

# Special Specification 7179

## Sanitary Sewer Systems



### 1. DESCRIPTION

This Item will govern for furnishing new materials and installing sanitary sewer systems shown on the plans.

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### 3. EXCAVATION, INSTALLATION, AND BACKFILL

3.1. **Pipe Installation.** Install pipes true to lines and grades as indicated on the plans. Inspect all pipe and fittings before placing in the trench. Clean all joint surfaces and soiled materials before connecting one another. As work progresses, maintain interior of pipes clean.

3.1.1. Standard Cover. Standard cover depends on the water main size and installation conditions and is generally

- 6 and 12 inch diameter Main: Minimum of 4-foot cover from top of pipe to finished grade
- Crossing under proposed storm sewer: Minimum of 2-foot cover from top of pipe to bottom of proposed storm sewer.

3.1.2. Potholing. Existing utilities shown on plans are for informational purposes only. Before new pipe installation, pothole all existing utilities and structures to confirm their location, depth, and size. In the event of conflict or discrepancy that affects the project design, notify the Engineer before proceeding with pipe installation to formulate a solution

3.1.3. Pipe Zone Embedment. Unless otherwise specified or shown on the plans, embed pipelines either Class I, II, or III material defined in this Article 6.2.4 and installed as described. Native or imported material for embedment may be used provided material conforms to this Specification.

Place embedment materials in lifts not exceeding 8 inches loose depth. Unless otherwise specified or directed in writing, provide homogenous material in the embedment zone

Place bedding to provide uniform and adequate longitudinal support under the pipe. Place the first lift of bedding material from the bottom of the trench to slightly above the bottom of the pipe grade. Unless otherwise shown on the plans, provide a minimum bedding of 4 inches in depth for pipe sizes 30 inches and smaller, and 6 inches for pipe sizes greater than 30 inches.

Install material true to line and grade with bell holes of ample dimension to permit pipe to rest on the full length of the barrel and to permit joint make-up and coating application at joints. Consolidate and compact the bedding material as described in Article 6, and lay pipe to indicated grade.

Place a second lift, and if required, subsequent lifts, of embedment material to the springline of pipe. This process is defined as haunching. Slice material under the haunches of the pipe, carefully filling all voids, and using care to prevent movement of the pipe.

Place Initial Backfill using a third lift from the springline of the pipe to the pipe crown, and a fourth lift from the pipe crown to a point 12 inches above the pipe.

3.1.4. Groundwater Installation. In areas where the pipe is installed below existing or future ground water levels, use Class I material throughout the pipe zone and enclose with a layer of approved geotechnical filter fabric. Place fabric carefully along the bottom of the trench and up the side of the trench a enough distance to lap over the top of the completed pipe installation. Lap fabric a minimum of 3 feet in the longitudinal at the end of one roll and beginning of the next, and lap 2 feet in the transverse at the top of pipe, except that for trench widths greater than 3 feet measured at the top of pipe, the top overlap will be 3-feet. Follow manufacturer's recommendations for installation. Provide fabric that is either Mirafi 140N, Dupont Tytar 3401, or approved equal.

3.1.5. Embedment Class Schedule. Unless otherwise shown on the plans, use the Utility Standard Embedment Class designations for the pipe material types listed in this Article to define each particular pipe's Embedment Condition allowed. Examine the detail drawings for additional information or other special bedding requirements.

3.1.6. Consolidation Methods in Embedment Zone. Compact embedment backfill by equipment that is suitable for the type of soil encountered, and is capable of producing the degree of compaction specified. Where applicable, provide backfill materials that is moisture conditioned to produce the required degree of compaction.

Do not use flooding or jetting methods for compaction of embedment material.

Use hand or mechanical tamping to compact Class II or III material used in bedding, haunching, and initial backfill, except that the use of mechanical tampers or vibratory compactors directly over the pipe in the embedment area is prohibited. Exercise caution in the use of mechanical compactors in the haunch and initial backfill to 12 inches above the pipe to avoid damaging or misaligning the pipe.

3.1.7. Pipe Zone and Backfill. Classify materials according to the Unified Soil Classification System as defined in ASTM D-2487.

3.1.8. Class I Material. Provide manufactured angular, well-graded, crushed stone per ASTM D-2321, 1/4 inch to 3/4 inch size material. Acceptable materials under this class designation are: ASTM D-448 - Stone Sizes 4, 67, 5, 56, 57, and 6. Pea Gravel and other uniformly graded material are not acceptable under this class.

Class II Material. Provide coarse sands and gravels per ASTM D-2487 with maximum particle size of 3/4 inch, including variously graded sands and gravels, containing less than 5 percent fines (material passing the #200 sieve) generally granular and non-cohesive, either wet or dry. Soil Types GW, GP, SW and SP are included in this class.

Class III Material. Provide fine sand and clayey (clay filled) gravels, per ASTM D 2487, including fine sands, sand-clay mixtures, and gravel-clay mixtures. Class III includes soil Types GM, GC, SM and SC.

Do not use Class IV or V material, as defined in ASTM D-2487, for embedment of flexible pipe.

- 3.1.9. **Compaction and Testing of Pipe Embedment Zone.** Class I material used in the embedment zone may be placed by loose dumping with a minimum of compactive effort, exercising care to assure proper placement of material under the pipe haunches.

Class I material does not specifically require testing unless directed, in which case, such test will be measured by ASTM D-4254 by percent of relative density.

Compact Class II material used in the embedment zone to a density of not less than 90% of Standard Proctor Density defined by ASTM D-698.

Compact Class III material used in the embedment zone to a density of not less than 90% of Standard Proctor Density defined by ASTM D-698.

Do not exceed a moisture content of 3% over the optimum in Class II or III material to assure proper compaction.

Unless otherwise directed, one compaction test in the embedment zone for Class II or III material will be taken at 200 feet intervals along the trench on either side of the pipe, or at any other intervals as may be judged warranted by questionable installation conditions. For pipe sizes 8 inches to 12 inches diameter, perform the first test on the side level with the top of pipe. For sizes 15 inches and larger, perform the first test at the springline of the pipe. For all sizes, perform the second test at the top of the embedment zone.

- 3.1.10. **Density Control and Laboratory Testing.** Unless otherwise specified, reference to "maximum dry density" means maximum density defined by ASTM D-1557 or D-698. Determination of density of backfill in-place, will be in accordance with the requirements of ASTM D-2922.

Unless otherwise specified, the Engineer selects a soils testing laboratory to perform initial density testing of in-place backfill and Contractor is responsible for all density testing of backfills, including tests found not to be within the minimum requirements of the specifications.

Provide laboratory materials testing, including but not limited to determination of Atterberg Limits, Proctor Curves, Grain Size Analysis, as well as laboratory certification of manufactured materials and as required by this Article

Notify the soils testing laboratory and the Engineer 24 hours in advance to obtain soil density tests to fulfill the compaction requirements.

## 3.2. **Measurement**

- 3.2.1. **Excavation and Backfill.** This Item will not be measured individually and is subsidiary to the installation of the various water mains, sanitary sewer mains, and related appurtenances.

- 3.2.2. **Cement Stabilized Backfill .** Unless shown on the plans as a pay item, quantities shown are for informational purposes. When specified as a pay item, this Item will be measured by the cubic yard as shown under Item 400, "Cement Sand".

- 3.3. **Payment.** The work performed and the materials furnished in accordance with this Article will not be measured or paid for individually as it is considered subsidiary to the various bid items for water main, including related appurtenances, such as all excavation, bedding, backfill for pipe zone (embedment), final

backfill, compaction and compaction testing. Associated dewatering is subsidiary to the different materials and sizes of water mains, steel casings, valves, fittings and appurtenances, and service installation, including but not limited to excavation, embedment and final backfill.

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#### 4. SANITARY SEWER FACILITIES

- 4.1. **Description.** Furnish all labor, materials, equipment and incidentals required and install sanitary sewer systems and adjustments as shown on the plans and as specified.

Verification of Utilities. The data furnished on the plans regarding the size and location of utility lines has been obtained from field surveys and the various utility companies. Verify the location of all utilities before commencing sewer construction. Perform all work within public right of way. Do not extend into or encroach upon private property including basements, residences, and places of business.

Coordination with City. Coordination with City is required for sewer line tie-ins and bypassing, where indicated in the specifications and on the plans

Water Main Crossing. Where gravity or force main sewers are constructed in the vicinity of water mains, ensure that the most current requirements of the Texas Commission on Environmental Quality (TCEQ) are met.

- 4.2. **Materials.**

- 4.2.1. **Polyvinyl Chloride (PVC) Flexible Pipe.** These standard specifications designate the requirements for furnishing and installing PVC gravity pipe for sanitary sewage, with a standard dimension ratio (SDR) as shown on the plans and/or specified herein. Furnish all materials, equipment, tools, labor, superintendence, and incidentals required for the complete construction of the work designated.

Quality Assurance. Code all PVC pipe to provide positive identification and prevent accidental damage to or interruption of the sanitary sewer facilities. Only provide pipe manufactured in the United States of America. Provide new materials including all pipe, fittings, and accessories. Perform manufacturer's physical and chemical tests according to the ASTM standard applicable to the respective PVC pipe type and diameter herein specified, to demonstrate pipe quality.

Submittals. Submit documentation on pipe products, fittings, and related materials as may be required by the Contract documents or the Engineer. Review all submittals before submission. Submit in a timely manner so as not to delay the project. Allow enough time for the Engineer's review and resubmission, if necessary. Include certifications from manufacturer that the product complies with appropriate ASTM standards.

Standards. Comply with applicable following requirements:

- ASTM D-1784 Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
- ASTM D-2321 Specification for Underground Installation of Flexible Thermoplastic Sewer Pipe
- ASTM D-3034 Specification for Type PSM Poly (Vinyl Chloride) (PVC) Large Diameter Plastic Gravity Sewer Pipe and Fittings
- ASTM D-3212 Joints for Drain and Sewer Pipes Using Flexible Elastomeric Seals
- ASTM F-477 Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

- ASTM F-679 Specification for Poly (Vinyl Chloride) (PVC) Large Diameter Plastic Gravity Sewer Pipe and Fittings
- ASTM F-789 Specification for Type PS-46 Poly (Vinyl Chloride) (PVC) Plastic Gravity Flow Sewer Pipe and Fittings
- ASTM F-794 Specification for Poly (Vinyl Chloride) (PVC) Large Diameter Ribbed Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter

Delivery and Storage. Inspect pipe, fittings, and accessories upon delivery and during progress of the work. Any material found defective will be rejected. Remove rejected material promptly from site.

Replace, at no additional cost to Department, any material found to be defective in manufacture or damaged.

Unload at point of delivery all pipe, fittings, and other accessories, haul to and distribute at the worksite. In loading and unloading, lift materials by hoists or rolled on skidways so as to avoid shock or damage. Do not incorporate materials that have been dropped into the work. Do not skid or roll pipe handled on skidways against pipe already on the ground.

Do not store PVC pipe outside exposed to prolonged periods of sunlight. Any discoloration of pipe due to such exposure is an indication of reduced pipe impact strength, and will be enough cause for rejection of the pipe. Remove rejected all pipe from the jobsite.

Pipe Schedule. All PVC gravity sewer pipe and fittings must meet and/or exceed all of the requirements of ASTM D-3034 for pipe sizes 4-inch thru 15-inch and ASTM F-679 for pipe sizes 18-inch thru 27-inch, unless otherwise noted on the plans or on the Bid Form. Pipe and fittings must have an integral bell with elastomeric seal joints.

Joints. Joints must be rubber ring sealed and must allow for thermal expansion and contraction joint assemblies must be capable of withstanding a one (1) hour 25 psi internal hydrostatic test with no leakage. Joints must meet requirements of ASTM D-3021. Rubber gaskets must be "Fluid-Type", "Ring-Tite", or equal and must be marked to indicate nominal pipe size and proper insertion direction. Gaskets must meet requirements of ASTM F477 and manufacturing tolerances of Rubber Manufacturers Association. Lubricants for joint components must have no deteriorating effect on gasket or pipe material, as recommended by pipe manufacturer.

Pipe Materials. Provide pipe and fittings made from polyvinyl chloride compounds that comply with the requirements for minimum cell classification defined by ASTM D-1784. Provide PVC fittings, service risers, and laterals with a SDR 26 rating.

Pipe Trenching, Installation and Backfill. Except as noted, Pipe Trenching, Installation and Backfill of PVC gravity sewer pipe will be in accordance with ASTM D-2321 and Article 6 of this specification.

- Trench Width: Refer to Article 6.3.2.1 for FLEXIBLE PIPE
- Pipe Installation: Following the preparation of the trench bottom and trench bracing installed where required, proceed up grade with spigot ends pointing down grade. Lay pipe true to lines and grades as shown on plans. Grade may be established by laser beam, or batter boards (not exceeding 50 foot intervals), and string line may be used with each pipe set to grade, from the string line, with a grade rod equipped with a "shoe" designed to fit into the flow line of the pipe

Testing. Inspect PVC and test for leakage and deflection in accordance with Article 11.3.3.

- 4.2.1.1. **Pipe Service Identification Colors.** The pipe service identification color for the exterior shell must be, green for pipes used as sanitary sewer, (gravity or force mains), and lavender (shade Pantone 522 or approved equal) for pipes used to carry recycled water. The coloring agent used must be resistant to the effects of sunlight and must allow the color to be stable for a period of at least six months in full sunlight.
- 4.2.2. **Cutting and Restoring Pavement.** Where sewer facilities must be installed in streets or other paved areas beyond limits of the roadway improvements, the work includes saw-cutting of the pavement and base to neat lines and prompt replacement of these materials after water excavation and backfill are completed. The replacement materials, as to type and thickness, are shown on the plans.
- 4.3. **Sanitary Sewer System.** Furnish labor, materials, equipment and incidentals to install sewer service lines as indicated on the plans.
- 4.3.1. Sewer Service Connections.

**Materials.** Conform to the material requirements of the City. Fittings, service risers, and laterals are as specified for the material type used. Where additional service connections are required on an existing main line, install an approved service saddle compatible to the size and type of both the collection line and service lateral. Encase saddles with Class B (2500 psi) concrete where PVC saddles with rubber seals and stainless steel bands are used in accordance with Department Standards to protect the steel bands from corrosion and to add stability.

**Tees and Riser.** Install tee or wye fittings for future house service connections. Use bell-type fittings and seal on the branch outlet with an approved plug that can be easily removed for service riser or lateral line installation.

Where ground water is encountered, install the tee and enough service line RISER, thereby raising the final bell above the ground water level. In deep trenches, extend the RISER to the depth of the intersecting service line, or to within 6 feet of the surface, whichever is designated on the plans or appropriate for field conditions.

**Service Connections and Laterals.** Provide new sewer service laterals and re-connections of all existing sewer service laterals to new lines installed to replace lines to be abandoned where required on the plans. Verify location of laterals indicated on the plans and ensure service is not interrupted to homes or other establishments.

The service must be completely and functionally tied into the customers sanitary plumbing and must include all fittings and clean-outs. A four-inch clean-out must be installed at each connection to an existing service. Service line cleanouts must have a 4-inch threaded plug installed flush with the ground surface. Services must be reconnected to the mains immediately upon completion and acceptance of pressure testing. In no case must any service be left unconnected overnight. Use proper specials and fittings to suit the actual conditions for connections between new work and existing work, where required. When it is necessary to interrupt service to existing facilities to make connection to an existing line, connections may need to be made at some time other than during normal working hours at no additional cost to the Department.

Install new services lines at a minimum slope of 2.08 (1/4" per foot) percent. Uniformly support service pipe on bedding having a density of not less than 90% of maximum density per ASTM D-1557. Carefully place and compact backfill on service lines in accordance with the requirements of Article 6.3.4. Plug the terminus of the service line with an approved universal end cap compatible with the pipe size and material.

- 4.3.2. **Manhole Structures.** Furnish all labor, materials, equipment and incidentals necessary to provide all manholes as required. Provide manholes for the various sized lines as listed.

Quality Assurance. Provide manholes free of visible leakage and test each structure for leaks. Repair all leaks in a manner subject to approval.

Submittals. Provide complete manufacturer's shop drawings on the manhole section(s), to include the joints, for approval. Revise shop drawings that do not meet specifications and re-submit approval. Include manufacturer's specification data and recommendations on the lifters and joint material. Submit documentation of compliance with ASTM C-478. Failure to provide either the detailed shop drawings, specification data and recommendation on lifters and joint material, or the letter certifying that all material provided meets specification is enough grounds to reject material.

Standards. Comply with the following applicable requirements:

- ASTM A-48 Specification for Gray Iron Castings
- ASTM A-82 Specification for Steel Wire, Plain, for Concrete Reinforcement
- ASTM A-185 Specification for Steel Welded Wire, Fabric, Plain, for Concrete Reinforcement
- ASTM A-615 Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
- ASTM C-33 Specification for Concrete Aggregates
- ASTM C-144 Specification for Aggregate for Masonry Mortar
- ASTM C-150 Specification for Portland Cement
- ASTM C-309 Specification for Liquid Membrane-Forming Compounds for Curing Concrete
- ASTM C-478 Specification for Pre-cast Reinforced Concrete Manhole Sections
- ASTM C-923 Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures and Pipe
- ASTM D-1557 Test Methods for Moisture-Density Relations of Soils and Soil Aggregate Mixtures Using 10-lb (4.54-kg) Rammer and 18-in (457-mm) Drop

- 4.3.2.1. **Manhole Structure Materials.**

Frame and Cover: Provide manhole frame and cover of cast iron of the weight, dimensions, and pattern indicated by the City Standard Details with self sealing ring and cover (400 lb ring and cover) – East Jordan Iron Works Cover EJIW No. V1430C DI with City of Nacogdoches Logo (ring EJIW No. V1430C DI). Provide casting made from superior quality, gray cast iron conforming to the requirements of ASTM A-48 with no holes in the cover, but edge notches for embedded rings used for lifting. Machine mating surfaces to assure a snug fit of the cover and frame.

Manhole Rings. Provide manhole rings used for a maximum 2 foot final grade in conformance to the applicable requirements of ASTM Specifications C-32, Grade MS.

Cement. Provide Portland Cement conforming to ASTM Specifications C-150, Type V.

Mortar Sand. Provide mortar sand conforming to ASTM Specifications C-144.

Concrete Aggregates. Provide concrete aggregates conforming to ASTM Specifications C-33 except that the requirement for gradation will not apply to concrete manhole conical and riser sections.

Steel Reinforcement. Provide billet-steel bars conforming to ASTM Specifications A-615 and welded steel wire fabric conforming to ASTM Specifications A-82 or to ASTM Specifications A-185.

Water. Provide water that is clean, clear, free from oil, acid or organic matter and injurious amounts of alkali, salts or other chemicals or deleterious materials.

Mortar. Provide mortar that is composed of 1 part Portland Cement Type V and 3 parts mortar sand mixed in an approved manner with water to form a workable mixture.

#### 4.3.2.2.

Pre-Cast Concrete Manholes. Design manhole riser and conical section for sewer and water installations in the diameters specified or shown. Provide all manhole sections with 5 inch wall thickness and tongue and groove, unless otherwise specified. Rings will be available in various lengths from one foot to four feet. Design the conical sections to be concentric and adapted to the ring at one end and standard cast iron frame at the other. Provide the base ring with a flat bottom joint. Steps or rungs are not required. Manufacture manhole section(s) in conformance with ASTM C-478 and any additional specifications listed here forth.

Concrete. Concrete to have a minimum 28 days compressive strength of 4000 psi. Water cement ratio to be 0.5 or less by weight or not more than 5.5 gallons per sack.

Aggregates. Conform to specifications outlined by ASTM C-33 except for lightweight aggregate. Aggregates will be free of deleterious substances causing reactivity with oxidized hydrogen sulfide. Grade both types of aggregates to produce a homogeneous concrete mix. Accurately weight all materials at a central batching facility for mixing.

Cement. Provide Portland Cement conforming to ASTM C-150, Type V (sulfate resistant) for sewer applications and enough to produce a minimum strength of 4,000 PSI, or other design strengths required.

Placing. Handled all concrete from the mixer or transport vehicle to the place of final deposit in a continuous manner, as rapidly as practicable, and without segregation or loss of ingredients, until (the approved unit operation) is completed. Place concrete in layers not to exceed two feet deep. Compact each layer by mechanical internal or external vibrating equipment. Limit duration of the vibration cycle to the time necessary to produce satisfactory consolidation without causing objectionable segregation.

Quality Assurance. The Engineer reserves the right to inspect the manufacturing process at any time to make tests on materials used, and to have cores cut out of the completed manholes for compressive strength testing and placement of reinforcement.

Curing. For purposes of early re-use of forms, the concrete may be heated in the mold after the initial set has taken place. Do not exceed a temperature of 160° and raise from normal ambient temperature at a rate not to exceed 40° per hour. Do not remove the cured unit from forms until enough strength is obtained for the unit to withstand any structural strain that may be subjected during the form stripping operation. After the stripping of forms, further curing by means of water spraying or a membrane curing compound of a clear or white type, conforming to ASTM C-309-58 may be used.

**Steel Reinforcement.** Use reinforcing steel as outlined in ASTM C-478 and any additional specifications herein. Apply the minimum steel area of 0.12 square inches to both risers and cone sections and the maximum center to center spacing of 6 inches as well. Place reinforcing steel for one line circumferential reinforcement on the tension side of the wall (the inner half part of the wall with a minimum 1-inch cover) for two lines circular reinforcement, refer to ASTM C-478. Sufficiently tie all reinforcing to withstand any displacement during the pouring operation.

**Joint Reinforcement.** Both tongue and groove will contain a #4 rebar.

**Lifters.** Design lifters to handle the imposed weights placed per manufacturer's requirements.

**Joint Material.** Seal all joints using Ram-Nek joint sealer in enough quantities by the vendor as part of the manhole section(s) in sizes per manufacturer's recommendations.

4.3.2.3. **Cast-In-Place Concrete Manholes.** In special circumstances, construct cast-in-place concrete manholes as shown on the plans, and provide the wall thickness not less than 6 inches. Ensure that the concrete is of good quality and well vibrated and the method of construction materials and type of forms used are approved.

4.3.2.4. **Manhole Connectors.** At manholes, a water-tight resilient connection will be made between the wall and the pipe by use of an Engineering approved manhole waterstop adaptor such as Indiana Seal Manhole Adaptor, Kor-N-Seal, or approved equal, meeting the requirements of ASTM C-923. The connector must be compatible to both the type of pipe wall and manhole wall, and be installed in strict accordance with the recommendations of the connector manufacturer.

4.3.2.5. **Installation.** Construct manholes at the location and details shown on the plans or as. After the excavation has been completed, pour the concrete base or bottom.

The riser work may proceed when the concrete has set enough. Neatly form the invert in the bottom of the manhole with concrete after the manhole rise has been completed. Construct invert with a true curve of as large a radius as the size of the manhole will permit and with a smooth trowel finish.

4.3.3. **Inspection and Testing.** Test all piping as specified herein unless otherwise directed.

**Standards.** Adhere to the following requirements when inspecting and testing sewer lines and manholes.

- ASTM C-1103 Standard Practice for Joint Testing of Installed Pre-Cast Concrete Pipe Sewer Line
- ASTM D-3034 Specification for Type PSM Poly(Vinyl Chloride)(PVC) Sewer Pipe and Fittings
- ASTM F-679 Specification for Poly(Vinyl Chloride)(PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings
- UNI-BELL-6 Standards and Practices for Low-Pressure Air Testing of Installed Sewer Pipe
- UNI-BELL-9 Polyvinyl Chloride (PVC) Large Diameter Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter (Nominal Pipe Sizes 18-48 Inch)

**Manufactured Products.** Provide all testing apparatus including pumps, compressors, hoses, gauges and fittings, mandrels, and other equipment necessary to perform the required tests.

Manholes must be tested for leakage separately and independently of the wastewater lines by either hydrostatic exfiltration testing or vacuum testing, in accordance with TCEQ regulations.

- 1) Hydrostatic Exfiltration Test -All wastewater lines coming into the manhole must be sealed with an internal pipe plug, then the manhole must be filled with water and maintained full for at least one hour. For concrete manholes a wetting period of 24 hours may be used before testing to allow saturation of the concrete. Test period must be for a minimum of 4 hours. Maximum leakage must be 0.025 gallons per foot diameter per foot of manhole depth per hour. If a manhole fails a leakage test, the manhole must be made watertight and retested by the same procedures.
- 2) Vacuum Test -All wastewater lines coming into the manhole must be sealed with plugs braced to prevent them from being drawn into the manhole. The test head must be placed inside the frame at the top of the manhole and inflated in accordance with the manufacturer's recommendations. A vacuum of 10 inches mercury must be drawn and the vacuum pump must be turned off. With the valve closed, the level of vacuum must be read after the required test time. If the drop in the level is less than 1 inch of mercury (final vacuum is greater than 9 inches of mercury), the manhole will have passed the vacuum test. The required test time is determined from the following table.

Minimum Time Required for a Vacuum Drop of 1" Hg (10" Hg - 9" Hg)(min:sec)			
Manhole Depth	48" Manhole	60" Manhole	72" Manhole
0 - 20'	0:40	0:50	1:00
22'	0:44	0:55	1:06
24'	0:48	1:00	1:12
26'	0:52	1:05	1:18

Any manhole which fails the initial test must be repaired and retested until a successful test is made.

#### 4.3.3.1.

**Leakage Testing.** To ensure the integrity of the pipe and joints, test all sewer lines installed under these specifications for leakage using the guidelines established by ASTM C-828 and UNI-BELL B6, and the methods and procedures here forth described.

General. Provide all testing apparatus including pumps, compressors, hoses, gauges and fittings and other equipment necessary to perform the required tests. Acceptable equipment can be as manufactured by Cherne Industries Incorporated or approved equal.

Conduct tests in the presence of the Engineer unless otherwise approved. Notify the Engineer 48 hours in advance of testing. Record test results on standard utility forms provided by.

Low pressure air testing may be conducted by Contractor or an approved independent testing firm with the full understanding to all persons conducting an Air Test that an Air Test may be dangerous if conducted improperly.

Test sewer lines after the "pipe zone" backfilling is completed and before construction of finished surfacing.

Where house laterals are included as integral part of the project, perform testing on the main and laterals after the risers or laterals have been completed and backfilled.

Thoroughly clean pipes before conducting leakage tests. Repair pipelines that exceed the allowable leakage rate and retest at no additional cost to the Department.

- 4.3.3.1.1. Exfiltration Air Testing. A Low Pressure Air Test is the standard method for testing sewer lines. Seal test pneumatic plugs above ground using a random pipe section pressurized to 5 psig. Plugs should remain intact without bracing or movement out of the section. Test procedure is as follows:
- Seal off each end of the section of pipe to be tested at a manhole connection. Securely brace test plugs.
  - Introduce air slowly into the test section through the test plug until an internal pressure of 4.0 psi is reached. Allow internal air temperature to stabilize. Adjust the internal air pressure to 3.5 psi, disconnect the air supply and begin the test.
  - Maintain the test pressure through section without losing more than 1.0 psi for a length of time as determined by Table 15. Sections losing more than 1.0 psi fail test and must be repaired and re-tested for acceptance. If the section being tested includes more than one size of pipe, calculate the test time for each size and add to determine the total test time for the section. .

Table 15.  
Total Test Time

Nominal Pipe Size (d)	Time (t).
Inches	Minutes/100 ft.
4	0.3
6	0.7
8	1.2
10	1.5
12	1.8
15	2.1
18	2.4
21	3.0
24	3.6
30	4.8
36	6.0
42	7.3

- 4.3.3.1.2. Infiltration Test. Infiltration testing of sewer lines under groundwater is mandatory. Perform this test before initiating any service connections and after backfilling. At testing time, maintain the level of the groundwater over the entire section of the pipe or near its maximum level.

Measure the allowable infiltration for any portion of the sewer system by a weir or current meter placed in the appropriate manhole and do not exceed 50 gallons per inch of internal pipe diameter per mile per day, including manholes.

Provide suitable plugs or other facilities to measure the amount of infiltration. If infiltration is excessive, immediately proceed to locate the source of leakage. Once located, seal the source of leakage by grouting, cementing and rebuilding as required, or by approved methods.

- 4.3.3.1.3. Joint Testing. As directed, perform individual joint testing of pipe larger than 24 inches in diameter in accordance with ASTM C-1103 for special conditions not covered by other test methods.
- 4.3.3.1.4. Inspection of Sewer Manholes. Visually inspect manholes installed under groundwater for infiltration leakage through all joints and the manhole base. Repair all leaks or cracks with an approved hydro-cement grout.
- 4.3.3.2. **Deflection Testing.** As a condition for acceptance of the pipeline, perform a mandrel test (deflection test) to verify the roundness and proper installation of the flexible pipeline. Within 30 days, but not less than 7 days after the installation and backfilling of the flexible sewer line, including any service connections, in the presence of the Engineer, test deflection of the pipe with a mandrel (GO-NOGO device).

**Mandrel Fabrication.** Provide mandrels of high quality fabrication and precision as commercially available by Cherne Industries Incorporated, or approved equal. Mandrels require approval and must be equipped with proven rings and meet the following requirements:

- Fabricate mandrel outside diameter (gauge dimension):
  - Mandrel O.D. = Pipeline Base I.D. - (% deflection limit x Pipeline Base I.D.) in accordance with ASTM D-3034, F-679, or UNI-BELL-9
- Design mandrel open preventing debris buildup between channels of adjacent fins. Include a minimum of nine fin sets that are removable from the mandrel core. Assemble gauges of various diameters by substituting fin sets of appropriate dimension. Provide a length of the minimum radius portion of the mandrel not less than one-third of the nominal diameter of the pipe being tested.

**Execution.** Before testing, flush pipe and clean. Flow is not permitted in the pipeline throughout the duration of the deflection test. Manually pull mandrel through the pipeline with a suitable rope or cable that is connected to an eyebolt at one end of the gauge. Attach a similar rope or cable to the eyebolt at the opposite end of the mandrel and apply tension to it. This will ensure that the mandrel maintains its correct position during testing, while providing easy removal of the mandrel should it become lodged in an excessively deflected pipeline. Winching or other methods of forcing the mandrel through the pipeline is unacceptable.

For pipeline tested within 30 days of installation, do not exceed a deflection of 5% of the base inside pipe diameter as established by ASTM Standards D-3034 and F-679 listed in Table 16.

Table 16.  
Deflection Gauge Dimensions: SDR35 OR RSC 160

Nominal Size	Average I.D.	Base I.D.	5% Deflection Gauge
6"	5.893	5.742	5.46
8"	7.891	7.665	7.28
10"	9.864	9.563	9.08
12"	11.737	11.361	10.79
15"	14.374	13.898	13.20
18"	17.564	16.976	16.13
21"	20.707	20.004	19.00
24"	23.296	22.480	21.36
27"	26.258	25.327	24.06

For pipeline tested beyond 30 days of installation, do not exceed a deflection of 7.5% of the nominal inside diameter or as established otherwise by the applicable governing body. Adjust mandrel gauge for 7.5% and seek approval. Make every effort to test for deflection before the 30 day expiration.

Maintain a permanent record of all testing with locations where excessive pipeline deflections occur and forward to the Engineer after completion of testing on each line.

Replace all sections of pipe that deflect more than 5% (or 7.5%). Lay pipelines with acceptable ovality such that the larger diameter is situated in the vertical direction. All expenses for re-trenching, backfill, compaction, paving, and related work necessary due to failure to satisfy deflection test requirements are Contractor's responsibility.

- 4.4. **Sewer Line Bypassing and Draining.** This section specifies the requirements for temporary bypassing, draining, flushing and abandonment of sewer lines. Keep excavations free from water during construction. Do not damage property or create a public nuisance when disposing water. Provide hand pumping equipment and machinery in good working condition for emergencies and have workers available for its operation.
- 4.4.1. Requirements. Provide labor, equipment, materials and supervision to temporarily bypass flow around work during sewer construction and/or during work associated with sewer construction when necessary. Drain and flush all sewers to be abandoned with a minimum of twice the sewer's volumes of water. Drain all sewers lines to be abandoned. Coordinate all work with the the Engineer.
- 4.4.2. Submittals. Twenty-one (21) calendar days before commencement of construction activities, then submit for review and approval drawings and complete design data showing methods and equipment proposed to use in sewer bypassing and draining. Include the following information:
- Drawings indicating the location of temporary sewer plugs and bypass discharge lines
  - Schedule times for bypasses
  - Capacities of pumps, prime movers, and standby equipment
  - Design calculations proving adequacy of the system and selected equipment
- 4.4.3. Job Conditions. If available, existing sewer system map of the project area can be obtained from the the Engineer.

Protection. Where bypassing or draining of the contents of a line is required, ensure that service for connecting sewer laterals are not disrupted. Discharge all flow into the nearest downstream manhole and only after consultation with City/Department operations to coordinate the discharge. Do not surcharge sewers or interfere with normal operation of related sewer facilities when bypassing and draining of the contents of a line. Discharging to the ground surface, receiving streams, storm drains, or discharging that result in groundwater contamination or potential health hazards is not permitted. In the event accidental discharging is caused by the Contractor's operations, City/Department is immediately entitled to employ others to stop the discharging without giving written notice to the Contractor.

Contractor is responsible for penalties imposed on the City/Department as a result of any discharge by the actions of Contractor's employees or subcontractors including legal fees and other expenses to the City/Department resulting directly or indirectly from the discharge.

Scheduling. Do not shut down the bypassing systems between shifts, on holidays or weekends, or during work stoppages without written permission from the ENGINEER. Submit a detailed outage plan and time schedule for operations when necessary to remove a sewer line or structure from service. Coordinate schedule with the Engineer and meet the restrictions and conditions specified in this section. In the detailed plan, describe the method for preventing accidental discharges, the length of time required to complete said operation, the necessary plan and equipment to be used to prevent accidental discharges. Observe the following restrictions:

- Systems or individual equipment items will be isolated, drained, decommissioned, de-energized, or depressurized in accordance with the detailed outage plan and schedule.
- Notify the Engineer, in writing, at least one week in advance of the planned operation.

4.4.4. Sewer Line Draining. Flush sewers to be abandoned with two pipeline volumes of water and allow to drain fully before abandoning.

4.4.5. Sewer Bypassing. Accomplish sewer bypassing by pumping or diverting the upstream flow around the proposed work and as directed. Provide temporary pumps, conduits, and other equipment to bypass the sewer flow.

Furnish the necessary labor, equipment and material, and supervision to set up and operate the pumping and bypass system. Equip engines with mufflers and/or enclosed to keep the noise level within local ordinance requirements. Provide pumps and bypass lines of adequate capacity and size to handle the flows.

Unless otherwise directed, bypass flow around proposed work whenever the depth of flow, as measured at the inlet pipe to the upstream manhole adjacent to proposed work, exceeds the crown elevation of the pipe; or whenever the equipment operating in the sewer provides an obstruction that restricts flow and causes the depth of flow to exceed the crown elevation.

4.4.6. Standby Equipment. Maintain on site enough equipment and materials to ensure continuous and successful operation of the bypass and dewatering systems. Maintain standby pumps fueled and operational at all times. Maintain on site a enough number of valves, tees, elbows, connections, tools, sewer plugs, piping and other parts or system hardware to ensure immediate repair or modification of any part of the system as necessary.

4.4.7. Damages. Repair, without additional cost to the Department, any damage that may result from negligence, inadequate or improper installation, maintenance, and operation of bypassing and draining equipment, including mechanical or electrical failures.

- 4.5. **Flowable Backfill.** When indicated on the plans, backfill trenches to the elevations shown with stabilized backfill meeting requirements of Item 401.
- 4.6. **Cutting and Restoring Pavement.** Where sewers must be installed in streets or other paved areas, the work includes saw cutting of the pavement and base to neat lines and prompt replacement of these materials after sewer excavation and backfill are completed. The replacement materials, as to type and thickness, are shown on the plans. Any work done or damage to base and/or pavement outside the limits shown on the plans will not be measured for payment and must be restored at no additional cost to the Department.
- 4.7. **Measurement.**
- 4.7.1. **Sanitary Sewer Mains (PVC).** Longitudinal measurement of sanitary sewers will be made along the centerline of the sewer by the foot of the various sizes of sewers in place, in accordance with these specifications, complete and approved. The lengths of sewer mains will be measured center of manholes where the installation involves connection of the sewer into a manhole at each end of the line being measured. Where the installation involves a connection to an existing sewer line, the measurement will be made from the end of the existing sewer line to the center of the manhole on the work being measured.
- 4.7.2. **Sanitary Sewer Manhole.** All sanitary sewer manholes satisfactorily completed in accordance with the plans and specifications will be measured by each of the various manhole types.
- 4.7.3. **New Sewer Service (Service Laterals).** New Sewer Service (Service Laterals) will be measured by each new sewer service connection of a particular size installed and accepted.
- 4.7.4. **Abandon and Fill Existing Sanitary Sewer Pipe.** This Item will be measured by the foot of existing sanitary sewer main that is abandoned in place.
- 4.7.5. **Remove Existing Manholes.** Existing manhole structures to be completely abandoned and removed as identified on the plans will be measured for each manhole removed.
- 4.7.6. **Abandon Existing Manholes.** Existing manhole structures to be completely abandoned as identified on the plans will be measured for each manhole removed.
- 4.7.7. **Connect Proposed Sanitary Sewer Main to Existing Manhole.** This Item will be measured per each connection of the proposed sanitary sewer main of the type and size shown on the plans to existing manhole, complete in place.
- 4.7.8. **Connect Existing Sanitary Sewer Main to Proposed Manhole.** This Item will be measured per each connection of the existing sanitary sewer main of the type and size shown on the plans to proposed manhole, complete in place.
- 4.8. **Payment.**
- 4.8.1. **Sanitary Sewer Mains (PVC).** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" herein will be paid for at the unit price bid for "SANITARY SEWER (PVC) (SDR 26)" of the type and size specified, complete in place.

This price is full compensation for furnishing all required materials and labor; potholing; excavation, including hand-digging, if needed, embedment and backfill; compaction and compaction testing for utilities, all fittings;

removal and disposal of existing manholes, except where indicated as being covered under a specific bid item; pipe connections to existing manholes; relocation or replacement of existing water and sewer lines required for placement of new sewer line; pipe concrete caps; plugs (temporary and/or permanent); testing; dewatering of groundwater, if needed; bypassing and any work related to the bypass including traffic control related to bypasses; removal and replacement of storm drains; removal and replacement of drainage structures; placing and joining of pipes and fittings; traffic control required for sewer work outside Project limits; coordination with utility companies, the city, and the Engineer; locating and protecting of existing utilities; and for all other items of material, labor, equipment, tools and incidentals necessary to complete the work in accordance with the plans and specifications

- 4.8.2. **Sanitary Sewer Manhole.** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" herein will be paid for at the unit price bid for "MANHOLE (SAN SEWER) (4' DIA)" of the size and type specified or indicated on the plans. This price is full compensation for furnishing all required materials, labor, gaskets, rings, covers, concrete collars, pipe penetrations, grout, groundwater dewatering, testing, concrete, excavation and backfill, grouting of inverts, coating interior and exterior where required, adjustment of new manhole to both temporary and finished grades, and tools and incidentals necessary to complete the work in accordance with the plans and specifications.
- 4.8.3. **New Sewer Service (Service Laterals).** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" herein will be paid at the unit price bid for each "NEW SEWER SERVICE LATERAL" of the particular size installed. This price is full compensation for furnishing all required materials and labor; excavation and backfill; fittings; cutting; bypassing; coordination; testing; and plugging/capping of abandoned utilities; draining of lines; vertical and horizontal adjustments; connections to existing sewers; and all other incidentals necessary to complete the work in accordance with the plans and specifications.
- 4.8.4. **Abandon and Fill Existing Sanitary Sewer Pipe.** The work performed and the materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for "ABAND/FILL EXIST SAN SEWER PIPE" of the size specified. This price is full compensation for furnishing all required materials, labor, and equipment, including but not limited to the following items: coordination, traffic control, potholing, excavation, complete flushing and draining (dewatering) of pipe, flowable backfill, cutting, capping/plugging, complete filling with approved flowable backfill of sanitary sewer mains to be abandoned, proper abandonment of all manhole structures with flowable backfill as indicated on the plans, and all other items for the project not indicated as being covered under the other specific bid items.
- 4.8.5. **Remove Existing Manholes.** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" herein will be paid for at the unit price bid for "REMOVE EXISTING MANHOLE (SAN SWR)". This payment will be for all labor, materials, plugs (temporary and permanent), excavation and backfill, cement stabilized backfill, groundwater dewatering, removal, disposal of materials, and all other incidentals necessary to complete the work in accordance with the plans and specifications.
- 4.8.6. **Abandon Existing Manholes.** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" herein will be paid for at the unit price bid for "ABND EX SAN SWR MANHOLE". This payment will be for all labor, materials, plugs (temporary and permanent), excavation and backfill, cement stabilized backfill, groundwater dewatering, removal, disposal of materials, and all other incidentals necessary to complete the work in accordance with the plans and specifications.

- 4.8.7. **Connect Proposed Sanitary Sewer Main to Existing Manhole.** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" herein will be paid for at the unit price bid for "CONNECT PRO SAN SWR MAIN TO EX MANHOLE" of the size and type specified or indicated on the plans. This price is full compensation for furnishing all required materials, labor, gaskets, rings, covers, concrete collars, pipe, pipe penetrations, grout, groundwater dewatering, testing, concrete, excavation and backfill, grouting of inverts, and tools and incidentals necessary to complete the work in accordance with the plans and specifications.
- 4.8.8.
- 4.8.9. **Connect Existing Sanitary Sewer Main to Proposed Manhole.** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" herein will be paid for at the unit price bid for "CONNECT EX SAN SWR MAIN TO PRO MANHOLE" of the size and type specified or indicated on the plans. This price is full compensation for furnishing all required materials, labor, gaskets, rings, covers, concrete collars, pipe, pipe penetrations, grout, groundwater dewatering, testing, concrete, excavation and backfill, grouting of inverts, and tools and incidentals necessary to complete the work in accordance with the plans and specifications.
- 4.8.10.