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Chapter 8

TECHNICAL SPECIFICATIONS FOR CONVEYANCE SYSTEMS

8.01 General Provisions

The technical specifications contained in this chapter, together with Oregon Department of Environmental Quality and U.S. Environmental Protection Agency standards and any other applicable requirement of the District and City, shall govern the character and quality of material, equipment, installation and construction procedures for gravity flow portions of public sanitary and storm sewer systems.

The requirements in this Chapter apply to both sanitary and storm conveyance systems, except where the provision is indicated as applying to only one type of system.

8.02 Manholes and Structures

8.02.1 Materials

a. Aggregate and Portland Cement

Aggregate and Portland Cement shall meet the standards set forth in ODOT/APWA "Oregon Standard Specifications for Construction 2002", Sections 02690 and 02010 respectively or updated ODOT/APWA Standard Specifications.

b. Concrete

Concrete shall meet the standards set forth in ODOT/APWA "Oregon Standard Specifications for Construction 2002", Sections 00440.

c. Manhole Frames and Covers

1. Sanitary and Storm:

A) Casting shall be tough, close grained gray iron, smooth and clean, free from blisters, blowholes, and all defects, and conform to ASTM A48, Class 30.
B) To ensure flat, true surfaces, all bearing surfaces shall be planed or ground. Covers shall be true and set within ring at all points.
C) Composite watertight and tamper proof frame and covers shall be installed on manholes in all easement and off street areas and on manholes located within the flood plain or along stream corridors.

2. Sanitary-additional requirements:

Frames and covers shall be standard or suburban, solid (2-hole), depending upon the type and location of the manhole and as approved by the District or City.

3. Storm-additional requirements:

Frames and covers shall be standard or suburban, solid, 16-hole or slotted depending upon the type and location of the manhole and as approved by the District or City.

d. Precast Manholes

1. Sanitary and Storm:

Materials for precast concrete manholes shall conform to the requirements of ASTM C478. Minimum wall thickness shall be five inches. Cones shall have the same wall thickness and reinforcement as riser sections. Joints shall be tongue and groove, rubber ring or keylock type. Cones shall be 3' eccentric. Flat Top Manholes may be approved by the District or City when site conditions preclude the use of a Standard Manhole.

2. Sanitary-additional requirements:

Prior to the delivery of any size of precast manhole section to the job site, yard permeability tests shall be conducted at the point of manufacture. The precast sections to be tested shall be selected at random from the stockpile material, which is to be supplied to the project. The sections shall meet the permeability test requirements of ASTM C14.

e. Precast Bases

At the option of the Contractor, precast base sections or manhole bases may be used provided all the details of construction are approved prior to construction.

f. Pipe Stubouts for Future Connections

1. Sanitary and Storm:

Pipe stubouts shall be of the same type as approved for use in the lateral, main, or trunk lines. Strength classifications shall be of the same class as in adjacent trenches. Where two different classes of pipe exist at a manhole, the higher strength pipe will govern strength classification.

2. Sanitary-additional requirements:

Rubber gasketed watertight plugs shall be furnished with each stubout and shall be adequately braced against air test pressures.

3. Storm-additional requirements:

The District or City may require the length of the stubout to be as long as it is deep. Knockouts may be used with District or City approval.

g. Preformed Manhole Gaskets

Gaskets shall be Kent seal No. 2 or Ram Neck conforming to federal specifications SS S 00210 or approved equal.

h. Manhole Steps

Materials shall be plastic with reinforcing bar, a minimum 1/2" Grade 60, meeting requirements of ASTM A615 encapsulated with injection molded copolymer polypropylene with serrated surfaces.

i. Non-shrink Grout

Non-shrink grout shall be Sika 212, Euco N S, Five Star, or CWS approved equal nonmetallic cementitious commercial grout exhibiting zero shrinkage. Grout shall not be amended with cement or sand and shall not be reconditioned with water after initial mixing. Non-shrink grout shall be placed or packed only with the use of an approved commercial concrete bonding agent. Unused grout shall be discarded after 20 minutes and shall not be used.

j. Chimney Seals (Sanitary only)

The internal and external rubber seal and seal extensions shall be as manufactured by Cretex Specialty Products, or CWS approved equal. The sleeves and extensions shall have a minimum thickness of 3/16 inches and shall be extruded from a high-grade rubber compound conforming to the applicable requirements of ASTM C923. The bands used for compressing the sleeve and extension against the manhole shall be fabricated from 16-gauge stainless steel conforming to ASTM A240 type 304, and screws, bolts, or nuts used on this band shall be stainless steel.

k. Manhole Pipe Connector

A flexible connector that is designed to produce a positive watertight connection for pipes entering a precast manhole. The connector shall be manufactured by A. Lok or a CWS approved equal and meet the requirements of ASTM C 923.

l. Concrete Manhole Closure Collar

All grade rings including casting shall be set in a minimum of one inch of non-shrinking grout. The Contractor may pour concrete closure collars within the entire dimensions, as shown on Standard Detail Sheet No. 140,

using approved form materials and or methods. Concrete shall conform to C94 Alternate 2 and shall have a compressive strength of 3000 psi at 28 days.

m. Structure Marker. Posts shall be a minimum of 8 feet in length and shall be 2" galvanized steel, painted orange or as approved by District or City.

8.02.2 Workmanship on Manholes

a. Foundation Stabilization

If, in the opinion of the Engineer unstable material exists that will not support the manhole or other structure, the Contractor shall install geotextile fabric or excavate below grade and backfill with foundation stabilization material.

b. Pipe Connections

1. Sanitary and Storm:

All pipes entering or leaving a manhole shall be placed on firmly compacted bedding. Special care shall be taken to ensure that the openings through which sewer pipes enter the structure are completely watertight by using non shrink grout. All flexible pipes shall be connected to manholes by using PVC sanded bell adapter, Kor-N-Seal boot, or solvent cement and clean sand application according to the manufacturer's recommendations.

2. Storm-additional requirements:

A) Aluminum pipe connections to manholes shall be wrapped where they will be in contact with concrete.
B) Ribbed pipe connections to manholes shall have 2 gaskets in non-shrink grout as shown on detail #030

c. Drop Manholes

1. Sanitary Only:

The maximum fall in a manhole is 12", measured from the existing flowline to the new flowline. When the drop is more than 12", an approved drop connection shall be used.

2. Storm Only:

The maximum fall in a manhole is four feet, measured from the existing flowline to the new flowline. When the drop is more than four feet, an approved drop connection shall be used.

d. Concrete Bases-Poured in Place

The Contractor shall remove water from the excavated area, provide 12 inches minimum layer of compacted 3/4 inch minus of crushed rock for a base, and construct the concrete base so that the first precast manhole section has a uniform bearing throughout the full circumference. There shall be a minimum of eight inches of concrete between the compacted gravel and the lowest invert of the manhole. The Contractor shall deposit sufficient concrete on the base to ensure a 6" min. overlap for watertight seal between base and manhole wall, see detail #020. Twenty four hours shall be allowed to elapse before placing the remaining sections on the base unless otherwise approved by the District or City.

e. Placing Manhole Section

The Contractor shall clean the end of sections of foreign materials and install the preformed plastic gasket in conformance with the manufacturer's recommendations.

f. Manhole Inverts

The Contractor shall construct manhole inverts in conformance with details and with smooth transitions to ensure an unobstructed flow through manhole, and remove all sharp edges or rough sections.

g. Manhole Stubouts

1. Sanitary and Storm:

The Contractor shall install stubouts from manholes for sewer extensions as shown or as required by the District or City. The Contractor shall construct invert channels in accordance with standard drawings. The maximum length of stubouts in manholes shall be 15 feet outside the manhole wall with no connections made to the line. Pipes shall be grouted in precast walls or manhole base to provide watertight seal around the pipes, see detail #030 . The Contractor shall provide compacted base rock as specified to undisturbed earth under all stubouts.

2. Storm-additional requirements:

Knockouts may be used in place of stubouts with District or City approval.

h. Manhole Extensions, Rings, and Covers

1. Sanitary and Storm:

Rings shall be set in a bed of non-shrinking grout with the non-shrinking grout carried over the flange or the ring and shall be set so that tops of covers are flush with the surface of adjoining pavement, or one foot above natural ground, unless otherwise

directed by the District or City. Manholes outside of paved areas may be adjusted to finish grade through the use of preformed plastic gaskets specified in subsection 8.02.1(g). Extensions shall be limited to a maximum height of 27 inches from the center point of the first step to the top of the casting.

2. Sanitary-additional requirements:

The Contractor shall install rings and covers on top of manholes to positively prevent all infiltration of surface or groundwater into manholes.

i. Manhole Taps

Taps into existing manholes shall be core drilled unless approved otherwise by the District or City. All non concrete pipe material used on a manhole tap shall be adapted with a water tight coupling compatible with concrete or approved equal (e.g., sanded manhole adapter, inserted manhole boot). The bonding material used to connect the pipe and/or coupling to the manhole shall be non shrink material that is approved by the District or City to ensure no ground water infiltration occurs.

j. Structure Marker

The District or City may require that structures located outside the right-of-way be marked with the installation of an approved marking post.

8.02.3 Types of Connections

a. Connection to Existing Manholes

The Contractor shall connect sewer lines to existing manholes at locations indicated; provide all diversion facilities and perform all work necessary to maintain flow in existing systems during connection to the manholes; and break out existing manhole bases or grouting as necessary and regrout to provide smooth flow into and through existing manholes. The Contractor shall allow no debris to enter the existing system while making the connection.

b. Manholes Over Existing Sewer Systems

1. The Contractor shall construct manholes over existing sewers at locations shown on plans. All broken edges shall be covered with non-shrinking grout and troweled smooth. The Contractor shall prevent any debris from entering the manhole while breaking into the existing pipe.

2. Final connection to the existing sanitary sewer shall not be made until the system has been tested in accordance with the

requirements of Section 8.05 and is ready for acceptance as outlined in Chapter 2.

3. The Contractor shall construct the new base under the existing lines and the precast sections as specified.

8.03 Catch Basins and Inlets (Storm only)

8.03.1 Materials

a. Aggregate, cement and concrete shall meet the requirements set forth in Section 8.02.

b. Frames, Grates and Covers

All materials shall be flat bar steel (standard grade), cast iron or ductile iron meeting the requirements of ASTM A28 Class 30B.

c. Forms

All exterior surfaces shall be formed with steel or plywood. Other surfaces shall be formed with matched boards, plywood, or other approved material.

d. Metal Reinforcement

All metal reinforcement shall conform to the requirements of ASTM A615, Grade 60, deformed bars.

e. Precast Concrete Units

All precast units shall conform to the same requirements as manholes ASTM C478.

8.03.2 Workmanship

a. Excavation and backfill will conform to the requirements of subsection 7.02.3 Construction.

b. Bedding

The Contractor shall remove all water and debris from ditch area, provide 8 inches minimum layer of compacted 3/4 inch minus crushed rock for a base.

c. Cast in Place

Cast in place catch basins shall have a minimum of 6 inches of concrete between the compacted gravel and the lowest invert. The forms used for

cast in place catch basins shall be tight and well braced. The storm pipe material being used shall extend into the poured concrete of the catch basin. All corners shall be chamfered. Immediately after placement, the concrete shall be consolidated with an approved vibrator. The top surface shall be screed and exposed surfaces troweled to a smooth finish free from marks or irregularities. After forms are removed, the Contractor shall patch any defects in the concrete with approved material.

d. Precast

After the base is prepared the Contractor shall set the precast catch basin to the proper line and grade. The storm pipe material being used shall connect to the precast catch basin.

e. Inverts, Stubouts and Sections

Contractor shall clean the ends of all pipes and sections that come in contact with the catch basin. All inverts, stubouts and sections shall be installed according to the details using a non-shrinking grout, making sure all sharp edges or rough sections are removed, to prevent obstruction of the flow.

f. Catch Basin Steps

All catch basins deeper than four feet, measured from top of frame to flowline, shall have steps.

8.04 Sewer Pipe and Fittings

8.04.1 General

a. Sanitary sewers

Sanitary sewer pipe shall have flexible gasket joints. Joints on all fittings shall be the same as the joints used on the pipe. Caps or plugs shall be furnished with each fitting, outlet, or stub as required with the same type gasket and/or joint in the pipe.

b. Storm sewers

The materials used shall be adequate to carry anticipated dead and live loads within the deflection limits specified by the manufacturer. All pipe and culverts shall have a minimum design service life of 75 years per Oregon Department of Transportation standards. Joints shall be gasketed unless otherwise approved by the District or City.

8.04.2 Materials

Materials shall be the following types or equal when approved in writing by CWS.

a. Concrete Pipe-NRCP/RCP (Storm and Sanitary)

1. Non-reinforced concrete pipe shall conform to requirements of ASTM C14. Unless otherwise specified, pipe shall conform to Class 3 design requirements.

2. Reinforced concrete, non-pressure pipe shall conform to the requirements of ASTM C76 or C655 and shall be of the class specified. Unless otherwise specified, pipe shall meet the design requirements of Wall B. Reinforced concrete low head pressure pipe shall conform to the requirements of ASTM C361.

3. Gaskets shall conform to the requirements of ASTM C443.

4. All concrete pipe shall be at least seven days old before it can be installed if it has been steam cured. If the pipe has not been steam cured, it must cure for a minimum of 21 days prior to use.

b. Ductile Iron Pipe-DIP (Storm and Sanitary)

Ductile iron pipe shall conform to the requirements of ANSI A21.50 1 or AWWA C150 1, cement lined push on joint. The minimum thickness class shall be Class 50 (up through 12 inch diameter pipe) and Class 51 (for 14 inch diameter and larger pipe). Ductile iron pipe and fittings shall also conform to the specifications for line and grade in subsection 8.04.3(a).

c. Polyvinyl Chloride Pipe-PVC (Storm and Sanitary)

1. Type:

A) ASTM 3034 SDR 35 or SDR 26 dia. 4 15"
B) ASTM F 679 SDR 35 dia. 18 24"
C) ASTM C 900; D 1784 DR 18 dia. 4 12"
D) ASTM C-905; D-1784, DR 18 dia. 16-24”

2. Gaskets shall conform to the requirements of ASTM 477 and ASTM 3212.

d. A2000-PVC (Storm only)

All A2000 PVC pipe and fittings shall conform to ASTM F949 specifications.

e. PVC Rib (Storm only)

PW Rib pipe and fittings shall be made of PVC, as defined in ASTM D1784. The pipe stiffness shall correspond with the series as determined in accordance with ASTM D2412. Series 46 and 28 are allowed. Gaskets shall conform with ASTM 477.

f. Polypropylene Pipe (Storm only)

1. Polypropylene pipe shall be corrugated double and triple wall pipe, and shall conform with ASTM F2764, SaniTite HP or approved equal.

2. Polypropylene pipe shall meet the following conditions:

A) Pipe diameters 12 inches to 30 inches must be dual-wall polypropylene.
B) Pipe diameters greater than 30 inches and up to 60 inches must be triple-wall polypropylene.

3. Joints shall be water tight and installed in accordance with manufacturer's recommendations and ASTM D3212, or approved equal.

g. High Density Polyethylene Pipe (HDPE)

1. Polyethylene pipe shall be high density polyethylene (HDPE) compound PE 3408 or PE 4710 and shall conform with ASTM D3350, or approved equal.

2. HDPE shall have a solid wall with a minimum wall thickness of DR 17.

3. Joints shall be leakproof, thermal, butt joints, welded in accordance with the manufacturer's recommendations and ASTM D3261, or approved equal.

h. Corrugated Aluminum-CAP and Corrugated Aluminum Pipe Arches-CAPA (Storm only)

1. Corrugated aluminum pipe and fittings shall conform to the requirements of AASHTO M196, M197 with watertight joints.

2. The connecting bands shall conform to the requirements of AASHTO M196, except the minimum width of bands for 12 inch and larger pipe shall be 12-inches. Minimum width for pipes less than 12-inches shall be 7-inches. The base metal of the connecting bands shall be the same base metal as that of the pipe. The gauge of the connecting bands may be two standard use thicknesses lighter than that used for the pipe, but not less than 0.060 of an inch thick. The band couplers shall be connected with stainless steel bolts of not less than ½ inch diameter.

3. Corrugated aluminum pipe shall not be placed in a ditch in direct contact with hydrating Portland Cement or lime.

i. Fittings

1. General

Tee fittings shall be provided in the sewer main for side sewers. All fittings shall be of sufficient strength to withstand all handling and load stresses encountered. All fittings shall be of the same materials as the pipe unless otherwise approved. Fittings shall be free from cracks and shall adhere tightly to each joining surface. All fittings shall be capped or plugged, and gasketed with the same gasket material as the pipe joint, fitted with an approved mechanical stopper, or have an integrally cast knockout plug. The plug shall be able to withstand all test pressures without leaking, and when later removed, shall permit continuation of piping with joints similar to those in the installed line.

2. Concrete Pipe

Fittings shall be manufactured integrally and be of a class at least equal to that of the adjacent pipe.

3. Ductile Iron

Fittings shall be mechanical or push on of the class as specified. Mechanical joint cast iron fittings shall conform to AWWA C110 and shall be of a class at least equal to that of the adjacent pipe. Push on joint fittings shall be gray iron with body thickness and radii of curvature conforming to ANSI A21.10. The inside diameter of the fittings shall match the inside diameter of the pipe.

4. PVC Pipe

Fittings shall conform to the applicable portions of the following specifications: ASTM D1785, ASTM D2729, ASTM D2466, ASTM 2467, ASTM D3033, and ASTM D3034. Fitting joints shall be the same as the pipe joints.

5. Line Tap Fittings.

Inserta Tee fitting shall be manufactured in accordance with ASTM D3034, and installed with rubber sleeve meeting ASTM F477 specifications, and 9/16-inch wide stainless steel bands meeting series 300 specification. This fitting may be used for gravity flow pipe materials consistent with the manufacturers specifications, e.g., concrete, ductile iron, rib type plastic, PVC, polypropylene. See Standard Detail 530.

j. Grout

Grout shall be Sika 212, Euco N S, Five Star, or approved equal nonmetallic cementitious commercial grout exhibiting zero shrinkage per ASTM C 827 and CRD C 621. Grout shall not be amended with cement or sand and shall not be reconditioned with water after initial mixing.

k. Proof Tests (Sanitary only)

The District or City may require that a joint system be pre-qualified as to the watertightness capability of the joint system. Material and test equipment for proof testing shall be provided by the manufacturer. When approved, internal hydrostatic pressure may be applied by a suitable joint tester. Pipe material and joint assembly may be subject to the following three proof tests at the discretion of the District or City.

1. Pipe in Straight Alignment

No less than three or more than five pipes selected from stock by the District or City shall be assembled according to the manufacturer's installation instructions with the ends suitably plugged and restrained against internal pressure. The pipe shall be subjected to 10 psi hydrostatic pressure for 10 minutes. Free movement of water through the pipe joint wall shall be grounds for rejection of the pipe.

2. Pipe in Maximum Deflected Position

A test section description follows for each pipe material. The pipe shall be subjected to 10 psi hydrostatic pressure for 10 minutes. Free movement of water through the pipe joint or pipe wall shall be grounds for rejection of the pipe.

3. Joints under Differential Load

The test section shall be supported on blocks or otherwise as described for each pipe material. There shall be no visible leakage when the stressed joint is subjected to 10 psi internal hydrostatic pressure for 10 minutes.

A) Concrete Pipe
For deflected position, a position one half inch wider than the fully compressed position shall be created on one side of the outside perimeter. For differential loads, one pipe shall be supported so that it is suspended freely between the adjacent pipes bearing only on the joints. In addition to the weight of the suspended pipe, a test load shall be added as given Table 8-1:

TABLE 8-1
TEST LOADS FOR PIPES UNDER DIFFERENTIAL LOAD
(CONCRETE PIPE)

Pipe Size (Inches)	Load Per Foot Laying Length Up to 4 Feet (Pounds)	Total Load for Pipe 4 Feet and Over (Pounds)
4	650	2,600
6	1,000	4,000
8	1,300	5,200
10	1,400	5,600
12	1,500	6,000
15	1,850	7,400
18	2,200	8,000
21	2,500	10,000
24 and over	2,750	11,000

B) Ductile Iron Pipe
For deflected position, a position 1/2 inch wider than the fully compressed section shall be created on one side of the outside perimeter. For differential loads, one of the pipes shall be supported so that it is suspended freely between adjacent pipe bearing only on the joints. A force shall be applied per Table 8-2 along a longitudinal distance of 12 inches immediately adjacent to one of the joints:

TABLE 8-2
TEST LOADS FOR PIPES UNDER DIFFERENTIAL LOAD
(DUCTILE IRON PIPE)

Pipe Size (Inches)	Force (Pounds)
4	600
6	900
8	1,200
10	1,500
12	1,800
15	3,700
18	4,400
21	5,000
24 and over	5,500

C) PVC Pipe
For deflected position, two 12 1/2 foot lengths shall be joined, then deflected along an arc of 720 foot radius (0.11 feet offset at the end of each length from a tangent at the joint). For differential load, two lengths shall be joined and uniformly supported for at least two feet on both sides of the joint and adjacent pipe to 95 percent of its vertical diameter.

8.04.3 Workmanship

a. Line and Grade

Survey control hubs for both line and grade shall be provided by the Engineer in a manner consistent with accepted practices. The Contractor shall establish line and grade for pipe by the use of lasers or by transferring the cut from the offset stakes to the trench at whatever intervals necessary to maintain the line and grade. The Contractor shall check line and grade as necessary. In the event that the limits prescribed in this Chapter are not met, the work shall be immediately stopped, the Engineer notified, and the cause remedied before proceeding further with the work. Variance from the established line and grade shall not be greater than 1/32 inch per inch of pipe diameter and shall not exceed 1/2 inch for line and 1/4-inch for grade, providing that such variation does not result in a level or reverse sloping invert. Variation in the invert elevation between adjoining ends of pipe, including fittings, shall not exceed 1/64 inch per inch of pipe diameter, or 1/2 inch maximum.

b. Side Sewer Connections

All side sewer connections shall be made with tee fittings unless otherwise approved by the District or City. Tee stations will be staked by the Engineer.

c. Pipe Handling

The Contractor shall unload pipe only by approved means. Pipe shall not be dropped to the ground and shall not be dropped or dumped into trenches. The Contractor shall inspect all pipes and fittings prior to lowering into trench to ensure no cracked, broken, or defective materials are used. The Contractor shall clean ends of pipe thoroughly, remove foreign matter and dirt from inside of pipe, and keep it clean during laying and joining. The Contractor shall lower pipe into the trench in such a manner as to avoid any physical damage to the pipe. The Contractor shall remove all damaged pipe from the job site.

d. Unless approved by the District or City, the Contractor shall not break into an existing sewer line until the system has been tested in accordance with the requirements of Section 8.05 and is ready for acceptance by the District or City, as outlined in Chapter 2. When a Contractor ties into a "live" line, the Contractor shall keep the new sanitary line plugged at the downstream end of the construction to prevent entry of groundwater and debris into the public sanitary sewer system.

e. Foreign Material

The Contractor shall take all precautions necessary to prevent excavated or other foreign material from entering into the pipe during the laying operation. At all times, when laying operations are not in progress, the Contractor shall use a mechanical plug at the open end of the last laid section of pipe to prevent entry of foreign material or creep of the gasketed joints.

f. Pipe Laying

Pipe laying shall proceed upgrade with spigot ends pointing in the direction of the flow. After a section of pipe has been lowered into the prepared trench, the Contractor shall clean the end of the pipe to be joined, the inside of the joint, and the rubber ring (if required) immediately before joining the pipe, and make assembly of the joint in accordance with the recommendations of the manufacturer for the type of joint used. The Contractor shall provide all special tools and appliances required for the joint assembly. After the joint has been made, the pipe shall be checked for alignment and grade. The trench bottom shall form a continuous and uniform bearing and support for the pipe at every point between joints.

g. Movable Shield

When pipe is laid within a movable trench shield, the Contractor shall take all necessary precautions to prevent pipe joints from pulling apart when moving the shield ahead. The bottom of the shield shall not extend below the springline of the pipe without recompacting the pipe zone.

h. Cutting Pipe

When cutting or machining the pipe is necessary, the Contractor shall use only tools and methods recommended by the pipe manufacturer and approved by the District or City. The Contractor shall cut cast iron or ductile iron pipe with milling type cutter or with rolling pipe cutter and shall not flame cut.

i. Transition Fittings

1. When joining different types of pipes, the Contractor shall use approved rigid fittings. No flexible fittings will be approved.
2. PVC couplers or adapters shall meet the ASTM 3034 SDR 35/C900 DR 18 D1784 specifications.
3. Ductile iron transition couplings shall meet the ASTM A536 80 for center and end rings, ASTM D2000 3 BA75 for gaskets and AWWA C 111 80 for bolts and nuts.

j. Concrete Closure Collars

The Contractor shall pour closure collars against undisturbed earth, remove all water from the excavation, construct suitable forms to obtain shapes that will provide full bearing surfaces against undisturbed earth as indicated, and use closure collars only when approved by the District or City, and then only to make connections between dissimilar pipe or where standard rubber gasketed joints are impractical. Before the closure collars are installed, the Contractor shall wash pipe to remove all loose material and soil from the surface on which they will be placed.

k. Pipe Bedding

The Contractor shall install pipe zone material uniformly on both sides of the pipe up to the springline of the pipe. Material shall be compacted to ensure proper support within the haunching area.

l. Line Taps

1. Line taps shall be core drilled unless approved otherwise by the District or City. Core drilled holes shall be done using a cylinder

style hole saw for plastic pipe material or a diamond core bit for concrete and ductile iron pipes.

2. Prior to installation of the tee, the area around the cored hole shall be clean and free of all rough edges.

3. While installing the tee, no rock, dirt, or debris shall be allowed to enter the main sewer line.

4. The Contractor shall install 3/4-inch minus gravel in the pipe zone around the line tap, from 4 inches below the pipe or to undisturbed ground and to 6 inches above the pipe.

5. Magnetic tape shall be installed within 18 inches of the top of pipe on all side sewers.

6. The sewer main shall be a minimum of two sizes (nominal inside diameter) larger than the line tap.

7. Inserta Tee's may not be used for newly constructed mainlines with an inside diameter (I.D.) of 10" or smaller.

8.05 Testing and Acceptance

8.05.1 General

a. Sequence of Testing

Testing shall occur in the following order. At the District's or City's discretion, failure of any of the tests may require all testing to be completed again.

1. Compaction
2. Placement of base rock
3. Mandrel
4. Air test (sanitary only)
5. Video

b. Type of tests

1. Sanitary sewers:

All gravity sanitary pipelines shall pass the required air tests, pass the required compaction test in accordance with Section 7.02.3(b)(6), be video inspected, and be free of visible leaks. All flexible pipes shall pass a deflection test. All projects shall pass the required manhole tests. On sanitary sewer pipe 42 inches in diameter and larger, individual joints may be tested by an approved joint testing device. All details of testing procedures shall be subject to approval of the District.

2. Storm sewers:

All gravity storm systems shall be video inspected, pass the required compaction test in accordance with Section 7.02.3(b)(6), and a deflection test for flexible pipes. All details of testing procedures shall be subject to approval of the District.

c. Test Equipment

1. Sanitary and Storm:

The Contractor shall furnish all necessary testing equipment and perform the tests in a manner satisfactory to the District or City.

2. Sanitary-additional requirements:

Any arrangement of testing equipment, which will provide observable and accurate measurements of air leakage under the specified conditions, will be permitted. Gauges for air testing shall be calibrated with a standardized test gauge.

8.05.2 Line Cleaning

Prior to the internal pressure testing for sanitary systems and inspection of sanitary and storm systems by the District or City, the Contractor shall ball and flush and clean all parts of the system. The Contractor shall remove all accumulated construction debris, rocks, gravel, sand, silt, and other foreign material from the system at or near the closest downstream manhole. If necessary, the Contractor shall use mechanical rodding or bucketing equipment. Upon the District or City inspection of the system, any foreign matter still present shall be flushed and cleaned from the system as required.

8.05.3 Manholes (Sanitary only)

a. Unless otherwise approved by the District, acceptance tests shall be conducted on a random sample of 25 percent or 3 sewer manholes, whichever is greater, selected by the District or City. Any manhole which fails acceptance testing shall be repaired and retested, and an additional manhole, selected at random, by the District or City shall be tested.

b. Sanitary sewer manholes shall be tested for acceptance after the trench has been backfilled, compaction requirements have been met, road base rock has been installed and the street paved, and chimney seals or concrete manhole closure collars have been installed. If the manholes have passed the tests and the castings have been disturbed by construction activities or need to be reinstalled, the manholes shall be re tested.

c. Hydrostatic Testing. The test will consist of plugging all inlets and outlets and filling the manhole with water to the rim. Leakage in each manhole shall not exceed 0.2 gallons per hour per foot of head above the invert.

Leakage will be determined by refilling to the rim using a calibrated or known volume container. Testing results shall be recorded on a form approved by the District.

d. Vacuum Testing. The test will consist of plugging all inlets and outlets. The test head shall be placed at the inside of the top of the cone, include grade rings and castings, and the seal inflated in accordance with the manufacturer's recommendations. A vacuum of 10 inches of mercury shall be drawn and the vacuum pump shut off. With the valves closed, the time shall be measured for the vacuum to drop to 9 inches. The manhole shall pass if the time for the vacuum reading to drop to 9 inches meets or exceeds the values indicated in Table 8-3.

TABLE 8-3
VACUUM TESTING TABLE

Depth of Manhole (feet)	Allowable Time (seconds) 48-inch	60-inch	72-inch
8	20	26	33
10	25	33	41
12	30	39	49
14	35	46	57
16	40	52	65
18	45	59	73
20	50	65	81
22	55	72	89
24	59	78	97
26	64	85	105
28	69	91	113
30	74	98	121

8.05.4 Air Testing, Pipe Line (Sanitary only)

a. General

After construction of the system, including service connections, required backfilling, compaction testing, placement of base rock for streets, and other required testing, the Contractor shall conduct a low-pressure air test. The Contractor shall provide all equipment and personnel for the test. The method, equipment, and personnel shall be subject to the approval of the District and City. The District or City may, at any time, require a calibration check of the instrument used. The pressure gauge used shall have minimum divisions of 0.10 psi and have an accuracy of 0.0625-psi (one-ounce per square inch). All air used shall pass through a single control panel.

b. Safety Precautions

All plugs used to close the sewer for the air test must be capable of resisting the internal pressures and must be securely braced, if necessary. All air testing equipment must be placed above ground and no one shall be permitted to enter a manhole or trench where a plugged line is under pressure. All pressure must be released before the plugs are removed. The testing equipment used must include a pressure relief device designed to relieve pressure in the test line at 10 psi or less and must allow continuous monitoring of the test pressures in order to avoid excessive pressure. The Contractor shall use care to avoid the flooding of the air inlet by infiltrated ground water. The Contractor shall inject the air at the upper plug if possible. Only qualified personnel shall be permitted to conduct the test.

c. Method

All air testing shall be by the Time Pressure Drop Method. The test procedures are described as follows:

1. Clean the lines to be tested and remove all debris.
2. The Contractor has the option of wetting the lines prior to testing.
3. Plug all open ends with suitable test plugs; brace each plug securely.
4. Check the average height of ground water over the line. The test pressures required below (Section 8.05.4(c)(8)) shall be increased 0.433 psi for each foot of average water depth over the line.
5. Add air slowly to the section of system being tested until the internal air pressure is raised to the test pressure specified below (Section 8.05.4(c)(8)).
6. After the internal test pressure is reached, at least two minutes shall be allowed for the air temperature to stabilize, adding only the amount of air required to maintain pressure.
7. After the temperature stabilization period, disconnect the air supply.

8. Acceptance shall be based upon meeting or exceeding the requirements specified below. Note the test method is dependent upon the type of pipe material.

A) Concrete Pipe:
Air Pressure Drop Method – The tested section, when tested on the air pressure drop method, will be acceptable if the time required for the pressure to drop from 3.5 psi to 2.5 psi is not less than the time in seconds (T) computed by the Formula:

$$T = K/C$$

Where K and C are computed as follows:
K = the sum of the computation 0.011d2L for each size of pipe and its length in the section.
C = the sum of the computation 0.0003882dL for each size of pipe and its length in the section, except that the minimum value for C shall be 1.
d = the inside diameter of the pipe in inches.
L = the length of pipe in feet.

B) PVC, HDPE, and Ductile Iron Pipe:
The minimum time duration permitted for the prescribed low-pressure exfiltration pressure drop from a starting pressure of 4.0 psi between two consecutive manholes should not be less than that shown in Tables 8-4 or 8-5. The tables list test duration values for pressure drops of 1.0 psi and 0.5 psi in excess of ground water pressure above the top of the sewer pipe, respectively. Values given accommodate both an allowable average loss per unit of surface area and an allowable maximum total leakage rate.

9. Record the diameter (in), length (ft), end manhole number, time, pressure drop, and groundwater level of the test on an inspection form. The recording form shall become a permanent record of the project.

8.05.5 Deflection Test for Flexible Pipe

a. Sewers constructed of flexible pipe materials shall be deflection tested. The test shall be conducted by pulling an approved mandrel through the completed pipeline. The diameter of the mandrel shall be 95 percent of the nominal pipe diameter unless otherwise specified by the District. The mandrel shall be a rigid, nonadjustable, odd numbering leg (9 legs minimum) mandrel having an effective length of not less than its nominal diameter. Testing shall be conducted after placement of base rock for streets and after the line has been completely balled and flushed out with water, compaction tests have been completed and accepted.

b. The Contractor will be required to locate and repair any sections failing to pass the deflection test and to retest the section.

8.05.6 Video Inspection of Gravity Systems

All sewers shall be video inspected and recorded in accordance with the order prescribed in Section 8.05.1 prior to the District or City acceptance of the systems. All pipes shall be thoroughly flushed immediately prior to the video inspection. A 1 inch target ball shall be placed in front of the camera. If the system is video inspected by a private firm or entity other than the District or City, a copy of the video recording and a written TV Inspection Report on a form approved by District, shall be supplied to the District or City. The video recording shall be recorded in color and on an electronic format as approved by the District. All problems discovered during video inspection shall be noted on the video recording and the written report.

8.05.7 Video Inspection for Warranty Acceptance

The sewer lines shall be video inspected during the one year warranty period to determine any defects in the system that are to be corrected by the developer or Contractor.

TABLE 8-4
SPECIFICATION TIME REQUIRED FOR A 1.0 PSIG PRESSURE DROP
FOR SIZE AND LENGTH OF PIPE INDICATED FOR Q = 0.0015*

1 Pipe Diam.	2 Min. Time	3 Length for Min. Time	4 Time for Longer Length	Specified Minimum for Length (L) Shown (min:sec)							
Inches	Min:Sec	Feet	Seconds	100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft	450 ft
4	3:46	597	.380L	3:46	3:46	3:46	3:46	3:46	3:46	3:46	3:46
6	5:40	398	.854L	5:40	5:40	5:40	5:40	5:40	5:40	5:42	6:24
8	7:34	298	1.520L	7:34	7:34	7:34	7:34	7:36	8:52	10:08	11:24
10	9:26	239	2.374L	9:26	9:26	9:26	9:53	11:52	13:51	15:49	17:48
12	11:20	199	3.418L	11:20	11:20	11:24	14:15	17:05	19:56	22:47	25:38
15	14:10	159	5:342L	14:10	14:10	17:48	22:15	26:42	31:09	35:36	40:04
18	17:00	133	7.692L	17:00	19:13	25:38	32:03	38:27	44:52	51:16	57:41
21	19:50	114	10.470L	19:50	26:10	34:54	43:37	52:21	61:00	69:48	78:31
24	22:40	99	13.674L	22:47	34:11	45:34	56:58	68:22	79:46	91:10	102:33
27	25:30	88	17.306L	28:51	43:16	57:41	72:07	86:32	100:57	115:22	129:48
30	28:20	80	21.366L	35:37	53:25	71:13	89:02	106:50	124:38	142:26	160:15
33	31:10	72	25.852L	43:05	64:38	86:10	107:43	129:16	150:43	172:21	193:53
36	34:00	66	30.768L	51:17	76:55	102:34	128:12	153:50	179:29	205:07	230:46
42	39:48	57	41.883L	69:48	104:42	139:37	174:30	209:24	244:19	279:13	314:07
48	45:34	50	54.705L	91:10	136:45	182:21	227:55	273:31	319:06	364:42	410:17

* *Q is the allowable rate in cu.ft/min/sf of inside surface area of pipe.*

TABLE 8-5
SPECIFICATION TIME REQUIRED FOR A 0.5 PSIG PRESSURE DROP
FOR SIZE AND LENGTH OF PIPE INDICATED FOR Q = 0.0015*

1 Pipe Diam.	2 Min. Time	3 Length for Min. Time	4 Time for Longer Length	Specified Minimum for Length (L) Shown (min:sec)							
Inches	Min:Sec	Feet	Seconds	100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft	450 ft
4	1:53	597	.190L	1:53	1:53	1:53	1:53	1:53	1:53	1:53	1:53
6	2:50	398	.427L	2:50	2:50	2:50	2:50	2:50	2:50	2:51	3:12
8	3:47	298	.760L	3:47	3:47	3:47	3:47	3:48	4:26	5:04	5:42
10	4:43	239	1.187L	4:43	4:43	4:43	4:57	5:56	6:55	7:54	8:54
12	5:40	199	1.709L	5:40	5:40	5:42	7:08	8:33	9:58	11:24	12:50
15	7:05	159	2.671L	7:05	7:05	8:54	11:08	13:21	15:35	17:48	20:02
18	8:30	133	3.846L	8:30	9:37	12:49	16:01	19:14	22:26	25:38	28:51
21	9:55	114	5.235L	9:55	13:05	17:27	21:49	26:11	30:32	34:54	39:16
24	11:20	99	6.837L	11:24	17:57	22:48	28:30	34:11	39:53	45:35	51:17
27	12:45	88	8.653L	14:25	21:38	28:51	36:04	43:16	50:30	57:42	64:54
30	14:10	80	10.683L	17:48	26:43	35:37	44:31	53:25	62:19	71:13	80:07
33	15:35	72	12.926L	21:33	32:19	43:56	53:52	64:38	75:24	86:10	96:57
36	17:00	66	15.384L	25:39	38:28	51:17	64:06	76:55	89:44	102:34	115:23
42	19:74	57	20.942L	34:54	52:21	69:49	87:15	104:42	122:10	139:37	157:04
48	22:67	50	27.352L	45:35	68:23	91:11	113:58	136:46	159:33	182:21	205:09

* *Q is the allowable rate in cu.ft/min/sf of inside surface area of pipe.*