

SECTION 02532
SANITARY SEWERS (GRAVITY)

PART 1. GENERAL

1.01 SCOPE

- A. The Work to be performed herein shall consist of the installation of wastewater gravity lines and lateral connections according to the Specifications and the Standard Drawings herein.

1.02 DEFINITIONS

- A. FRP: Fiberglass Reinforced Pipe.
- B. CCTV: Closed Circuit Television.
- C. SDR: Standard Dimension Ratio.
- D. HDPE: High Density Polyethylene.
- E. Pipe Stiffness Classification: Referred to as SN.
- F. Pressure Class: Referred to as PN.

1.03 SUBMITTALS

- A. Action Submittals:
 - 1. Information on gasket polymer properties.
 - 2. Tee fabrication details.
 - 3. Application methods, application requirements, and chemical resistance data for coating and lining products.
 - 4. Complete Shop Drawings and laying diagrams showing location of each pipe section as requested by the OWNER.
 - 5. FRP:
 - a. Detailed pipe fabrication drawings showing pipe details, special fittings and bends, dimensions, coatings, standards for design, and other pertinent information.
 - b. Layout drawing showing location of each pipe section and, if special sections are provided, each special length.
 - c. Pipe pressure class and pipe stiffness.

- d. Details for connections to non-fiberglass pipe material.
 - e. Product Data:
 - 1) Manufacturer's data for couplings, fittings, saddles, gaskets, and other pipe accessories. Indicate maximum rated working pressure and test pressure for each item. Indicate storage requirements, installation, and repair instructions.
 - 2) Lining and coating data for protection of metallic fittings.
- B. Informational Submittals:
- 1. Certificates:
 - a. Manufacturer's Certificate of Compliance for each type of pipe that products furnished meet requirements of this section.
 - b. Certification of Calibration: Approved testing laboratory certificate if pressure gauge for hydrostatic test has been previously used. If pressure gauge is new, no certificate is required.
 - c. Certified statement from manufacturer of gaskets, setting forth that basic polymer used in gaskets and test results of physical properties of compound are in accordance with ASTM F477 for PVC pipe, AWWA C111 for ductile iron pipe, and ASTM D4161 for FRP pipe.
 - 2. Manufacturer's Written In-Plant Quality Control Program: Quality control procedures and materials testing to be used throughout manufacturing process. Submit prior to manufacture of any pipe for this Project.
 - 3. Test or historical performance data to verify that joint design meets requirements of these specifications.
 - 4. At the OWNER's discretion the CONTRACTOR may be required to supply certified mill tests, samples, or other suitable form of verification that the material meets the required specifications.
 - 5. Manufacturer's written recommendations for pipe handling and installation.
 - 6. FRP:
 - a. Provide historical data indicating that polyester resin systems have proven history of performance for use with pipe similar in construction and composition to proposed product.
 - b. Report from CONTRACTOR identifying vertical cross-section deflections after completion of backfilling and removal of dewatering systems.
 - c. Factory Testing:
 - 1) Manufacturer shall perform the following in plant tests, according to ASTM D3262 and shall supply submittals of test results prior to delivery of pipe to Site. Factory testing shall be performed on pipe sections to be furnished for this Project and shall include:
 - a) Production test.
 - b) Long term hydrostatic qualification test.
 - c) Joint tightness qualification test.

- d) Beam strength and longitudinal tensile strength qualification test.
- 7. HDPE:
 - a. CONTRACTOR Certifications:
 - 1) Installer: Certifications of training by pipe bursting system manufacturer stating that installer have been fully trained in the use of the pipe bursting equipment by an authorized representative of the equipment manufacturer.
 - 2) Insertion Equipment Operator: Certification from pipe manufacturer of training in the proper method for handling and installing the new pipe.
 - 3) Fusion Equipment Operator: Certifications of training by the pipe fusion equipment manufacturers that the operators have been fully trained in the use of the fusion equipment by an authorized representative of the equipment manufacturer.
 - 8. Pipe deflection test results.
 - 9. Field Leakage Testing Plan: Submit at least 15 days in advance of the testing and include at least the following:
 - a. Testing dates.
 - b. Piping systems and sections to be tested.
 - c. Test type.
 - d. Method of isolation.
 - e. Method of conveying water from source to system being tested.
 - f. Calculation of maximum allowable leakage for piping section(s) to be tested.
 - g. Method for disposal of test water, if applicable.
 - h. CCTV Inspection Equipment: Reference Specification 02541, Sewer Television Inspection
 - 10. Leakage test results.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products as recommended by the manufacture to prevent damages. Materials shall be made safe from theft, vandalism, and damage.
- B. All products and materials specified herein shall be inspected at the request of OWNER or RESIDENT PROJECT REPRESENTATIVE. All materials that fail to conform to these Specifications shall be rejected. After delivery to the Site, any materials that have been damaged in transit or are otherwise unsuitable for use in the Work shall be rejected and removed from the Site by the CONTRACTOR at no cost to the OWNER.

PART 2. PRODUCTS

2.01 PIPE

- A. Polyvinyl chloride (PVC) Pipe:
1. Pipes and fittings shall meet or exceed the requirements of ASTM D3034, SDR 26 for pipe from 4 inches to 15 inches in diameter unless otherwise noted. For sizes from 18 inches to 24 inches in diameter, the pipe shall meet or exceed the requirements of ASTM F679, wall thickness T-1.
 2. Cell Classification: 12454-B or 12454-C for 15-inch and smaller pipe diameters and 12454-C for 18-inch through 36-inch pipe diameters.
 3. Gaskets: Factory fabricated rubber compression type with solid cross section conforming to ASTM F477. Lubricant for joining pipe as approved by pipe manufacturer.
- B. Ductile Iron Pipe:
1. Conform to ASTM A746.
 2. Push on with rubber gaskets conforming to AWWA C111. Lubricant for joint pipe as approved by pipe manufacturer Ceramic epoxy lined and coated outside with an asphaltic coating.
 3. Ceramic Epoxy Lining:
 - a. 40-mils dry film thickness lining, consisting of amine cured novolac epoxy containing at least 20 percent by volume quartz pigment manufactured under the name of Protecto 401.
 - b. Line interior of bell and exterior of spigot in joint sealing areas with 6 mils to 10 mils of specified lining.
 - c. Surface Preparation: SP10 near-white abrasive blast.
 - d. Pinhole Detection: 2,500 volts minimum over 100 percent of lined surfaces.
 4. Fittings: Ductile iron conforming to AWWA C110, lined and coated same as pipe.
- C. FRP:
1. Manufactured according to the following standards:
 - a. ASTM D3262, Standard Specification for Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe.
 - b. ASTM D4161, Standard Specification for Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Joints Using Flexible Elastomeric Seals.
 - c. ASTM D2412, Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.
 2. Service Conditions and Design Requirements:
 - a. External Loads: To be determined for individual application, including depth of cover and embedment condition. Embedment shall be per Section 02321, Excavation, Bedding, and Backfill for Utilities.

- b. Pipe Stiffness: SN shall be a minimum of 46 and shall be determined based on project site conditions.
3. Resin: Manufacturer shall use only polyester resin system with proven history of performance for pipe manufacturer. Historical data shall have been acquired from composite material of similar construction and composition as proposed product.
4. Glass Reinforcement: Reinforcing glass fibers used to manufacture components shall be of highest quality commercial Grade E glass filaments with binder and sizing compatible with impregnating resins.
5. Silica Sand: Minimum 98 percent silica with maximum moisture content of 0.2 percent.
6. Additives: Curing agents, pigments, dyes, fillers, thixotropic agents, when used, shall not detrimentally affect performance of product.
7. Lengths: Pipe shall be supplied in nominal lengths of 20 feet. Actual laying length shall be nominal plus 1 inch, minus 4 inches. At least 90 percent of pipe supplied for each class of pipe shall be furnished in nominal length sections.
8. Pipe Ends: Square to pipe axis with maximum tolerance of 1/8 inch.
9. Joints:
 - a. Pipe shall be field connected with fiberglass sleeve couplings that utilize elastomeric sealing couplings that utilize elastomeric sealing gaskets made of EPDM rubber compound as sole means to maintain joint water tightness.
 - 1) Joints shall meet requirements of ASTM D4161.
 - 2) Rated for working, test, and surge pressures, even under deflected conditions.
 - 3) Tie-ins, when needed, may utilize gasket-sealed mechanical couplings.
 - b. Gaskets: Suitable for service conditions and loads indicated.
 - c. Joint Lubricant: Suitable for service conditions and as recommended by manufacturer.
10. Fittings: Change in direction or any deflection angles shall be accomplished with manholes as indicated on Drawings or fittings with manhole risers for pipe larger than 48 inches.
11. Manufacturers:
12. Hobas Pipe USA, Inc.
13. US Composite Pipe South; Flowtite.

D. HDPE

1. Pipe and Fitting: ASTM F714.
2. Resin: Meet requirements of ASTM D3350 for PE 4710 with cell classification of 445474C. Pressure rating based upon hydrostatic design stress of 1,000 psi at 73.4 degrees F.

3. Minimum Pressure Rating: 80 psi (unless otherwise detailed on design drawing).
4. Minimum wall thickness conforming to SDR 26 (unless otherwise detailed on Drawings).
5. Mid-Span Restrain/Wall Pipe: ISCO IPS Wall Anchor or approved equal.
6. Gaskets: Material, size and thickness as recommended by flange manufacturer and in accordance with PPI Technical Note 38.

2.02 TRANSITION FITTINGS

A. Steel Shielded Couplings:

1. Designed to join sewer pipes of the same or different material or size and designed for resistance to heavy backfill loads and shear forces, and provide improved pipe alignment. Shielding couplings shall fit over the end of plain end or spigot pipe to form a positive seal against infiltration and exfiltration in non-pressure applications.
2. Manufactured from elastomeric polyvinyl chloride (PVC) which is unaffected by soil conditions and resistant to chemical, ultraviolet rays, and normal sewer gases. The PVC material shall contain bactericide and fungicide to inhibit growth of bacteria and fungus. The PVC material shall be 55 minimum to 65 maximum Shore A durometer hardness. Couplings shall conform to ASTM D5926 and ASTM C1173 and the applicable parts of ASTMs C443, C425, C564, and D1869,
3. The coupling shall be cased with a corrosion resistant Series 300 stainless steel band and end clamps which when tightened to 60 inch-pounds torque, seal the joint.
4. Manufactures
 - a. Fernco 5000 Series or approved KUB equal
 - b. Approved and listed by all of the following code agencies: SBCCI (Southern Building Code Congress International, Inc.), BOCA (Building Officials & Code Administrators International, Inc.), IAPMO (International Association of Plumbing and Mechanical Officials), and CSA (Canadian Standards Association).

B. Flexible Couplings:

1. Designed to join sewer pipes of the same or different material or sizes. Flexible couplings shall fit over the end of plain end or spigot pipe to form a positive seal against infiltration and exfiltration in non-pressure applications. Flexible couplings shall flex with normal earth movement to maintain integrity of seal. Use of flexible couplings shall be approved by the OWNER..

2. Manufactured from elastomeric polyvinyl chloride (PVC) which is unaffected by soil conditions and resistant to chemical, ultraviolet rays, and normal sewer gases. The PVC material shall contain bactericide and fungicide to inhibit growth of bacteria and fungus. The PVC material shall be 55 minimum to 65 maximum Shore A durometer hardness. Couplings shall conform to the applicable parts of ASTM C443, ASTM C425, ASTM C564, and ASTM D1869.
3. Flexible coupling shall be supplied with two corrosion resistant Series 300 stainless steel clamps, which when tightened to 60 inch-pounds torque, seal the joint.
4. Approved and listed by all of the following code agencies: SBCCI (Southern Building Code Congress International, Inc.), BOCA (Building Officials & Code Administrators International, Inc.), IAPMO (International Association of Plumbing and Mechanical Officials), and CSA (Canadian Standards Association).

C. Ductile Iron Couplings:

1. Designed to join sewer pipes of the same or different material or size and designed for resistance to heavy backfill loads and shear forces, and provide improved pipe alignment.
2. Romac 501 fitting or approved equal

D. HDPE:

1. HDPE MJ Adapter with metal insert, Metal Gland, Gasket, and attachment Bolts and Nuts.

2.03 DOUBLE SWEEP CLEANOUT

- A. Double sweep cleanout shall be SDR 26 as manufactured by Plastic Trends, Inc.

2.04 CLEANOUT BOX

- A. Cleanout box in paved (traffic bearing) areas shall be Sigma Corporation, Model P-107.
- B. Cleanout box in non-traffic bearing areas shall be high-density polyethylene of one piece molded construction, Model MSBCF1015-12 with polymer concrete cover, Model 1015, gray, marked "SEWER" with lift eye as manufactured by Carson Industries, LLC. Cleanout cap inside the cleanout box in unpaved areas shall be PVC.

2.05 MANHOLE CONNECTIONS

- A. Connections to new precast manholes: In accordance with Section 02530, Manholes.

- B. Connections to existing manholes:
 - 1. Trelleborg: Kor-N-Seal flexible connector.
 - 2. GPK Products Inc: Sanded Manhole Adapter.

PART 3. EXECUTION

3.01 PVC AND DUCTILE IRON PIPE INSTALLATION

- A. All pipe shall be installed in accordance with the Project Drawings, manufactures recommendations, and in the presence of the OWNER. Do not begin the backfilling of trenches until the pipe in place has been visually inspected by the OWNER. Pipe installation shall begin at the lowest elevation, unless otherwise approved by the OWNER.
- B. Before placing sewer pipe in position in the trench, carefully prepare the bottom and sides of the trench, and install any necessary bracing and sheeting as provided in Section 02321, Excavation, Bedding, and Backfill for Utilities.
- C. Lower pipe, fittings, and appurtenances into trench, piece by piece, by means of crane, slings, or other suitable tools and equipment, in such a manner as to prevent damage to pipe materials, protective coatings and linings. Do not drop or dump pipe into trenches.
- D. Lasers shall be used to install sewer lines and the type and procedures shall be approved by the OWNER. Reference points for both line and grade shall be set at each manhole. Check for pipe alignment and grade after each joint has been made. Measure for grade at pipe invert, not at top of pipe.
- E. Do not allow water to run or stand in the trench while pipe laying is in progress or before the trench has been backfilled. Do not at any time open up more trenches than the available pumping facilities are able to dewater.
- F. Trench bottoms that are found to be unsuitable shall be stabilized as specified in Section 02321, Excavation, Bedding, and Backfill for Utilities.
- G. Carefully inspect each piece of pipe and special fitting before it is placed, and lay no defective pipe in the trench. Pipe laying shall proceed upgrade, starting at the lower end of the grade and with the bells upgrade. Ensure that bottom of pipe is in contact with bottom of trench for full length of each section. Place sufficient pipe bedding material to secure pipe from movement before next joint is installed. When pipe laying is not in progress, keep the ends of the pipe tightly closed with an approved temporary plug.

- H. Excavation for bell holes shall be large enough to allow ample room for the pipe joints to be properly made. Excavate out bell holes no more than two joints ahead of the pipe laying. Carefully grade the bottom of the trench between bell holes so that each pipe barrel rests on a solid foundation as specified in Section 02321, Excavation, Bedding, and Backfill for Utilities. Install each pipe with a close concentric joint to avoid sudden offsets or inequalities in the flow line.
- I. As the Work progresses thoroughly clean the interior of the pipe in place. After each line of pipe has been laid, carefully inspect it, and remove and, in accordance with all laws and regulations, dispose of all earth, trash, rags, and other foreign matter from its interior.
- J. For all tees that are plugged and laid in rock, cut or blast a minimum of 6 linear feet of ditch line in the direction and to the approximate grade of the future lateral as directed by the OWNER, but do not excavate the material. Furnish the OWNER with a record of the exact location of each tee installed.
- K. Where the sewer line being installed is replacing an existing sewer with confirmed or suspected lateral service connections, the CONTRACTOR shall perform pre-installation CCTV inspection to locate active services, including:
 - 1. Cleaning: required if necessary to identify active services.
 - 2. CCTV Inspection: provide a DVD of the CCTV inspection.
 - 3. Dye Testing: to determine if the services are active.
 - 4. Bypassing Wastewater: Reference Section 02542, Sewer Flow Control.
 - 5. Line Obstructions: If CCTV inspection cannot be completed due to line obstructions that cannot be removed by sewer cleaning, notify the OWNER to coordinate alternate investigative measures, as appropriate.
- L. Carefully protect from damage all existing sewers, water lines, gas lines, sidewalks, curbs, gutters, pavements, electrical lines, and other utilities or structures in the vicinity of the work at all times. If it is necessary to repair, remove, and/or replace any such utility or structure in order to complete the work properly, do so in compliance with the provisions set forth in other sections of these Specifications. Any such work shall be considered incidental to the construction of sewer mains.
- M. Wastewater flow shall be maintained in the existing sewers in accordance with Section 02542, Sewer Flow Control.
- N. Restrain pipe joints in accordance with the project drawings (if specified).

3.02 FRP INSTALLATION

A. General:

1. Join pipe in accordance with manufacturer's instructions, unless otherwise shown or specified.
2. Comply with all applicable requirements of paragraph 3.01 of this specification.

3.03 HDPE INSTALLATION

A. General:

1. Install in accordance with AWWA M55, PPI TR-33 ASTM F2620 and pipe manufacture's recommendations.
2. Fittings: Thermal butt fusion of same rating as pipe
3. Joining: Butt fuse. Provide data logger data if requested by the OWNER
4. Flanges: Thermally butt fused to end of pipe. Install with backup rings of Type 316 stainless steel.
5. Transition Fittings: Where transitioning between materials and connecting to valves use HDPE MJ Adapter with metal insert, Metal Gland, Gasket, and attachment Bolts and Nuts.

3.04 TRANSITION FITTINGS

- A. Connections where pipe materials change shall be made using a shielded coupling in accordance to the manufacture's recommendations.
- B. Installation of a ductile iron transition coupling or flexible coupling must be approved by the OWNER. The OWNER may require the flexible coupling to be encased with concrete.

3.05 CONNECTIONS TO MANHOLES

- A. Connections to new precast manholes: In accordance with Section 02530, Manholes.
- B. Unless otherwise noted on the Project Drawings, connections to existing manholes shall be made using a Kor-N-Seal flexible connector in accordance with the manufactures recommendations.

3.06 SERVICE LATERALS

A. Shutdown:

1. Notify OWNER at least one week prior to the shutdown when it is necessary to shutdown a private service line while Work is in progress and before the service lines are reconnected. Notify building occupants with a KUB approved door hanger not less than 36 hours prior to shutdown.

2. When a service lateral will be disconnected the flow shall be controlled in accordance with Specification 02542, Sewer Flow Control.
3. No service is to remain shut down without sewer flow control or a leak free temporary connection. Otherwise, CONTRACTOR shall then provide temporary living quarters (i.e., hotel) for the resident at no additional cost to OWNER or the resident. Temporary living quarters shall be approved by OWNER and coordinated through OWNER's Customer Support Representative. Commercial sewer services shall be maintained when businesses are open.

B. Installation:

1. If the Work consists of constructing a new sewer to replace an existing one, existing laterals shall be replaced to the property line in accordance with the standard detail herein unless directed otherwise by the OWNER. Laterals which have been disconnected, cut or abandoned shall be plugged and sealed with a backing block securing the plug. CONTRACTOR shall provide the street address of each reconnected lateral.
2. Use eccentric or concentric PVC reducer fitting to transition pipe diameters and then a steel shielded transition coupling to connect to the existing private property lateral.
3. CONTRACTOR shall install laterals with a minimum slope of 1 percent from the mainline sewer to a point 2 feet on customer side of cleanout
4. Cleanouts shall be installed for each active service. Cleanouts should be located on the property line or easement outside traffic bearing areas unless directed otherwise by the OWNER. However, where a long lateral crosses another private property, the cleanout should be located at the road right-of-way.
5. Where saddles are used the saddle shall be installed on a clean-cut, properly sized hole on the existing sewer, such that a watertight connection results. The cut in the existing pipe shall be made with a hole saw which retains the coupon. Sewer saddles shall not be used on vitrified clay pipe, or any other pipe deemed unsuitable for this method by the OWNER.
6. Service or house connections to existing sewers that are damaged or removed shall be repaired or replaced by the CONTRACTOR at its own expense as an incidental part of the Work.
7. Install new service laterals to existing manholes as specified in Section 02530, Manholes. Reshape the bottom at the manhole as necessary to fit the invert of sewer pipe.
8. To prevent undermining of traffic bearing areas, a Class A Grade D aggregate bulkhead shall be installed between the cleanout stack and traffic bearing area in.
9. Place backfill, bedding, and cover in accordance with Section 02532, Excavation, Backfill, and Bedding of Utilities.

C. Service Connection to Sewer Mains:

1. Make connections to ductile iron pipe with a minimum 6-inch ductile iron saddle with Protecto 401 ceramic epoxy coating.
2. Make connections to HDPE with a minimum 6-inch HDPE branch or electro-fusion saddle or for 8-inches or greater installations a minimum 6-inch "Inserta-Tee" (Inserta Fittings Company).
3. Make connections to FRP with a minimum 6-inch "Inserta-Tee" (Inserta Fittings Company).
4. Connections to 8-inch CIPP mains shall be with a full saddle PVC tee solvent welded skirt to the liner with stainless steel straps, and minimum 6-inch gasketed branch connection.
5. Connections to greater than 8-inch CIPP mains shall be with a minimum 6-inch "Inserta-Tee" (Inserta Fittings Company).
6. Make connections to PVC pipe mains with 6-inch PVC tee fitting.

3.07 TESTING OF GRAVITY SEWERS

A. Visual Tests:

1. Prior to backfilling, the CONTRACTOR shall coordinate with the OWNER for a visual inspection of the sewer. The visual tests may include a check for proper grade and alignment, sufficient pipe bedding, pipe condition, and general cleanliness. The CONTRACTOR shall immediately repair all defects found by such inspection.
2. Sewers shall be built so as to remain true to line and grade. The inclining grade of the bottom of the sewer after completion shall be such that, after flooding, the flood water drains off so that no remaining puddle of water is deeper than 1/2 inch on pipe 36 inches internal diameter or smaller and 3/4 inch on pipe larger than 36 inches internal diameter. Any section of pipe that does not comply with the specifications at any time previous to final acceptance of the work shall be replaced or re-laid at the CONTRACTOR's expense.
3. The CONTRACTOR shall be held strictly responsible that all parts of the work bear the load of the backfill. If cracks 1/100 inch develop in the pipe within one year from the date of final acceptance of the work, the CONTRACTOR shall be required to replace, at his expense, all such cracked pipe. To this end, the CONTRACTOR is advised to purchase pipe under a guarantee from the manufacturer, ensuring proper service of sewer pipe under conditions established by the Drawings, Specifications, and local conditions at the Site of the Work.

B. Air Testing for Sewers 24 inches in Diameter and Smaller:

1. The CONTRACTOR shall be responsible for providing all labor and equipment for air testing.

2. This recommended practice defines the proper procedures for acceptance testing of installed gravity sewer pipe using low-pressure air, to provide assurance that the pipe, as installed, is free from significant leaks. Included are requirements for equipment accuracy, safety precautions, line preparation, test method, and minimum holding times. Air test results shall be recorded on the work sheet, which is included below in Paragraph E Air Test Data Sheet.
3. Only lines tested after backfilling to final grade will be considered for acceptability. However, this test may also be used by the installer as a presumptive test to determine the condition of the line prior to backfilling. During sewer construction, all service laterals, stubs and fittings into the sewer test section shall be properly capped or plugged to prevent air loss that could cause an erroneous air test result. It may be necessary and is always advisable for the CONTRACTOR to restrain gasketed caps, plugs, or short pipe lengths with bracing stakes, clamps, and tie-rods or wire harnesses over the pipe bells.
4. Unless otherwise specified, the CONTRACTOR shall furnish all the necessary equipment and be responsible for conducting all low-pressure air tests. In addition, the CONTRACTOR shall be responsible for any necessary repair work on sections that do not pass the test.
5. The OWNER shall witness all low-pressure air tests and verify the accuracy and acceptability of the equipment utilized. The OWNER will inform the CONTRACTOR regarding acceptable methods of repair in the event one or more sections fail to pass the low-pressure air test.
6. Ensure that all plugs are installed and braced in such a way that blowouts are prevented. As an example of the hazard, a force of 250 pounds is exerted on an 8-inch plug by an internal pipe pressure of 5 psig, and a force of 2,250 pounds is exerted on a 24-inch plug by an internal pressure of 5 psig. The CONTRACTOR must realize that sudden expulsion of a poorly installed plug, or of a plug that is partially deflated before the pipe pressure is released, can be very dangerous. For this reason, it is recommended that every plug be positively braced against the manhole walls, and that no one be allowed in the manhole adjoining a line being tested so long as pressure is maintained in the line.
 - a. It is further recommended that internal pressure of more than 9 psig not be permitted except for leak location equipment where the plugs are firmly tied together.
 - b. Use either mechanical or pneumatic plugs. All plugs shall be designed to resist internal testing pressures without the aid of external bracing or blocking. However, the CONTRACTOR should internally restrain or brace the plugs to the manhole wall as an added safety precaution throughout the test.

7. All pressurizing equipment used for low-pressure air testing shall include a regulator or relief valve set no higher than 9 psig to avoid over-pressurizing and displacing temporary or permanent plugs. As an added safety precaution, the pressure in the test section should be continuously monitored to make certain that it does not at any time exceed 9 psig. (It may be necessary to apply higher pressure at the control panel to overcome friction in the air supply hose during pressurization.)
8. To facilitate test verification by the OWNER, all air used shall pass through a single, above ground control panel. The aboveground air control equipment shall include a shut-off valve, pressure relief valve, input pressure gauge, and a continuous monitoring pressure gauge having a pressure range from 0 to at least 10 psi. The continuous monitoring gauge shall be no less than 4 inches in diameter with minimum divisions of 0.10 psi and an accuracy of plus or minus 0.04 psi. Two separate hoses shall be used to: 1) connect the control panel to the sealed line for introducing low-pressure air, and 2) a separate hose connection for constant monitoring of air pressure build-up in the line. This requirement greatly diminishes any chance for over-pressurizing the line.
 - a. If pneumatic plugs are utilized, a separate hose shall also be required to inflate the pneumatic plugs from the above ground control panel.
9. After a manhole-to-manhole reach of pipe has been backfilled to final grade and compacted, prepared for testing, and a 24-hour waiting period has elapsed, the plugs shall be placed in the line at each manhole and secured.
 - a. The CONTRACTOR is advised to seal test all plugs before use. Seal testing may be accomplished by laying one length of pipe on the ground and sealing it at both ends with the plugs to be checked. The sealed pipe should be pressurized to 9 psig. The plugs shall hold against this pressure without bracing and without any movement of the plugs out of the pipe. No persons shall be allowed in the alignment of the pipe during plug testing. It is advisable to plug the upstream end of the line first to prevent any upstream water from collecting in the test line. This is particularly important to high groundwater situations.
 - b. When plugs are being placed, the pipe adjacent to the manhole shall be visually inspected to detect any evidence of shear in the pipe due to differential settlement between the pipe and the manhole. A probable point of leakage is at the junction of the manhole and the pipe, and this fault may be covered by the pipe plug, and thus not revealed by the air test.

10. Low-pressure air shall be slowly introduced into the sealed line until the internal air pressure reaches 4.0 psig. If the groundwater table is above the sewer being tested, the air pressure shall be increased 0.43 psi for each foot that the water table is above the invert of the sewer, up to a maximum of 9.0 psig. After a constant pressure of 4.0 psig (greater than the average groundwater back pressure) is reached, the air supply shall be throttled to maintain that internal pressure for at least 2 minutes. This time permits the temperature of the entering air to equalize with the temperature of the pipe wall.
 - a. When temperatures have been equalized and the pressure stabilized at 4.0 psig (greater than the average groundwater backpressure), the air hose from the control panel to the air supply shall be shut off or disconnected. The continuous monitoring pressure gauge shall then be observed while the pressure is decreased to no less than 3.5 psig (greater than the average backpressure of any groundwater over the pipe). At a reading of 3.5 psig, timing shall commence with a stopwatch.
 - b. If the time shown for the designated pipe size and length (see Air Test Time Tables below) elapses before the air pressure drops 0.5 psig, the section undergoing test shall have passed. The test may be discontinued once the prescribed time has elapsed even though the 0.5 psig drop has not occurred. If the pressure drops 0.5 psig before the appropriate time shown in the air test table below has elapsed, the air loss rate shall be considered excessive and the section of pipe has failed the test.
 - c. If the section fails to meet these requirements, the CONTRACTOR shall determine at its own expense the source, or sources, of leakage, and shall repair or replace all defective materials or workmanship to the satisfaction of the OWNER. The extent and type of repair which may be allowed, as well as results, shall be subject to the approval of the OWNER. The completed pipe installation shall then be retested and required to meet the requirements of this test.

C. Testing for Sewers Larger than 24 Inches in Diameter:

1. The CONTRACTOR is responsible for providing all labor and equipment for testing. Testing shall be accomplished via a hydrostatic test. An ultrasonic test or seepage and infiltration test are only allowed when a hydrostatic test cannot be performed and approved by the OWNER.
2. Hydrostatic Test:
 - a. Perform testing in the presence of the OWNER or RESIDENT PROJECT REPRESENTATIVE.
 - b. Pipe over 24 inches in diameter shall be tested for leakage using Hydrostatic Exfiltration Test Method.

- c. Individual joints may be tested on pipe 36 inches in diameter and larger at CONTRACTOR's option.
- d. Pipe shall successfully pass leakage test prior to acceptance.
- e. Test sections of constructed sewer between stations only after service connections, manholes, and backfilling are completed. Testing may be done prior to placement of asphaltic concrete or roadway structural section.
- f. Isolate new pipelines that are connected to existing pipelines. Install pipe plugs as required to allow section of new pipe to be pressure tested.
- g. Plug wyes, tees, stubs, and service connections with gasketed caps or plugs securely fastened or blocked to withstand internal test pressure. Such plugs or caps shall be removable, and their removal shall provide socket suitable for making flexible jointed lateral connection or extension.
- h. Furnish testing equipment and perform tests as approved by OWNER. Testing equipment shall provide observable and accurate measurement of leakage under specified conditions.
- i. Supply of temporary water shall be collected as specified below:
 - 1) Any and all OWNER water used by CONTRACTOR shall be from a metered supply with an approved backflow device to protect the water supply. All metered water supply shall be paid to OWNER through the regular billing system.
 - 2) CONTRACTOR shall be responsible for obtaining transient water meter(s) from OWNER, which shall be installed on the trucks or at fire hydrant(s). All related charges for the set-up shall be considered incidental to the cleaning of the existing sanitary sewer mains.
 - 3) CONTRACTOR shall be responsible for preventing contamination of the potable water system. CONTRACTOR when drawing water from a public hydrant shall use a backflow preventer or an 18-inch air gap.
 - 4) No fire hydrant shall be obstructed or used when there is a fire in the area.
 - 5) It shall be CONTRACTOR's responsibility to obtain approval to use OWNER's fire hydrants.
 - 6) CONTRACTOR shall remove the water meter(s)/piping etc. from all fire hydrants at the end of each working day and to dispose of water used during testing.
- j. Test sections of constructed sewer between stations only after service connections, manholes, and backfilling are completed. Testing may be done prior to placement of asphaltic concrete or roadway structural section.

3. Hydrostatic Exfiltration Test:
 - a. Procedure:
 - 1) Maximum filling velocity shall not exceed 0.25 foot per second, calculated based on full area of pipe.
 - 2) Expel air from piping system during filling.
 - 3) Apply and maintain specified test pressure with hydraulic force pump. Valve off piping system when test pressure is reached.
 - 4) Maintain hydrostatic test pressure continuously for 2 hours minimum, adding additional make-up water only as necessary to restore test pressure.
 - 5) Determine actual leakage by measuring quantity of water necessary to maintain specified test pressure for duration of test.
 - b. Measurement Accuracy: Plus or minus 1/8 gallon of water leakage under specified conditions
 - c. Joints shall sustain maximum water loss limit of 0.8 gallon per inch diameter per 1,000 feet of pipe, including service connections within test section per 2 hours. Allowable leakage shall be modified as stated below if hydrostatic head is other than 6 feet.
 - d. Hydrostatic Head:
 - 1) At least 6 feet above maximum estimated groundwater level in section being tested, but no less than 6 feet above inside top of highest section of pipe in test section, including service connections.
 - 2) In every case, determine height of water table at time of test by exploratory holes or such other methods approved by OWNER. OWNER will make final decision regarding test height for water in pipe section being tested.
 - 3) If hydrostatic head is other than 6 feet, allowable leakage as computed by criteria above shall be adjusted by the square root of actual head divided by square root of 6.
 - e. Length of Pipe Tested: Limit length such that pressure on invert of lower end of section does not exceed 16 feet of water column. In no case shall length be greater than 700 feet or distance between manholes when greater than 700 feet.
 - f. Dispose of test water in a manner acceptable with OWNER and regulatory agencies.

4. Hydrostatic Joint Testing:
 - a. If pipe fails to pass hydrostatic test and location of leak cannot be readily identified, individual joint tests shall be performed. After leaking joints have been located and repaired, retest pipeline.
 - b. Provide device specifically designed for testing of pipe joints and consisting of a metal cylinder, seal ring on each side of joint, and method of applying pressure to joint.
 - 1) Manufacturer:
 - a) Mechanical Research and Design, Inc., Manitowoc, WI.
 - b) Cherne Industries, Inc., Minneapolis, MN.
 - c) Approved equivalent
 - 2) Measurement Accuracy: Plus or minus 0.05 gallon of water leakage under specified conditions.
 - 3) Determine height of groundwater table at time of test.
 - 4) Minimum Pressure, Each Joint: 2.5 psi above backpressure of groundwater.
 - 5) Minimum Test Duration, Each Joint:
 - a) 20 minutes for 60-inch diameter pipe and smaller.
 - b) 10 minutes for pipe larger than 60-inch diameter.
 - 6) Maximum Leakage: Leakage per joint shall not exceed maximum water loss limit of 0.0008 gallon per hour per inch-diameter times length of distance between pipe joints.
5. Ultrasonic Test:
 - a. The CONTRACTOR may utilize an ultrasonic method to detect leaks if hydrostatic testing is not possible and approved by the OWNER. An ultrasonic transmitter shall be utilized to determine if a leak has occurred, which will be indicated by the sound of a running faucet.
 - b. If the pipe is buried, then the ultrasonic test shall be carried out by placing a metal rod on the pipe and placing the transmitter on the metal rod to listen for leaks. Proceed in 10 to 25 foot intervals.
6. Seepage and Infiltration Test:
 - a. The CONTRACTOR may utilize conduct seepage and infiltration testing if hydrostatic testing is not possible and approved by the OWNER. Testing may only be conducted where the natural groundwater is 24 inches or more above the top of a section of pipe, the CONTRACTOR shall measure the flow of water in the pipe and the rates of seepage and infiltration. Measure the flow rate by using a calibrated weir. Leave the weir in the line until the flow rate has stabilized. The CONTRACTOR is responsible for verifying the groundwater level by providing sight gauges in manholes or digging test holes at suitable locations.
 - 1) The total seepage and infiltration of groundwater as determined by the test shall in no case exceed 50 gallons per 24 hours per inch-mile of pipe. Make infiltration tests on all sewer

construction before placing the lines in service and before making any connections to other sewers. If the amount of infiltration into the sewer(s) is in excess of the maximum quantity specified above, then repair the joints, relay the sewer (if necessary), or perform other remedial construction, at the CONTRACTOR's expense, in order to reduce groundwater infiltration to within the specified limits.

- 2) In making infiltration tests, furnish the required equipment and labor and do the necessary pumping under the direction on the OWNER. Tests may be repeated until each sewer individually meets the Specifications for infiltration amounts as set above.
- b. Where the groundwater is not 24 inches or more above the top of the pipe section being tested, the CONTRACTOR shall perform an exfiltration test. Bulkhead the pipe below the lower manhole of the section being tested with a pneumatic plug or other device. Insert a vent pipe 48 inches long in the stopper of the upper end of that section. Then fill the lower manhole with water, or add water until there is a minimum of 4 feet over the upper end; make certain that all air is forced out through the vent tube. Measure the drop in the level of the water in the manhole due to exfiltration over a specific time, and calculate the water loss due to exfiltration. The total exfiltration shall not exceed that specified above for infiltration.

D. Air Test Time Tables:

1. The following tables indicate the time that must elapse before the air pressure inside the pipe drops 0.5 psig. If the pressure inside the pipe drops 0.5 psig before the time has completely elapsed, the air loss rate shall be considered excessive and the section of pipe has failed the test.

MINIMUM SPECIFIED TIME REQUIRED FOR A 0.5 PSIG PRESSURE DROP FOR SIZE AND LENGTH OF PIPE INDICATED FOR Q=0.0015 FT³ /MIN.

1 Pipe Dia. (in.)	2 Min. Time (min.: sec.)	3 Length For Min. Time (ft.)	4 Time for Longer Length (sec.)	Specification Time for Length (L) Shown (min.:sec.)			
				100 ft.	200 ft.	300 ft.	400 ft.
4	1:53	597	.190 L	1:53	1:53	1:53	1:53
6	2:50	398	.427 L	2:50	2:50	2:50	2:51
8	3:47	298	.760 L	3:47	3:47	3:48	5:04
10	4:43	239	1.187 L	4:43	4:43	5:56	7:54



12	5:40	199	1.709 L	5:40	5:42	8:33	11:24
15	7:05	159	2.671 L	7:05	8:54	13:21	17:48
18	8:30	133	3.846 L	8:30	12:49	19:14	25:38
21	9:55	114	5.235 L	9:55	17:27	26:11	34:54
24	11:20	99	6.837 L	11:24	22:48	34:11	45:35

A. Air Test Data Sheet:

1. Air test results shall be recorded on the following worksheet:

AIR TEST DATA SHEET

Owner (Name of city, district, etc.):	Test No.:
Identification of Pipe Installation (Job name, location, contract number, etc.):	

Field Test Data: (To be filled in by the inspector)										
Date:				Specified Maximum Pressure Drop:				psig		
Identification of Pipe Material Installed:										
Pipe Under Test				Specification Time	Field Test Operations Data					
Upstream MH sta #	Downstream MH sta #	Dia. D (in.)	Length L (ft.)		Refer to UNI-B-6 (min.:sec.)	Pressure Initially Raised to (psig)	Time Allowed for Pressure to Stabilize (min.)	Start Test Pressure (psig)	Stop Test Pressure (psig)	Elapsed Time (min.:sec.)
Inspector's Name and Title:										
Signature of Inspector:										



If a section fails, the following items should be completed:

Identify section(s) that failed:

Leak (was) (was not) located. Method used:

Description of leakage found:

Description of corrective action taken:

For test results after repair refer to Test No.:

Inspector:

3.08 PVC PIPE DEFLECTION TESTING

- A. The CONTRACTOR is responsible for providing all labor and equipment for deflection testing.
- B. Test deflection of the pipe by manually pulling with twine a one-piece nine-arm go/no-go mandrel (sized in accordance with ASTM D3034) through the pipe. Within 24 hours after compaction of the backfill is complete, the line shall be tested using a 5 percent deflection mandrel. If the line is satisfactory, it shall be retested using a 7.5 percent deflection mandrel no less than 30 days following the completion of compaction.

3.09 INSPECTION

- A. Television Pipeline Inspection:
 - 1. General:
 - a. Contractor shall internally inspect sewer pipelines by closed circuit television (CCTV) after successful completion of pipeline cleaning.
 - b. Cleaning and CCTV inspections shall be conducted in accordance with Section 02541, Sewer Television Inspection.
 - c. Conduct the inspection in presence of the OWNER.

3.10 CLEANUP

- A. After completing each section of the sewer line, all debris and construction materials shall be removed from the work site and disposed of in compliance with all applicable laws and regulations and with Section 02321, Excavation, Bedding, and Backfill for Utilities. Then the surface shall be graded and smoothed on both sides of the line. The entire area shall be left clean and in a condition satisfactory to the OWNER. The CONTRACTOR shall keep cleanup operations as close to active pipe laying activities as practical generally following by less than 300 feet or as approved by the OWNER.

END OF SECTION