream in 100 feet increments. The dye will be injected until, in the opinion of the inspector, the area is saturated.
 - 3. Dye shall be injected in the vicinity of all service taps.
 - 4. The inspector will observe the downstream manhole and, if dye appears in the manhole, the line has failed the test. If the line fails the test, the Contractor shall make necessary repairs and retest.
- D. Required results: Absence of dye entering the line.
- E. Inspection requirements: The project inspector will be on site to observe all dye testing.

2309.4 Manhole Inspection/Testing

- A. Preparation: The Contractor shall ensure that the manholes to be inspected are clean, properly grouted, and that the appropriate rings and lids have been installed.

B. Procedure:

1. The inspector shall visually inspect each manhole for compliance with the standards.
2. A vacuum test shall be performed by introducing a vacuum 100 inches Hg after the holes have been plugged. If the vacuum pressure drop exceeds 1 inch Hg in one minute, the manhole has failed the test.
3. If a dye test is required, it shall be prepared in the same manner as a line test except:
 - a. The dye injection shall be at 4 equally spaced locations around the manhole.
 - b. Dye shall be injected until, in the opinion of the inspector, the area is saturated.
 - c. The project inspector shall observe the manhole for 30 minutes and if dye appears on the walls of the manhole, the manhole has failed the test. If the manhole fails the test, the Contractor shall make necessary repairs and retest.
4. Required results:
 - a. The manhole shall pass the visual inspection.
 - b. The manhole shall pass the vacuum test.
 - c. If a dye test is required, no dye shall appear on the sides of the manhole in 30 minutes.

C. Inspection requirements: The project inspector shall be on site to observe all testing.

2310 APPLICABLE STANDARD DETAILS

SAN-01	Sanitary Sewer Installation
SAN-02	Sewer Pipe Table
SAN-03	Precast Manhole/Drop Manhole
SAN-04	Cast in Place Manhole
SAN-05	Manhole Steps & Invert Details
SAN-06	Manhole Frame & Cover
SAN-07	Sanitary Sewer Manhole Pipe Connector
SAN-08	Water Table Cradle for Flexible Pipe
SAN-11	Lift Station
SAN-12	Sewer Deflection Gage

END OF SECTION

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