

Kenosha Water Utility Standard Construction Specifications
Sanitary Sewer

Table of Contents

1)	Sanitary Sewer Main Pipe (Gravity Fed)	3
2)	Sanitary Sewer Force Main Pipe (Pressure Fed)	4
3)	Joints.....	5
4)	Fittings	5
5)	Manholes.....	6
6)	Manhole Adjustments and Reconstructs.....	9
7)	Laying of pipe.....	10
8)	Lateral Connections.....	12
9)	Insulation.....	13
10)	Tracer Wire.....	14
11)	Deflection Testing	15
12)	Infiltration Testing.....	16
13)	Low Pressure Air Testing.....	17
14)	Vacuum Testing and Televising.....	19

Section 0200 – Sanitary Sewer

1) *Sanitary Sewer Main Pipe (Gravity Fed)*

1.1. Materials

- a) Sanitary sewer main shall be installed using Polyvinyl Chloride Pipe (PVC) and shall be of class SDR 26 for depths up to twenty-five feet (25') deep. The minimum size for sanitary sewer main is eight inch (8"). PVC pipe & fittings – eight inch thru fifteen inch (8" - 15") shall meet ASTM Standard D3034. Eighteen inch thru forty-eight inch (18" – 48") shall meet ASTM Standards F-679 PS115. For depths greater than twenty-five feet (25'), pipe shall be PVC class C-900, ductile iron, or concrete and designs shall be approved separately by the Engineer. Pipe shall be marked at intervals of five feet (5') or less as follows:
 - (i) Manufacturer's name or trademark
 - (ii) Nominal pipe size
 - (iii) PVC cell classification
 - (iv) SDR number
 - (v) ASTM Designation D3034 or F-679 PS115
 - (vi) Date of Manufacture
- b) All sanitary sewer pipe material and appurtenances shall be furnished by Contractor. All sanitary sewer main pipe and appurtenance materials shall be manufactured and installed in the current year unless prior written approval has been given by the KWU Director of Engineering. All sanitary sewer pipe and appurtenances shall be in accordance with the latest AWWA standards.
- c) A copy of all shipping invoices shall be furnished with a sworn statement by manufacturer that the inspection and all specified tests have been made and the results comply with the requirements of the standards stipulated. Any pipe or accessories found by the Engineer to be defective, damaged or not complying with the AWWA standard shall be rejected. The replacement of rejected materials shall be the responsibility of Contractor at no additional expense to Kenosha Water Utility.

1.2. Construction Methods

- a) Sanitary sewer main shall be generally located at the centerline of the proposed street.
- b) Pipe shall be subject to rejection on account of any visual deficiencies.

2) Sanitary Sewer Force Main Pipe (Pressure Fed)

2.1. Materials

- c) Sanitary force mains shall be PVC water main class pipe conforming to AWWA C-900 with a pressure class not less than 150, and a dimension ratio not greater than DR 18; unless otherwise approved by the Engineer. A #12 gage standard solid green PVC coated copper tracer wire shall be used along the top of the pipe, taped at ten foot (10') intervals. Tracer wire shall be brought to grade in 2 piece cast iron valve boxes, located every three-hundred feet (300') along the route. The valve box cover shall be labeled "Sewer" and shall extend from the force main to finished grade. Pipe shall be marked at intervals of five feet (5') or less as follows:

- (i) Manufacturer's name or trademark
- (ii) Nominal pipe size
- (iii) PVC cell classification
- (iv) SDR number
- (v) AWWA Designation
- (vi) Date of Manufacture

2.2. Materials

- a) The maximum job site pull-in force shall not exceed the manufacturer's recommended safe pull-in force.
- b) Directionally drilled pipe shall sit undisturbed for a minimum of 48-hours to allow for settlement of the directionally drilled pipe prior to extension of the pipe or installation of any fittings or appurtenances unless otherwise approved by the Director of Engineering.
- c) If recommended by the manufacturer due to job site conditions and pull-in equipment, contractor may select a lesser DR rating (stronger pipe) with approval from the Director of Engineering.
- d) When recommended by the pipe manufacturer, the contractor shall install measures to protect against contraction or expansion of the pipe. Possible recommended measures may include, but are not limited to, concrete wall anchors and/or additional joint restraint beyond the completed directionally drilled pipe sections.

3) Joints

3.1. Materials

- a) All pipes shall have bell and spigot ends designed for a rubber gasket push-on joint, providing a water tight seal. The assembly of joints shall be in accordance with the pipe manufacturer's recommendations. All rubber gaskets for PVC pipe shall conform to ASTM F477.
- b) The assembled joint shall pass the performance tests required in ASTM D-3212 for gravity pipe and performance tests required in ASTM D-3139 for pressure pipe.

4) Fittings

4.1. Materials-Sanitary Sewer Main

- a) Fittings such as saddles, tees, wyes, elbows and others on gravity sanitary sewer shall be of PVC pipe material rated DR 26 corresponding to and having a joint design compatible with adjacent pipe. Approved adapters shall be provided for transition to other types of pipe. Fittings shall be clearly marked as follows:
 - (i) Manufacturer's name or trademark
 - (ii) Nominal pipe size
 - (iii) Material Designation
 - (iv) AWWA or ASTM Designation D3034 or F-679.

4.2. Materials-Sanitary Sewer Force Main

- a) Fittings on sanitary force mains shall be ductile iron, class 250 conforming to AWWA C-110/ANSI A21.10 or cast ductile iron compact fittings conforming to AWWA C-153/ANSI A21.53 with a pressure rating of 350 psi. Fittings shall have a cement mortar lining and an internal bituminous coat conforming to AWWA C-104/ANSI A21.4. All fittings shall have mechanical joints using Megalugs with rubber gaskets and stainless steel T-bolts and nuts. An anode bag shall be supplied by KWU and installed by the contractor at each fitting. All ductile iron fittings shall be wrapped with polyethylene encasement in accordance with AWWA C-105/ANSI A 21.5. Fittings shall be clearly marked as follows:
 - (i) Manufacturer's name or trademark
 - (ii) Nominal pipe size
 - (iii) Material Designation
 - (iv) AWWA or ASTM Designation D3034 or F-679.

5) Manholes

5.1. Materials

- a) Manholes shall be located at any bend or deflection locations when laying sanitary sewer. Spacing of manholes shall be at a maximum of four-hundred feet (400') for sewers of fifteen inches (15") or less and five-hundred feet (500') for sewers eighteen inches to thirty inches (18" to 30") in accordance with NR 110.13.
- b) Manhole barrels shall be constructed of pre-cast reinforced concrete sections. The minimum diameter of manholes shall be forty-eight inches (48") for pipe that is eight inch to twenty-four inch (8" to 24") in diameter. Refer to the table on the detail sheet.
- c) Pre-cast manholes and tops shall conform with ASTM Specifications, C478, latest revision. Pre-cast manholes are to be provided with eccentric cones. The minimum wall thickness shall be in conformance with the table on the detail sheet. Reinforced integral floors shall have a minimum thickness of six inches (6").
- d) The top of the pre-cast cone shall have minimum three inches (3") vertical ring integrally cast with the cone. The surface shall be smooth and free of form offsets cracks or honeycomb.
- e) Each pre-cast reinforced concrete manhole riser and top section shall be clearly marked with the name or trademark of the manufacturer and the date of manufacture. This marking shall be indented into the manhole section or shall be painted thereon with waterproof paint.
- f) All manholes are to be constructed as detailed on the Standard Detail Sheet. The flow lines shall be continuous through the manhole and in cases where the pipe is not extended through, provide a smooth channel by pouring concrete (Class "A") up to the spring line of the pipe. A pre-cast manhole bottom section may be used for Type "B" manholes.

5.2. Testing

- a) Each manufacturer shall provide a suitable core-drilling machine conforming to ASTM Designation C-497 on his premises and an operator to take test cores as directed by the Testing Laboratory personnel.
- b) Pre-cast reinforced concrete manhole risers and tops shall be tested in accordance with ASTM Designation C-497 by a testing laboratory, approved by the Engineer, for concrete compressive strength compliance by compression tests on cores drilled from 5% of the lot. When manhole sections are made on a sewer pipe machine, the number of compression tests on cores may be reduced to one percent of the lot, with a minimum of two cores per lot. Unless otherwise specified, absorption tests will be waived.
- c) All sampling, monogramming and testing expenses incurred by the testing laboratory shall be paid by the Contractor.
- d) Pre-cast reinforced concrete manhole risers and tops meeting the strength requirements will be considered acceptable and shall be stamped with an appropriate monogram. Special bottom risers and adjusting rings need not be tested. Copies of test reports shall be submitted to the Engineer before the manhole sections are installed in the project. Final acceptance will be made after field inspection upon delivery to the job site.

- e) Pre-cast reinforced concrete manhole risers and tops shall be subject to rejection for failure to conform to any of the testing specification requirements. In addition, individual sections of manhole risers and tops may be rejected because of any of the following reasons:
 - i. Fracture or cracks passing through the wall, except for a single end crack that does not exceed the depth of the joint.
 - ii. Defects that indicate imperfect proportioning, mixing and molding.
 - iii. Surface defects indicating honey-combed or open texture.
 - iv. Damaged ends, where such damage would prevent making a satisfactory joint.
 - v. Manhole steps out of line, or not properly spaced.
 - vi. Visible infiltration into manhole.
 - vii. The internal diameter of the manhole section shall not vary more than one percent from the nominal diameter.
 - viii. Any continuous crack having a surface width of 0.01 inch or more and extending for a length of 12 inches or more regardless of position in the section wall.

5.3. *Manhole Joints, Connections and Steps*

- a) Joints for pre-cast manholes shall meet the requirements of ASTM C-443, latest revision, except that sealant shall be butyl rubber gasket or butyl rubber rope. Flexible butyl rubber gaskets or rope shall comply with the physical requirements for Type "B" gaskets in AASHTO Designation M-198, or Federal Specification SSS-00210-A, sealing compound, preformed plastic for expansion joints and pipe joints.
- b) All sanitary manholes shall have an exterior joint sealer applied to each joint, meeting the requirements of ASTM C-877. Acceptable manufacturer shall be MacWrap External Collar by Mar Mac Construction Products Co. Inc. or EZ-Wrap by Press Seal Gasket Corporation. The sealer installation shall be approved by the Engineer after application and prior to backfilling.
- c) All sanitary sewer pipe to manhole connections shall be with a flexible, watertight pipe to manhole seal meeting the requirements of ASTM C-425 and C-443. All new manholes will have factory installed boots built into the structure, prior to delivery to the job-site. Kor-N-Seal boots by NPC or approved equal shall be used.
- d) If a manhole is leaking prior to final acceptance by the Utility, manholes shall have all internal barrel joints grouted and an epoxy coating may be required. No cementitious lining will be allowed.
- e) When a sewer main or lateral enters a manhole any distance above the manhole invert, bedding material shall be placed the full depth of the excavation under the pipe prior to laying of pipe. Any sewer main or lateral entering a manhole greater than two feet (2') above the spring-line of the outgoing pipe (NR110.13) shall be an outside drop manhole, Type D or DD. The drop pipe shall be the same diameter as the incoming sewer.
- f) Connections to existing manholes by the use of coring will only be allowed at precast manhole structures, or if approved by the Engineer.
- g) All manholes shall be provided with steps equally spaced vertically at sixteen inches (16") on

center installed by the manufacturer. Steps shall be embedded into the riser or conical top section of the wall a minimum of three inches (3"). Manhole steps shall be PS2-PF5, as manufactured by MA Industries or equal made of copolymer propylene plastic conforming to the requirements of ASTM C-478. Each section of the manhole shall be aligned so the steps create a continuous ladder.

5.4. Manhole Frame and Lid

- a) All sanitary manholes shall be installed with a casting with self-sealing lid ground and machined bearing. Cover shall have two concealed pick holes which allow no water to enter the manhole and shall be embossed or engraved with the Kenosha Water Utility logo, refer to the Detail Sheet. Neenah R-1642 for asphalt roadways and Neenah R-1642-B for concrete roadways or approved equal. All manholes shall have an internal/external chimney seal by Adaptor Inc. or approved equal, installed after final grade is established. The chimney seal shall extend from the top of the cone section to the base of the frame. Seal materials shall conform to ASTM C-877 or ASTM C-923. Any metal parts shall be made of Type 304 stainless steel.
- b) Low profile frames, Neenah R-1642-A or approved equal, are allowed with approval from the Engineer.

6) *Manhole Adjustments and Reconstructs*

6.1. *Sanitary Manhole Adjustments*

- a) All adjustments of manhole height from the top of cone shall be made with expanded polypropylene rings as manufactured by Cretex or approved equal, and sealed together using M-1 structural adhesive as manufactured by Chem Link or approved equal following the manufacturers' recommendations.
- b) Rings shall have an inside diameter to match the manhole opening, be not less than two inches (2") nor more than six inches (6") high, and have a wall thickness of six inches (6") unless otherwise specified. Where necessary rings shall be grooved to receive manhole steps. No cracked or broken rings shall be used.
- c) The top of pre-cast manhole cones shall be set a maximum of eighteen inches (18") lower than established grade in unimproved areas, with the top of the manhole cover being ringed up flush with the existing ground. The maximum number of adjusting rings to be used in unpaved areas shall be six two-inch (2") rings or a total of twelve inches (12"). The minimum number of adjusting rings shall be one two-inch (2") ring. The maximum height of adjusting rings shall be eight inches (8") in paved areas.
- d) In new subdivisions, the cone section will be set to eight inches (8") below finished grade, a steel plate will be placed over the cone section and the pavement will be placed to the binder grade. The asphalt will be sawcut and removed around the manhole and the casting will be set to binder grade. The chimney seal will be installed at this time. When the final lift of asphalt is placed a paving ring will be installed in the casting frame to bring the lid to finished grade. No laterals shall be extended or connected to until after manhole castings are set to binder grade or finish grade.
- e) Whenever the raising or lowering of a manhole causes the distance between the top of cone and top of casting to be in excess of twenty-four inches (24"), or if the top of cone must be removed more than eight inches (8"), it shall be reconstructed. The work shall consist of removing the existing cone of the manhole and reconstructing a new cone to grade by adding precast concrete sections as provided in the plans and specifications, and installing a manhole casting supplied by Owner on the structure.
- f) The work under this item shall be paid for at the contract unit price which price shall be full compensation for furnishing all required materials, for all necessary excavation, backfilling, disposal of surplus material and for all labor, tools, equipment, and incidentals necessary for the completion of the work.
- g) On existing manhole structures within the project limits, the Contractor shall be required to exchange existing castings and frames for corresponding new ones. Castings and frames will be exchanged on a one for one basis. If the Contractor loses a casting or frame, a new one may be obtained from the Owner but must be replaced prior to final project payment.
- h) See the Standards for Public Right-of-Way Restoration for additional requirements and tolerances.

7) Laying of pipe

7.1. Construction Methods

- a) Sanitary sewer shall be installed in strict conformance with the drawings using a laser level. Deflections in the vertical plane are detailed on the profile view of the drawings. Pipe elevations, as shown, must be strictly followed in order to ensure proper vertical separation at sewer crossings. Any deviation from the drawings must be approved by the Engineer and Contractor shall accurately track changes on record drawings. The grade of sewer pipe as shown on the profile is that of the inner side of the invert and to which the work must conform. A variation of half inch (0.5") from either line or grade will be deemed sufficient reason to cause the work to be rejected and rebuilt. All pipes shall be laid with bells uphill and work will progress upgrade.
- b) Minimum slopes for mains shall be according to NR 110.13 Table 1, as follows:
 - i. 8-inch 0.40 (ft/100 ft)
 - ii. 10-inch 0.28 (ft/100 ft)
 - iii. 12-inch 0.22 (ft/100 ft)
 - iv. 15-inch 0.15 (ft/100 ft)
 - v. 18-inch 0.12 (ft/100 ft)
 - vi. 21-inch 0.10 (ft/100 ft)
 - vii. 24-inch 0.08 (ft/100 ft)
- c) The interior of the sewer shall, as the work progresses, be cleared of all dirt, cement and superfluous materials of every description. The end of all pipe will be plugged with a water tight plug, approved by the Engineer, except during working hours while additional pipe is being added to those places. The new sanitary sewer shall have a mechanical plug installed at the connection to the existing sanitary sewer, which is to stay in place until the new sanitary sewer is accepted. The plug will be removed upon satisfactory final inspection.
- d) The bottom of the trench shall be undercut to provide a minimum of four inches (4") of bedding and cover material between the natural soil and the bottom outside barrel of the pipe to be installed. The pipe is to be entirely surrounded and covered to a height of at least one foot (1') above the top with bedding and cover material. Bedding and cover material shall be carefully placed by hand to fill completely all spaces under and adjacent to the pipe. The first lift of granular backfill shall be two feet (2') with each subsequent lift being no more than eighteen inches (18"). Refer to the detail sheet. Bedding, cover, and backfill shall be considered incidental to the cost of the sanitary sewer installation.
- e) The maximum width of the trench excavation at the top of the pipe shall be the outside diameter of the pipe used plus twenty-four inches (24"), except when close sheathing is required. In case of deep trenches requiring the use of additional sets of stringers and sheathing, the width of trench may be increased to allow for the additional stringers and sheathing, provided the lower set is held to the minimum width required to lay the pipe.
- f) Where the trench width for that portion of trench depth between the trench bottom and the outside top of the pipe barrel, for any reason exceeds the width provided for the class of pipe shown on the sewer plan profile for the bid section, the Contractor shall furnish a

- stronger class of pipe for that section for no additional compensation.
- g) Not more than fifty feet (50') of trench shall be open at any one time in advance of the completed sanitary sewer except upon written permission of Engineer. In no case shall such excavation extend at the same time across more than two parallel streets that intersect the street in which the work is being done. Lateral trenches will not be left open for more than forty-eight (48) hours. All trenches left open overnight shall be properly fenced and barricaded.
 - h) When a new sewer is to be laid starting from an existing sewer with a different type of joint, or in relaying or reconnecting building sewers, the connecting joint shall be made with a flexible rubber coupling, a Strongback Fernco or approved equal. The coupling shall be securely strapped to the pipe with a stainless steel strap on each side of the joint. If required by the Engineer, it shall be encased in concrete a minimum of six inches (6") thickness around the entire repair coupling and for twelve inches (12") on each side of the joint.
 - i) In backfilling, the pipes must not be disturbed from line or grade. Material used for bedding, cover, and backfilling will conform to Section 6 of the General Specifications. All granular backfill shall be compacted to a minimum density of 95% of Standard Proctor Density. The first lift shall be two feet (2') with each subsequent lift being no more than eighteen inches (18"). The contractor is responsible for providing testing results to the owner with the cost of the testing considered incidental to the cost of the pipe. The contractor will be held liable for pipe breakage and misalignment caused during backfilling.
 - j) When laying sewer pipe in cold weather, the Engineer may stop the work when the quality of work is in danger. Rubber gaskets or joint material shall be warmed to ensure a proper seal. No pipe shall be laid on frozen ground.
 - k) The Contractor shall keep all finished excavation free of water or sewage during the preparation of the subgrade until the completion of the work. Ground water or rainwater will not be allowed to flow into sanitary sewers. No water or sewage shall be allowed to run over or through any incomplete portions of the work unless approved by the Owner.
 - l) Whenever a water main crosses over a sanitary sewer, there shall be a minimum of six inches (6") from the bottom of the water main to the top of the sanitary sewer. Whenever a water main crosses under a sanitary sewer, there shall be a minimum of eighteen inches (18") from the top of the water main to the bottom of the sanitary sewer pipe.

8) Lateral Connections

8.1. Materials

- a) The minimum lateral diameter from the main to the right of way line shall be six inches (6"). If approved by the Director of Engineering, single family residential homes may be allowed to use a four inch (4") lateral. Pipe material shall be PVC SDR-26, with rubber gasket joints conforming to ASTM F-477. Sewer laterals will in general be laid to a grade of a minimum of one-quarter inch to the foot.
- b) The top of the sewer stub at the curb line shall be a minimum of nine feet (9') and a maximum of ten feet (10') below grade at the property line. Risers six inches (6") in diameter shall be installed on all sewers over ten feet (10') in depth. Risers shall be used to bring the sanitary sewer to a minimum depth of nine feet (9') and a maximum depth of ten feet (10'). Riser designs should follow the designs designated in the Standard Specifications for Sewer and Water Construction in Wisconsin, latest edition.
- c) Sanitary sewer laterals less than eight inches (8") will be connected to the mainline and not connected to manholes, whenever possible. All laterals sized eight inches (8") and above must tie into the sanitary main at a manhole in accordance with SPS 382.35.

8.2. Construction Methods

- a) All building sewer services from the main to the right of way (ROW) shall be installed in accordance with Chapter 32, Rule 7 of the KWU Rules and Regulations and the local plumbing code and regulations.
- b) All building sewer services beyond the ROW shall be installed in accordance with the Department of Safety and Professional Services Chapter 382 to 387 for new construction and Chapter 366 for plumbing inside an existing building. All local plumbing code and regulations shall be followed.
- c) Any deviation over two feet (2') from the wye location on the plans shall require prior approval of the Engineer.
- d) When installing mainline sanitary, a prefabricated wye fitting shall be installed for each lateral connection. When installing sanitary laterals to existing mainline sanitary, a "cut-in-wye" shall be used and installed by core drilling a hole in the main and attaching a flexible rubber "T" or "Y" saddle with stainless steel clamps. Another acceptable fitting is an Inserta-Tee, installed according to the manufacturer's recommendations.
- e) Unused stubs shall terminate with the last pipe being two feet (2') long, and shall be plugged using solid cap fitting that is water tight. A two inch by four inch (2" x 4") stake, eight feet (8') long and painted green shall be placed vertically at the end of all laterals or wyes to locate for future extensions.
- f) If sanitary house sewers are in conflict with water main or storm sewer lines, the Contractor shall furnish all labor, materials and equipment necessary to complete the connections. The cost of materials, equipment and labor to offset the sanitary lateral shall be included in the cost of the main or sewer, unless specified on the plan.

9) *Insulation*

9.1. *Materials*

- a) Insulation shall be closed-cell extruded polystyrene boards with minimum dimensions of two inches (2") thick and four feet (4') wide. Insulation shall be provided around the water main where crossed in the sanitary sewer trench where water main cover is less than five and a half feet (5.5') or where a sanitary sewer passes within two feet (2') of a water main or service. A minimum of two layers shall be used, four inches (4") total thickness.

9.2. *Construction Methods*

- a) Insulation shall be placed in locations as shown on the plans or as directed by the Engineer.
- b) Prior to placement of the polystyrene boards, bedding material shall be placed to a height of six inches (6") over the top of the pipe and leveled. The insulating boards shall be placed on the cover material with the long side parallel to the centerline of the water main for a minimum width of O.D. + twenty-four inches (24"). The boards shall be placed in a staggered arrangement to eliminate continuous transverse joints. Each layer should be placed to cover the joints of the layer immediately below.
- c) The first lift of backfill material shall consist of six inches (6") of bedding material which shall be end or side dumped onto the insulation board and spread in such a manner that construction equipment does not operate directly on the insulation. This layer shall be compacted with equipment that exerts a contact pressure of 70 to 80 psi. Once this layer has been compacted to the specified density, the remaining layers of backfill may be constructed utilizing conventional procedures.

10) Tracer Wire

10.1. Materials

- a) Tracer wire shall be a #12-gauge THWN solid copper wire that is green in color. The wire shall be centered over the top of the pipe and taped at ten foot (10') intervals using thermoplastic tape with a pressure sensitive adhesive face.
- b) The wire shall extend across all fittings. The wire shall be brought to ground level along the outside of each manhole and into the manhole, below grade, underneath the frame in a coiled up piece. Cost of wire and accessories shall be considered incidental to the sanitary sewer main installation.

10.2. Construction Methods

- a) For service laterals, tracer wire shall be centered over the top of the pipe and shall extend from the building foundation to the main. The tracer wire shall be brought to grade outside the cleanout with a lid labeled "sewer". The contractor shall drill a hole in the side of the cleanout near the top and push the end of the tracer wire through for future locating. The cost of wire and labor shall be considered incidental to the sanitary service installation.
- b) In locations where proposed pipe is being connected to existing sanitary mains or laterals, and there is an existing tracer wire located on the existing pipe, the Contractor shall connect the two wires together by means of a splicing or locking connector hardware, which shall be approved by the Owner. The Contractor shall check the tracing ability of the tracer wire prior to backfilling and shall verify results with the Inspector.

11) Deflection Testing**11.1. Deflection Testing**

- a) Deflection tests shall be performed by the Contractor and witnessed by the Engineer for all sewer pipe installed. The deflection test shall be performed using a rigid ball or mandrel, and shall be performed without mechanical pulling devices. The test shall be performed after all backfill has been placed and consolidated but before paving is completed. If deflection testing occurs within 30 days of placement of the final backfill, deflection may not exceed 5%. This test is performed by using the 95% testing device. Maximum deflection may not exceed 7.5% when testing occurs more than 30 days after placement of the final backfill. This test is performed by using the 92.5% testing device. The dimensions of the devices are listed below

Table 11.1 Testing Device Dimensions for PVC SDR 26 Deflection Testing

Nominal Size Inches	Minimum Diameter (Inches)		
	Base ID	5% Deflection	7.5% Deflection
8	7.67	7.28	7.09
10	9.56	9.08	8.85
12	11.36	10.79	10.51
15	13.90	13.20	12.85
18	16.98	16.13	15.70
21	20.00	19.00	18.50
24	22.48	21.54	20.79

12) Infiltration Testing

12.1. Infiltration Testing

- a) The Contractor shall follow the guidance set in the Standard Specifications for Sewer and Water Construction in Wisconsin, latest edition, Chapter 3.7 for testing.
- b) This test shall be performed on all pipes larger than thirty-six inches (36"). All other pipes shall have no visible infiltration allowed. The infiltration test shall not be considered a valid leakage test unless the top surface of the ground water level is at least two feet (2') above the top of the pipe for the entire test length of the tested section during the test measurement. The Contractor may simulate this condition, at no cost to the Owner.
- c) The rate of infiltration of water into the sewer project, including manholes, shall not exceed two-hundred (200) gallons per day per inch diameter, per mile of sewer. The Contractor is required however, to repair all visible leaks, even if the infiltration requirements are met.
- d) The maximum infiltration rate for manholes tested separately and independently shall be one-tenth (0.1) gallons per foot of diameter per foot of head per vertical foot of manhole per hour.
- e) The maximum allowable infiltration, expressed in gallons per hour, is shown in Table 12.1 for various pipe sizes.

Table 12.1 Allowable Limits of Infiltration (Based on 200 Gal/diam(in)/mile/day)

<i>Diameter of Sewer</i>	<i>Infiltration per ft per hr.</i>
	<i>Gallons</i>
36"	0.0568
42"	0.0663
48"	0.0758
54"	0.0852
60"	0.0947
66"	0.1042
42" dia. Manhole 0.0663 Gal. per vertical ft. per hr.	
48" dia. Manhole 0.0758 Gal. per vertical ft. per hr.	

13) Low Pressure Air Testing

13.1. Low Pressure Air Testing

- a) The Contractor shall follow the guidance set in the Standard Specifications for Sewer and Water Construction in Wisconsin, Chapter 3.7, latest edition for testing.
- b) All sanitary sewers 36 inches and smaller in diameter must pass a low pressure air test. The Contractor shall perform this test in the presence of the Engineer. Contractor shall supply all testing equipment. Equipment must be adequate and appropriate for application. All labor and equipment cost shall be borne by the Contractor. The apparatus for this low pressure air test shall be set up as indicated in File #31 from the Standard Specifications for Sewer & Water Construction in Wisconsin. This air test is based upon an allowable leakage rate of $0.0015 \text{ ft}^3/\text{min}/\text{ft}^2$ of internal surface area.
- c) Only after the sanitary sewers, including appurtenances and sanitary lateral stubs have been installed, backfilled, and cleaned, shall the Contractor proceed with an air test.
- d) Low Pressure Air Test Procedure
 - i. The section of sewer line to be tested should be flushed and cleaned prior to conducting the low pressure air test. This serves to clean out any debris, wet the pipe, and produces more consistent results.
 - ii. Isolate the section of the sewer line to be tested by means of inflatable stoppers or other suitable test plugs. Plug or cap the ends of all branches, laterals, tees, wyes, and stubs to be included in the test to prevent air leakage. One of the plugs should have an inlet tap, or other provision for connecting a hose to a portable air source.
 - iii. If the test section is below the ground water level, determine the height of the ground water above the top of the pipe at the upstream end of the test section. If the groundwater level is more than two feet (2') above the top of the pipe at the upstream end, the air test should not be used. For every foot of ground water above the pipe spring line, increase the gage test pressures by 0.43 pounds per square inch.
 - iv. Connect the air hose to the inlet tap and a portable air control source. The air equipment should consist of necessary valves and pressure gages to control the rate at which air flows into the test section and to enable monitoring of the air pressure within the test section. Also, the testing apparatus should be equipped with a pressure relief device set no higher than 9.0 psig to prevent the possibility of loading the test section with the full capacity of the compressor.
 - v. Add air slowly to the test section until the pressure inside the pipe is raised to 4.0 psig greater than the average back pressure of any ground water that may be over the pipe. Do not exceed 9.0 psig.

- vi. After a pressure of 4.0 psig is obtained, regulate the air supply so that the pressure is maintained between 3.5 and 4.0 psig (above the average ground water back pressure) for a period of two minutes. This allows the air temperature to stabilize in equilibrium with the temperature of the pipe walls. The pressure will normally drop slightly until temperature equilibrium is obtained. During this period, all plugs should be checked with a soap solution to detect any plug leakage.
- vii. Determine the rate of air loss by the time pressure drop method. After the two-minute air stabilization period, air is slowly introduced into the section of pipe to be tested until the pressure is raised to approximately 4.0 psig. The air supply is then disconnected and the test pressure allowed decreasing to 3.5 psig. The time required for the test pressure to drop from 3.5 psig to 2.5 psig is determined by means of a stopwatch and this time interval is then compared to the specification time as calculated from Table II to determine if the rate of air loss is within the allowable time limit. If the time is equal or greater than the times indicated in the tables, the pipe line shall be deemed acceptable.
- viii. Upon completion of the test, the bleeder valve is opened and all air is allowed to escape. Plugs should not be removed until all air pressure in the test section has been released. During this time, no one should be allowed in the trench or manhole while the pipe is being decompressed.

Table 13.1 *Minimum Specified Time Required For A 1.0 Psig Pressure Drop*

Pipe Diameter, in	Minimum Time, min	Length for Minimum Time, ft	Time for Longer Length, s	150 ft	200 ft	250 ft	300 ft	400 ft
4	3:46	597	0.38L	3:46	3:46	3:46	3:46	3:46
6	5:40	398	0.854L	5:40	5:40	5:40	5:40	5:42
8	7:34	298	1.52L	7:34	7:34	7:34	7:36	10:08
10	9:26	239	2.374L	9:26	9:26	9:53	11:52	15:49
12	11:20	199	3.418L	11:20	11:24	14:15	17:05	22:47
15	14:10	159	5.342L	14:10	17:48	22:15	26:42	35:36
18	17:00	133	7.694L	19:13	25:38	32:03	38:27	51:16
21	19:50	114	10.47L	26:10	34:54	43:37	52:21	69:48
24	22:40	99	13.674L	34:11	45:34	56:58	68:22	91:10
27	25:30	88	17.306L	43:16	57:41	72:07	86:32	115:22
30	28:20	80	21.366L	53:25	71:13	89:02	106:50	142:26
33	31:10	72	25.852L	64:38	86:10	107:43	129:16	172:21
36	34:00	66	30.768L	76:55	102:34	128:12	153:50	205:07

14) Vacuum Testing and Televising

14.1. Vacuum Testing of Sanitary Manholes

- a) All sanitary manholes shall be tested for leakage by the use of vacuum testing equipment.
- b) Isolate the manhole to be tested by plugging the inlet and outlet pipes with an inflatable stopper or other suitable test plugs. The plugs shall be securely braced to avoid the plugs from being drawn into the manhole. Plug lift holes with non-shrink grout.
- c) Vacuum test equipment may be placed at the inside top of the cone section or at a higher elevation in accordance with the testing equipment being used. Inflate the seal to 40 psi to effect a seal between the base and the manhole. Run vacuum pump until a vacuum of ten inches (10") of mercury is obtained.
- d) With vacuum pump shut off and the valve on the vacuum line of the test head closed, measure the time for the vacuum to drop to nine inches (9") of mercury. The manhole test is acceptable if the time exceeds the values listed in Table 14.1.
- e) If the test fails, repair or seal the manhole using non-shrink grout or other materials that are approved. Retest until an acceptable test is obtained.
- f) Test may be conducted before or after backfilling.
- g) The cost of the equipment, materials and labor necessary to perform the testing shall be included in the cost of sanitary manhole.

Table 14.1 *Minimum Test times in Seconds for Various Manhole Diameters*

Depth (Ft.)	4' Manhole	5' Manhole
	Time (sec.)	Time (sec.)
8	20	20
10	25	33
12	30	39
14	35	46
16	40	52
18	45	59
20	50	65
22	55	72
24	59	78
26	64	85
28	69	91
30	74	98

14.2. Televising Sanitary Sewers

All sanitary sewer pipes installed shall be televised under the supervision of the Engineer and a copy of the video shall be submitted to the Kenosha Water Utility Engineering Division for review and approval. Any damaged sections of pipe shall be repaired under the supervision of the Kenosha Water Utility.