

## **CONSTRUCTION SPECIFICATIONS FOR SANITARY SEWER LINE EXTENSIONS**

### **400 General**

This section describes WMU policy relating to sanitary sewer construction.

No sanitary sewer line (main) shall be smaller than 8-inches in diameter. Sanitary sewer mains shall be designed to provide peak flow velocities not less than two (2) feet per second (FPS) based on Manning's formula using an "n" value of 0.013. The following are the recommended minimum slopes which should be provided for sewers 42 inches or less. Slopes greater than these may be desirable for construction, to control sewer gases or to maintain self-cleansing velocities at all rates of flow within the design limits:

<u>Nominal Pipe Size</u>	<u>Minimum Slope in feet per 100ft</u>	<u>Nominal Pipe Size</u>	<u>Minimum Slope in feet per 100ft</u>
8 inch	0.40	24 inch	0.08
10 inch	0.28	27 inch	0.067
12 inch	0.22	30 inch	0.058
14 inch	0.17	33 inch	0.052
15 inch	0.15	36 inch	0.046
16 inch	0.14	39 inch	0.041
18 inch	0.12	42 inch	0.037

### **401 Types of Sanitary Sewer Pipe**

Polyvinyl Chloride (PVC) pipe, standard dimension ratio (SDR) 35 is required and shall conform to ASTM D3034, latest revision. Gasket PVC fittings must be compatible with SDR 35 pipe in accordance with the latest ASTM standards. The pipe and fittings shall be homogeneous throughout and free from visible cracks, holes, foreign inclusions, or other injurious defects. All pipe shall have a "home" mark. Joints shall be of the elastomeric gasket push-on type meeting all requirements of ASTM D3212. Minimum sewer main pipe size shall be 8-inches. Minimum service lateral pipe size shall be 6-inches.

Corrugated HDPE pipe, for direct bury purposes, conforming to ASTM F2736 and F2764 latest revisions. As approved by WMU for large diameter (12" to 30") gravity sewer pipe with bury depths less than 10 feet. The pipe shall consist of an extended bell and spigot joint with redundant, double-gasketed joints conforming to ASTM D3212 and ASTM F2764. Bedding and backfill to comply with the WMU standard for sanitary sewer pipe bedding and backfill standards for gravity sewer pipe. The remainder of the backfill shall be dictated by the location of the pipe (roadway or green space) and the cleanliness of the spoil removed from the trench. Debris, frozen material, large clods or stones, organic matter, or other unstable materials shall not be used as backfill.

Centrifugally Cast, Fiberglass-Reinforced, Polymer Mortar Pipe, for direct bury, meeting stiffness class 46 or greater and conforming to ASTM D3262, latest revision. Authorized only as approved by WMU for large diameter (18" or greater) gravity sewer pipe in depths exceeding 10 feet. Bedding and backfill to comply with the WMU standard for sanitary sewer pipe bedding and backfill standards for gravity sewer pipe and those recommended by the manufacturer. The remainder of the backfill shall be dictated by the location of the pipe (roadway or green space) and the cleanliness of the spoil removed from the trench. Debris, frozen material, large clods or stones, organic matter, or other unstable materials shall not be used as backfill.

#### Ductile Iron (DI) pipe:

The standard pipe for sanitary sewers exceeding 10 ft. in depth or with less than 3 ft. of cover shall be Class 51 Protecto 401 lined Ductile Iron pipe unless otherwise approved.

Any pipe found defective, not meeting the specifications or improperly installed shall not be accepted and shall be replaced by pipe meeting these specifications at no additional cost to WMU.

### **402 Types of Force Main Pipe**

#### **402.1 Ductile Iron Pipe**

Ductile Iron pipe shall be designed in accordance with ANSI/AWWA C151/A21.50 -81, and shall be centrifugally cast in accordance with ANSI/AWWA C151/A21.51 -81 for "Ductile Iron Pipe Centrifugally Cast in Metal Molds or Sand Lined Molds for Water or Other Liquids". The grade of iron shall be 60-42-10.

Ductile Iron pipe shall be of the bell and spigot push-on, single rubber gasket type with standard thickness class 51 for the corresponding pipe size.

Ductile iron pipe shall be lined with cement mortar and coated with bituminous material, both inside and outside in accordance with the requirements as set forth in the ANSI/AWWA C104/A21.4-85 for "Cement Mortar Lining for Ductile Iron and Gray Iron Pipe and Fittings for Water". Only a coal tar outside coating, or other compatible coating, shall be applied to pipe which is to receive a bitumastic finish coat.

Ductile iron sanitary sewer pipe shall be lined by the manufacturer with a polyethylene lining complying with ANSI/ASTM D1248. Lining shall be American Ductile Iron Pipe with Protecto 401 Ceramic Epoxy-lining, US Pipe with Protecto 401 Ceramic Epoxy-lining or approved equal.

#### **402.2 Polyethylene Pipe**

Polyethylene pipe shall be a high density, high molecular weight, polyethylene pipe having a cell classification of PE 345434C, conforming to ASTM D3350, latest revision, "Polyethylene Plastic Pipe and Fittings Material". The dimensions and workmanship are specified by ASTM F-714, latest revision, "Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter".

The pipe shall be DR-11, 160-psi total dynamic working pressure, minimum. The pipe shall be laid in 40'-0" sections and installed in accordance with these specifications and ASTM D2321, latest revision, "Underground Installation of Flexible Thermoplastic Sewer Pipe". High Density Polyethylene (HDPE) pipes/fittings shall be allowed for use as wastewater pressure pipe where compatible with the specific conditions of the project. The use of material other than HDPE pipe may be required by WMU if it is determined that HDPE pipe is unsuitable for the particular application.

Pipe and fittings shall be homogeneous throughout and free of: (1) serious abrasion, cutting or gouging of the outside surface; (2) visible cracks; (3) kinking caused by excessive or abrupt bending; (4) flattening; (5) holes; (6) blisters; and (7) foreign inclusions or other injurious defects. They shall be uniform in color, opacity, density, and other physical properties. The average outside and wall thickness of pipe and fittings shall be in accordance with ASTM D2122, latest revision.

All jointing of polyethylene pipe shall be accomplished by the butt fusion technique.

### **402.3 C900 PVC Pipe**

C900 pressure pipe, for pipe sizes from 14 inches to 48 inches and conforming to AWWA C905, with gaskets meeting ASTM F 477 and joints in compliance with ASTM D 3139.

The pipe shall be DR-25, 165-psi total dynamic working pressure, minimum. Joints shall be of the elastomeric gasket push-on type meeting all requirements of ASTM D3212. This application is for open cut trenching, a higher thickness class and/or coupling joint (restrained joint) may be specified for horizontal directional drilling applications.

### **403 Encasement Pipe**

Casing pipe shall conform to AWWA C200-86 and AWWA M11 latest revision, and shall be placed at the location shown on the plans in accordance with the noted size, length, and type of material. The steel casing pipe shall have a minimum wall thickness of 1/4" for new casing pipe or 3/8" for salvaged casing pipe.

PVC casing pipe will be approved on a case by case basis by WMU.

For existing pipe installations, split steel casing pipe shall conform to the above specifications except that it shall be in two (2) semi-circular sections joined by a continuous weld from one end to the other without any traceable voids. All casing pipes shall be sealed at each end with a rubber Fernco end seal.

The casing pipe should be 6-8 in. larger than the outside diameter of the carrier pipe bells. The carrier pipe may be pushed or pulled through the completed casing pipe in accordance with the manufactures recommendation for installation into casing pipe.

Minimum wall thickness shall be as listed below:

<u>Nominal diameter (inches)</u>	<u>Wall thickness (inches)</u>
18 or less	0.0375
24	0.500
30	0.500
36	0.532
42	0.625

All welds at the joints will be a continuous circumferential weld on the outside of the pipe.

Casing spacers shall be Cascade CCS or approved equal and shall be placed around the carrier pipe to ensure approximate centering within the casing pipe to prevent damage during installation in accordance with the manufacturer's recommendation. Casing spacers shall have a bolt on shell made in two (2) sections. All metal components shall be Type 304 (18-8) Stainless Steel. It shall have an elastomeric liner to isolate the shell from the carrier pipe. It shall have runners attached to the shell and be designed to provide a minimum of .75 inches between the carrier pipes greatest outside diameter and the casing pipes inside diameter. The chock runners shall be beveled with high abrasion resistance and a low friction coefficient.

Care must be exercised in order to avoid contact between the carrier and casing pipes. In order to avoid the transfer of earth and live loads to the carrier pipe, the space between the carrier and casing pipes should not be filled completely.

Trace wire shall be installed with the carrier pipe as a continuous run of 12 gauge copper clad wire affixed to the top runners of the casing spacers.

#### **404 Watertight Joint Materials**

All sewer line compression joints for SDR 35 PVC pipe, bell and spigot pipe shall conform to ASTM, designated C425-74.

All Corrugated HDPE pipe, for direct bury purposes, shall conform to ASTM F2736 and F2764 latest revisions. The pipe shall consist of an extended bell and spigot joint with redundant, double-gasketed joints conforming to ASTM D3212 and ASTM F2764.

All Centrifugally Cast, Fiberglass-Reinforced, Polymer Mortar Pipe shall consist of a low profile bell-spigot joint consisting of an integral straight bell fixed to one pipe end that seals to the spigot end of another pipe by compressing an elastomeric gasket contained in a groove on the spigot.

All ductile iron pipe as specified herein shall have rubber gasket joints and will be either the mechanical or the push-on joint type. In all respects this pipe must conform to ANSI/AWWA C111/A21.11-80, "Rubber Gasket Joints for Ductile Iron and Gray Iron Pressure Pipe and Fittings." DI Fittings must be Class 125, cement lined with asphalt coating.

Water stops as required shall be as manufactured by Indiana Seal or approved equal.

Butyl Rubber Sealants shall be used on all manholes to seal the joints, both at the keyed joint lines and the joint line on the outside of the manhole using products similar to ConSeal CS-101 and ConWrap CS-212.

#### **405 Manholes**

Manholes shall conform to ASTM C478, Standard Specification for Precast Reinforced Concrete Manhole Sections, and shall be located at each vertical or lateral change of direction, at the beginning and end of every line, and at any intersection of lines.

Reinforced concrete shall consist of cementitious materials, mineral aggregates, and water, in which steel reinforcement has been embedded in such a manner so that the steel reinforcement and concrete act together. Aggregates shall conform to specification, except that the requirements for gradation shall not apply. Minimum compressive strength of concrete manhole products covered must meet the requirement. The aggregates shall be sized, graded, proportioned, and mixed with such proportions of cementitious materials and water as will produce a homogeneous concrete mixture of such quality that the products will conform to the test and design requirements. Concrete products shall be subjected to either steam or water curing. Test methods such as compression and absorption testing shall be performed

Manholes shall be a maximum of 400 feet apart and shall be to the elevations shown on the drawings. To reduce infiltration into the sewer through the manholes and to provide substantially watertight manholes, the manhole barrels shall be jointed with an approved sealant at the keyed joints and along the external joint of the sections to be jointed, such as manufactured by Con-Seal / Con-Wrap or approved equal. The ends of the barrels shall be formed by the manufacturer to permit the proper use of such sealants.

Precast inverts shall be used at all new manholes installed. The invert shall be a smooth troweled surface and the table shall be brushed finished. See WMU standard detail drawings.

Special admixtures shall be required in cases to control the effects of where Hydrogen Sulfide Gases or Microorganisms on the concrete structure.

## **405.1 Castings**

Manhole castings shall consist of cast iron frames, 22 ¾" diameter covers, weighing not less than 460 pounds per cover and lid and in special conditions, 510 pounds per cover and lid with 28" diameter cover will be used. Manhole casting shall be 310 lbs., J.R. Hoe MF-310 or approved equal. Manhole lid shall be 150 lbs., J.R. Hoe ML-150 or approved equal.

When installed in Green Space, manhole frames and lids shall be bolted to the manhole cone section with no less than four (4) ¾-inch, stainless steel, expansion bolts. Bolts, washers and nuts shall be Hilti or approved equal.

Manhole castings requiring grade adjustment shall be raised with precast concrete grade rings. No bricks, wood shims or blocks shall be used to adjust or reset the frame height. No more than two such rings shall be used on any one manhole.

## **405.2 Frame Seals**

Frame seals shall be designed to prevent leakage of water through the frame/casting and barrel section and/or riser portions of the manhole throughout a 50 year design life and conforming to the design and specifications as those manufactured by Cretex Specialty Products, to include the warranty of the product. The seal shall remain flexible throughout this design life, allowing repeated vertical movements of the frame of not less than 2 inches and/or repeated horizontal movement of not less than 1/2 inch, at rates greater than 1/10 inch per minute.

Frame seals shall be installed on newly constructed sanitary sewer manholes. The frame seal rubber sleeve and extensions shall consist of a flexible rubber sleeve, extensions and wedge strips shall be extruded or molded from a high grade rubber compound conforming to the applicable material requirements of ASTM C-923. The sleeve shall be either double, triple, or quadrupled pleated with a minimum unexpanded vertical height of 8 inches, 10 inches, and 13 inches respectively and a minimum thickness of 3/16 inches. The top and bottom section of the sleeve shall contain an integrally formed expansion band recess and multiple sealing fins. The top section of the extension shall have a minimum thickness of 3/32 inches and shall be shaped to fit into the bottom band recess of the sleeve under the bottom chimney seal band. The remainder of the extension shall have a minimum thickness of 3/16 inches. The bottom section of the extension shall contain an integrally formed expansion band recess and multiple sealing fins matching that of the rubber sleeve. Any splice used to fabricate the sleeve and extension shall be hot vulcanized and have a strength such that the sleeve shall withstand a 180 degree bend with no visible separation.

The expansion bands used to compress the sleeve against the manhole shall be of 16 gauge stainless steel conforming to ASTM A-240, Type 304, with a minimum width of 1-3/4 inches. The bands shall have a minimum adjustment range of 2-1/2 diameter inches

and the mechanism used to expand the band shall have the capacity to develop the pressures necessary to make a watertight seal. The band shall be permanently held in this expanded position with a positive locking mechanism, any studs and nuts used for this mechanism shall be stainless steel conforming to ASTM F-923 and 594, Type 304.

Installation shall be in accordance with the manufacturer's instructions. Installation should be accomplished after final grade has been established.

### **405.3 Drop Inlets**

Drop inlets shall be provided at manholes where indicated on the plans and at all manholes that have a difference between the inlet and outlet elevations of one foot or greater. Manhole barrel sections shall be supplied with openings for upper and lower inlet pipes. The annular spaces between the inlet pipes and the manhole walls shall be filled with non-shrink grout. Grout shall be finished smooth and flush with the adjoining interior and exterior manhole wall surfaces. All new installations shall be a precast outside drop the encasement of the outside drop pipe at existing manholes shall be with Class C (2000 psi) concrete, shall be doweled with reinforcing steel and shall extend a minimum of two linear feet, or to the undisturbed soil, whichever is greater. In the case where precast drop manholes are furnished, the encasement shall be integral with the base and riser sections.

Connections to existing manholes of a single lateral may be constructed with an inside drop configuration using pre-manufactured fiberglass, PVC and stainless steel components as manufactured by Duran, Inc.; Lyme, CT (800-434-0277) or approved equal. Each drop connection shall include inside drop bowl, pipe coupler, drop pipe, and drop end. The system shall be secured to the manhole with stainless steel straps and fasteners as recommended by the manufacturer.

### **405.4 Stubs**

Stubs for future sewer pipe shall be installed as indicated by the drawings, with a minimum length set at four (4) feet. The stub is to be grouted in place to match the invert inside of the manhole. Existing sewer pipe stubs shall be removed as required.

## **406 Sanitary Sewer Appurtenances**

### **406.1 Branches and Fittings**

Directional Tees shall be placed in the sewer for individual property service connections as shown on the drawings. The service connection shall consist of an injection molded Tee, 6" PVC, SDR 35 bell and spigot pipe, with a cleanout at the point of connection at the property line.

Manufactured wye and tee fittings shall be used with Polyvinyl Chloride Pipe (PVC) in accordance with ASTM's standard D3034, latest revision.

#### **406.2 Tracer/Locate Wire**

All sanitary sewer lines installed as of the approval date of this manual shall be installed using tracer wire or locate wire. This does not negate the requirement for sanitary sewer line marking tape, which is installed 18-inches below the finished grade.

Tracer wire shall be 12 gauge Copper Clad Steel (CCS) with a minimum 30 mil HDPE coating. The tracer wire for sanitary sewer lines shall be green in accordance with the APW uniform marking code.

The tracer wire shall be placed in the same orientation to all installed pipe. Lay the tracer wire immediately parallel to the sanitary sewer main at the bottom of the trench. Securing the wire to the pipe is not recommended. Lay mainline tracer wire continuously, by-passing around the outside of manholes and fittings on the street side of the sanitary sewer main.

Connectors used to splice individual legs or components of the tracer system shall be of the type to protect the connections from moisture and corrosion. Copperhead SnakeBite connectors and 3M DBR are two of the commonly used moisture displacement connectors. Twisting the wires together and wrapping with electrical tape is not an approved method for connecting tracer wire legs.

The ends of all branches (service laterals) shall be grounded with a drive in magnesium grounding rod similar to the Copper Head Industries Grounding Rod. Connect the lateral tracer line to the main line tracer wire using moisture and corrosion resistant connectors. Two feet of extra wire (slack) shall be installed below ground to reduce the possibility of grounding rods and wires being broken during future excavations. Grounding rods shall be installed perpendicular to the laying direction of the service laterals.

Trace wire installation shall be performed in such a manner that allows proper access for connection of line tracing equipment and proper locating of wire without loss or deterioration of low frequency (512Hz) signal for distances in excess of 900 linear feet, and without distortion of signal caused by multiple wires being installed in close proximity to one another. Trace wire systems must be installed as a continuous single wire. No looping or coiling of wire is allowed. Any damage occurring during installation of the trace wire must be immediately repaired in an approved waterproof method. Taping and/or spray coating shall not be allowed. Two feet of extra wire (slack) shall be installed below the access box to reduce the possibility of grounding rods and/or access box wires being broken during future excavations.

As a minimum, access boxes shall be installed at all originating manholes (if one does not currently exist) and terminating manholes. Access boxes shall have an adequate number



of leads to connect any tracer wires and a ground. Access boxes shall not be installed in roadways.

All tracer wire installation shall be field verified by using a conductive mode locator set at 512 Hz. Continuity test will not be accepted. Any legs/lengths of tracer wire that cannot be readily traced shall be corrected

### **406.3 Detectable Mylar Tape**

All sewer lines must be marked with a 2-inch printed Mylar detectable tape labeled "Sanitary Sewer", as manufactured by Lifeguard or approved equal. The tape shall be installed 18" below finished grade and directly over the sewer line. See WMU standard detail drawings.

### **406.4 Plugs**

During construction, any connections to existing manholes shall be plugged with a watertight plug until such time the sanitary sewer line construction is complete.

All unattended sewer lines and appurtenances must be plugged with a watertight plug at the end of each working session. The plugs must be compatible with the pipe being installed to allow ease of attachment and be removable without harm to the pipe.

### **406.5 Combination Sewage Air and Vacuum Valve**

The sewage air and vacuum valve shall permit unrestricted passage of air during filling of the force main and unrestricted entry of air into the force main under vacuum conditions due to main break or draining of main to prevent column separation and pipeline collapse due to vacuum. After the main is filled the S.A.V.V. will incorporate two (2) stainless steel floats having a common stainless steel float guide to maintain an air gap between the bottom float and top shut-off float to retard the waste solids from clogging the shut-off float. The internal baffle will protect the shut-off float from direct airflow and shall retain the buna-n seat in place without distortion for tight shut-off but easy removal. Both floats shall withstand 1000 psi or more. The S.A.V.V. shall include quick disconnect hose and blow off valves to permit flushing without dismantling.

Body, Cover & Baffle Cast Iron	ASTM A48 Class 30
Internal Bronze Parts	ASTM B143
Stainless Steel Floats	ASTM A240
Buna-n	ASTM SB800
Internal Delrin Parts	ASTM D2133
Exterior Paint <i>Red Lead</i>	TTP86 B Type IV

The sewage air and vacuum valve shall be an APCO valve model 401WA, valve height 25-1/2" with flushing attachments 33-1/2", an International Valves Vent Tech SWG-C

Series, or approved equal. The sewage air and vacuum valve shall include an odor control system as shown in the standard details for sewers.

#### **407 Installation**

All sewer lines will be installed in accordance with ASTM specifications designated D2321.

The pipe laid in non-traffic areas shall be encased in #9 crushed stone from 6 inches below the outer diameter of the pipe to 12 inches above the outer diameter of the pipe for the full width of the trench.

Pipe laid in traffic areas will be installed as non-traffic areas including backfilling the entire trench to the top of the ditch with #9 crushed stone or compacted DGA as specified in any permits granted for roadway installation of the sanitary sewer line.

The designated class and required pipe size shall be laid to form a closed joint with the next adjoining pipe, bringing the inverts continuously to the required line and grade shown on the drawings. The pipe shall be laid in an upstream direction, with the bells upstream. All sanitary sewer installations shall begin at the lowest downstream manhole and proceed upstream to a terminating manhole.

In no case shall water be allowed to rise in or above the pipe before the pipe is properly installed. No walking on or working over the pipes after they are laid, except as may be necessary in placing and compacting the backfill, will be permitted until the pipes are covered with backfill to the proper depth.

#### **407.1 Concrete Encasement**

A concrete encasement is required where the sewer pipe to be laid will have less than two feet of final cover or crosses a stream. The concrete cap is to be installed as shown on the drawings and in accordance with the standard detail drawings.

The sewer pipe shall be laid in a crushed stone cradle and wrapped in heavy plastic four (4) mils (minimum). The concrete shall be placed around the pipe to the required width and depth to a plane six (6) inches (minimum) above the top of the sewer pipe for the full trench width.

In shallow sewer line applications, the concrete must extend beyond the point where the sewer pipe attains thirty (30) inches of cover. In stream crossing applications the concrete shall extend a minimum of ten (10) feet beyond each stream bank. Proper bracing shall be provided to prevent possible floating of the sewer pipe. Construction joints will be required every ten (10) feet.

## **408 Testing (General)**

Winchester Municipal Utilities representative must witness each satisfactory air test before it will be accepted as fulfilling requirements of these specifications.

Forty-eight hour notice to Winchester Municipal Utilities is required prior to testing. Contractors shall furnish all necessary equipment, materials, and trained or knowledgeable personnel required to conduct tests.

Equipment must be accurate and approved by Winchester Municipal Utilities. All gauges will be liquid filled gauges.

All defective work, as so proven by the tests, shall be immediately repaired and retested until proven to be satisfactory.

Testing shall in no way relieve the contractor of the responsibility for correcting poor workmanship. All visible defects must be repaired regardless of test results.

During testing Winchester Municipal Utilities reserves the right to inspect each individual line, from manhole to manhole, either by use of smoke testing, lights, mirrors, closed circuit televising, or other means to determine if construction is in accordance with Winchester Municipal Utilities specifications.

Any and all other tests required as a condition of permits obtained for the sanitary sewer construction must be conducted to the satisfaction of the permitting agency.

### **408.1 Low Pressure Air Test For Sanitary Sewers**

Air testing shall be required on all sewer lines less than thirty (30) inches nominal diameter.

The maximum length of line to be air tested at any one time shall be from manhole to manhole.

Tees and service laterals shall be considered as part of the line being tested. All plugs shall be firmly blocked to insure that they will not be displaced during testing.

Sanitary sewer lines to be tested shall be flushed and cleaned prior to test as required.

Clean pipe to be tested by propelling snug fitting inflated rubber ball through the pipe with water as required.

Dirt, debris and trash shall be collected at existing manhole and disposed of properly. Dirt, debris and trash shall not be permitted to enter the flow in the existing sanitary sewer.

A small screen with ¼ inch (minimum) square openings shall be used to collect debris.

Minimum holding time limit for each pipe size shall be determined from the following table:

**MINIMUM TEST TIME FOR VARIOUS PIPE SIZES**

<u>Nominal Pipe Sizes, in</u>	<u>Time seconds/100 ft</u>	<u>Nominal. Pipe Size, in</u>	<u>Time seconds/100 ft</u>
4	18	15	126
6	42	18	144
8	72	21	180
10	90	24	228
12	108		

Add air slowly to the portion of the sewer line installation under test until internal pressure is raised to four (4) psi.

After an internal pressure of four (4) psi is obtained, allow at least two (2) minutes for air temperature to stabilize, adding only the amount of air required to maintain pressure.

At the end of the stabilization period with the line pressure being four (4) psi, the test times listed above are the minimum allowable time for one (1) psi pressure drop. If the pressure drop is greater than 1 psi during the prescribed test time the line section shall have failed.

If the sewer line to be tested is submerged in ground water, insert a pipe probe (by boring or jetting) into backfill material adjacent to the center of the pipe, determine pressure in probe when air passes slowly through it. This is backpressure due to ground water submergence over the end of the probe. All gauge pressures in test shall be increased by this amount.

**408.2 Manhole Air Vacuum Test**

Vacuum testing will be required on all sanitary sewer manholes. All plugs, stub-outs, and boots shall be secured to prevent movement while the vacuum is being drawn. Manholes to be tested shall be cleaned and flushed prior to testing. Listed below are the specifications required for Manhole Air Vacuum Testing.

1. Testing shall include the joint between the concrete cone section and the manhole frame.
2. A measured vacuum of 10 inches of mercury shall be established in the manhole after the one minute stabilization.

3. The time for the vacuum drop to nine inches shall be recorded. Acceptance standards for leakage shall be established from the elapsed time for a negative pressure change from 10 inches to 9 inches of mercury.
4. Minimum holding times for each manhole shall be determined from Table 1.
5. If the manhole fails the vacuum test, necessary repairs shall be made and the vacuum test shall be repeated until the manhole passes the test.
6. If the manhole joint mastic is pulled out during the vacuum test, the manhole shall be disassembled and the mastic replaced. The test shall then be repeated as specified above.
7. Minimum test times for various manhole diameters (ASTM C1244 - 93).

**(Table 1)**

Depth (ft.)	Diameter (in.)								
	30	33	36	42	48	54	60	66	72
	Time (sec.)								
8	11	12	14	17	20	23	26	29	33
10	14	15	18	21	25	29	33	36	41
12	17	18	21	25	30	35	39	43	49
14	20	21	25	30	35	41	46	51	57
16	22	24	31	34	40	46	51	58	67
18	25	27	31	38	45	51	59	65	73
20	26	30	35	42	50	53	65	71	81
22	31	33	39	46	55	64	71	79	89
24	33	36	41	51	59	64	78	87	97
26	36	39	46	55	64	75	85	94	105
28	39	41	49	59	69	81	91	101	113
30	41	45	53	65	74	87	98	106	121

**409 Safety Precautions**

Air/vacuum tests may be dangerous if, because of lack of knowledge and training, or carelessness, a line or manhole is improperly prepared. It is extremely important that various plugs be installed and braced in such a way as to prevent blowouts. Since an internal pressure of five (5) psi exerts a force of two hundred and fifty (250) pounds on an eight (8) inch plug, it should be realized that sudden expulsion of a poorly installed plug or of a plug that is partially deflated before pipe pressure is released can be very dangerous. WMU recommends that no one should be allowed in manholes of section being tested at time of test or until after lines have been depressurized. Pressurizing equipment shall include a regulator set at ten (10) psi to avoid over pressurizing and damaging an otherwise acceptable line.