



STATE OF TENNESSEE  
DEPARTMENT OF ENVIRONMENT AND CONSERVATION  
DIVISION OF WATER RESOURCES  
William R. Snodgrass - Tennessee Tower  
312 Rosa L. Parks Avenue, 11<sup>th</sup> Floor  
Nashville, Tennessee 37243-1102

August 13, 2014

Mr. Justin T. Bowling, P. E.  
Engineer 3  
Metro Water Services  
e-copy: justin.bowling@nashville.gov  
1600 2nd Avenue North  
Nashville, TN 37208

Subject: **Metro Water Services Nashville**  
**County: Davidson**  
**Wastewater Project Number: 14-0459**  
**Project: Standard Sewer Specifications**

Dear Mr. Bowling:

The Tennessee Department of Environment and Conservation, Division of Water Resources, acknowledges the receipt of 6 sets and one CD of your documents on July 17, 2014.

Review of your standard sanitary sewer specifications shows that they are in conformance with our guidelines. Therefore, they have been stamped "APPROVED". This approval will remain in effect until August 13, 2017.

We are returning 5 copies to you and retaining one copy for our files. To expedite matters, please reference the assigned wastewater project number 14-0459 on any future correspondence. If we may be of any assistance, please feel free to contact Mr. Adnan Bahour at (615) 532-0638 or by E-mail at [Adnan.Bahour@tn.gov](mailto:Adnan.Bahour@tn.gov).

Sincerely,

Vojin Janjic  
Manager, Water-Based Systems

cc: Water-Based Systems File  
Ms. Ann M. Morbitt, Unit Manager, TDEC Division of Water Resources, [Ann.Morbitt@tn.gov](mailto:Ann.Morbitt@tn.gov)

APPROVAL EXPIRES  
AUG 13 2017  
TN, DEPT. OF ENVIRONMENT & CONSERVATION  
DIVISION OF WATER POLLUTION CONTROL

# SPECIFICATIONS

FOR  
STATE APPROVAL

STANDARD SEWER SPECIFICATIONS

ISSUED BY

TN DEPT OF ENVIRONMENT  
AND CONSERVATION  
JUL 17 2014  
DIV OF WATER RESOURCES  
RECEIVED

APPROVED FOR CONSTRUCTION  
THE DOCUMENT BEARING THIS STAMP HAS BEEN RECEIVED AND REVIEWED BY THE  
TENNESSEE DEPT. OF ENVIRONMENT & CONSERVATION  
DIVISION OF WATER POLLUTION CONTROL  
AND IS HEREBY APPROVED FOR CONSTRUCTION BY THE COMMISSIONER

AUG 13 2014

THIS APPROVAL SHALL NOT BE CONSTRUED AS CREATING A PRESUMPTION OF COR-  
RECT OPERATION OR AS WARRANTING BY THE COMMISSIONER THAT THE APPROVE  
FACILITIES WILL REACH THE DESIGNED GOALS  
FOR THE COMMISSIONER

BY *Asha Babar*

THE METROPOLITAN GOVERNMENT OF NASHVILLE AND DAVIDSON COUNTY  
222 THIRD AVENUE NORTH, 6TH FLOOR  
NASHVILLE, TENNESSEE 37201



July 14, 2014

METRO WATER SERVICES  
1600 SECOND AVENUE NORTH  
NASHVILLE, TN 37208

WPC14 - 0459

## SECTION 02730 - SANITARY SEWERAGE SYSTEM

*(Sewer Specifications for State Submittal for Expiration of WPC11-0346 State Approved Sewer Specifications)*

### PART 1 - GENERAL

1.1 SUMMARY - Work under this section includes providing all labor, material, equipment, tools, and services required for furnishing, installing, constructing, testing, and/or abandoning sanitary gravity sewers, pressure pipelines, and/or appurtenances.

### 1.2 RELATED SECTIONS

- A. Section 02222: Excavating
- B. Section 02223: Backfilling
- C. Section 03300: Cast-in-Place Concrete

### 1.3 MEASUREMENT AND PAYMENT

A. Sanitary Sewer - Measurement for payment of sanitary sewer inside and outside roadways shall be made horizontally along the centerline of the sewer in-place from the center of the manhole and/or where construction begins to the center of the manhole and/or where construction ends and no deductions in length will be made for manholes. Plugging of abandoned lines, manholes, and filling with lean concrete shall be considered incidental to new sewer construction and no separate payment shall be allowed. The unit price bid for sewers shall include the cost of excavation and proper backfill necessary for the complete installation of the sewer and appurtenances and no separate payment shall be allowed. The unit price bid for sewers shall not include the removal and disposal of unstable materials and crushed stone refill beyond the limits of typical excavation necessary to establish satisfactory foundations. The unit price bid for sewers shall not include tee branches; manhole bases; manhole sidewalls; frames and covers; and other items specifically set out in the contract documents and these items shall be paid separately under specific items listed.

B. 6-inch Tee Connections - Payment will be made at the unit price bid for each 6-inch tee connection ordered by the Engineer to be installed. The laying length of the tee joint will not be deducted from measurement for payment of sanitary sewer pipe.

C. 6-inch Sewer Pipe for House Services - Measurement for payment of 6-inch sewer pipe for house services, including riser pipes and gravel backfill, shall be made parallel to the centerline of the sewer in place. Measurement will be made from the wall of the sewer main where the connection is made to the property line or to the point of reconnection. All cost involved in placing riser pipes for 6-inch house sewers, including necessary bends and concrete blocking, shall be merged in the unit price bid for 6-inch house sewer services.

D. Reconnection of Live Sanitary Services - Payment shall be made at the unit price bid for each reconnection of live sanitary services including installing clean out assemblies; installing transition couplings, and plugging existing connections at storm sewers.

E. Manholes up to 6-foot in depth with base - Payment for manholes up to 6-foot in depth with base for manholes shall be made at the unit price bid per each manhole installed. Separate items may be listed in the bid schedule for each different size of manhole diameters. The cost for manhole bases shall be merged into the unit price bid for each manhole up to 6-foot in depth. The unit price bid shall include excavation, backfill, manhole

fillet (invert), manhole steps, pipe resilient connectors, stub-outs, plugs, sealing, and items needed for a complete installation.

F. Additional Manhole Sidewalls - Payment for additional manhole sidewalls shall be made at the unit price bid per vertical foot that exceeds the 6-foot manhole depth for various sizes of manholes as set out in the Bid Schedule. Measurement of additional manhole sidewall shall be made vertically in place from the invert of the outlet sewer pipe to the bottom side of the frames and cover in place excluding the initial 6 feet.

G. Manhole Frames and Covers - Payment for manhole frames and covers shall be at the unit price bid per each for the various types as set out in the Bid Schedule. The quantity to be paid shall be the actual number of manhole frames and covers of each type installed.

H. Standard Drop Pipe Assemblies - Payment for standard drop pipe assemblies shall be made at the unit price bid for each of the various types installed complete and in place as set out in the Bid Schedule. Where drop assemblies are required on existing manholes, it shall be the Contractor's responsibility to verify the type and shape of the existing manhole base and sidewall. Standard drop pipe assemblies shall be external to the manhole unless approved by the Engineer.

I. Manhole Vent Pipe Assemblies - Payment for manhole vent pipe assemblies shall be made at the unit price bid for each vent pipe assembly completely installed in place as set out in the Bid Schedule.

J. Concrete Encasement - Payment for concrete encasement shall be made at the unit price bid per cubic yard of concrete installed. Measurement for payment for concrete encasement shall be made by multiplying the allowable cross-sectional area by the actual horizontal linear length of encasement. The pipe area shall be deducted from the cross sectional area.

K. Excavation of Material / Undercutting and Refill - Payment for excavation and backfill of material for sewer projects shall be merged into the unit price bid of other items in the contract and no separate payment will be allowed except by the expressed written approval of the Engineer. All excavations shall be unclassified with no distinction made between rock and soil. In the event that a grade change is required during construction or other special conditions exist and with the expressed written approval of the Engineer, additional items may be needed including: Bid Item-Unclassified Excavation 0-foot to 10-foot in Depth; Bid Item-Unclassified Excavation 10-foot to 20-foot in Depth; and Bid Item-Unclassified Excavation 20-foot and Over in Depth. For these special items, payment width will be  $4/3$  outside diameter plus 24 inches for pipe and outside diameter plus 36 inches for manholes. No additional excavation shall be allowed for payment where the grade change is 1-foot or less. Where the grade is raised more than 1-foot, 85percent of the resultant reduction in excavation will be computed for credit to the Owner by the Contractor. Payment for furnishing and installing additional backfill material for inside or outside roadway shall be considered an integral part of these special bid items, and no separate payment will be allowed unless expressly directed in writing by the Engineer. If crushed stone refill is required by the Engineer for backfilling undercut areas, payment will be made for cubic yards of material installed at allowable dimensions under the special item Crushed Stone Refill. No payment will be allowed for material installed at the Contractor's discretion.

1.4 REFERENCE STANDARDS - Where materials and methods are indicated in these Specifications as being in conformance with a standard specification, it shall refer to the latest edition of the specifications and shall include all interim revisions. Listing of a standard specification without further reference indicates that the particular material or method shall conform to such listed specification.

A. American Water Works Association (AWWA)

- C-210 Ductile Iron Coal-Tar Epoxy Coating
- C-302 Reinforced Concrete Pipe (Non-Cylinder - Pressure Pipe)
- C-500 Gate Valves 3" through 48" for Water and Sewerage Systems
- C-600 Installation of Ductile-Iron Water Mains

B. American National Standards Institute (ANSI)

- A-21.4 Cement Mortar Lining for Ductile Iron and Gray Iron Pipe and Fittings for Water
- A-21.10 Ductile-Iron and Gray Iron Fittings, 3"-48" for Water and Other Liquids
- A-21.11 Rubber Gasket Joints for Ductile Iron and Gray Iron Pressure Pipe Fittings
- A-21.51 Ductile Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids

C. American Society of Testing Materials (ASTM)

- A-48 Ductile Iron Castings
- C-33 Standard Specification for Concrete Aggregates
- C-39 Compressive Strength of Cylindrical Concrete Specimens
- C-76 Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
- C-172 Concrete Testing
- C-361 RCP Low Head Pressure Pipe
- C-443 Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets
- C-478 Precast Reinforced Concrete Manhole Sections
- C-497 Testing Concrete Pipe, Sections, or Tile
- C-923 Resilient Connectors Between Reinforced Concrete Manhole Structures and Pipes
- C 1103 Joint Acceptance Testing of Installed Precast Concrete Pipe Sewer Line
- C-1214 Concrete Pipe Sewer Lines by Negative Air Pressure (vacuum)
- C-1619 Specifications for Rubber Gaskets
- D-3034 Type PSM Poly(vinyl chloride)(PVC) Sewer Pipe and Fittings
- D-3212 Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals

- D-3262 Standard Specifications for Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe
- D-4161 Standard Specifications for Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Joints Using Flexible Elastomeric Seals
- D-2412 Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading
- D-3681 Standard Test Method for Chemical Resistance of Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe in a Deflected Condition
- D-638 Test Method for Tensile Properties of Plastics
- D-695 Standard Test Method for Compressive Properties of Rigid Plastics
- F-477 Specification for Elastomeric Seals (gaskets) for Joining Plastic Pipe

## 1.5 SUBMITTALS

A. Shop Drawings - The Contractor shall submit for the Engineer's approval descriptive details and shop drawings covering full details of pipe, fittings, specials, joints, joint materials, and cuts of all castings.

### B. Material Test Requirements

1. Required tests shall be done by an independent testing laboratory selected by the Contractor and approved by the Engineer. All tests shall be at the expense of the Contractor and no separate payment shall be allowed.
2. Where the total quantity of sanitary sewer pipe including all pipe sizes is less than 1,000 feet, the pipe shall be visually examined by the Engineer at the site for conformance to the Specifications.
3. Where the total quantity of pipe, including all sizes exceeds 1,000 feet, tests shall be performed by an independent laboratory for conformance with the specifications. Tests shall be conducted on one-half of one percent of the number of pipe of each size, but in no case less than two specimens of each size. Mill certification shall be required.
4. The number and manner of tests for sewer pipe joints for conformance to the Specifications shall be the same as required for the sewer pipe.
5. All materials to be incorporated in the construction of sanitary sewers and appurtenances shall be subject to inspections and tests by the aforementioned independent test laboratory.

#### a. Ductile Cast Iron Gravity Sewer Pipe and Fittings

- 1) Where the total quantity of ductile cast iron gravity and/or pressure sanitary sewer pipe and fittings, including all sizes, is less than two hundred tons, each piece shall bear the manufacturer's serial number and shall be certified by the manufacturer for conformance with ANSI A21-51 / AWWA C-151 and ANSI A21.10 / AWWA C-110.

2) Where the quantity, including all pipe sizes exceeds two hundred tons, tests shall be by independent laboratory for conformance with ANSI A21-51 / AWWA C-151 and ANSI A21.10 / AWWA C-110.

**b. Polyvinyl Chloride (PVC) Sewer Pipe 6-inch through 30-inch**

1) The polyvinyl chloride (PVC) pipe shall be in conformance with ASTM D3034, SDR35 through 15-inch and F-794, F-949 or F-679 for 18-inch through 30-inch of the latest revision. Flexible elastomeric gaskets conforming to ASTM D-3212 shall be used for pipe jointing.

2) Acceptance of all PVC pipes and joints shall in part be based on the receipt of a written certification. This certification shall consist of a copy of the manufacturer's test report or a statement by the seller, accompanied by a copy of the test results, that the material has been independent laboratory sampled, tested, and inspected in accordance with the provisions of applicable ASTM standards. Each certification furnished shall be signed by an authorized agent of the seller or manufacturer and submitted to the Engineer.

**c. Reinforced Concrete Pipe**

1) Reinforced concrete pipe shall conform to ASTM C-76, Class 3, 4, or 5 as indicated on Plans Wall B or C, and shall be furnished with minimum laying lengths of 12 feet for steel end ring joints, and 8-foot minimum for rubber and concrete bell and spigot joints unless otherwise approved in writing by the Engineer.

2) Joints for reinforced concrete sewer pipe. Rubber gaskets shall be extruded or molded and cured in such a manner that any cross section will be dense, homogenous, and free of porosity, blisters, pitting, and other imperfections and shall be either steel end ring type conforming to ASTM C443 or ASTM C 361, or rubber and concrete joints conforming to ASTM C443 or ASTM C361. Rubber gaskets for either joint shall meet the testing requirements of ASTM C443 or ASTM C361. Optional joint designs shall be submitted to the Engineer for review. Joints shall be tested to ensure water tightness. Assembled gravity sewer pipe joints in straight alignment shall be subjected to an internal pressure of 13 psi (30 feet) pressure head for 10 minutes per ASTM C443.

**d. Centrifugally Cast Fiberglass Reinforced Polymer Mortar Pipe (CCFRPM)**

1) Pipes: Pipes shall be manufactured and tested in accordance with ASTM D3262 and ASTM 3681 (Strain Corrosion Test.) A valid copy of full test report by an outside third party independent lab, demonstrating a 50 year extrapolated strain corrosion value of 0.90% in 1 Normal Sulfuric Acid environment typical of conditions found in sanitary sewers. No short term validation test results will be accepted in lieu of above referenced full test report.

2) Joints: Joints shall meet the requirements of ASTM D4161. As a supplement to the testing requirements of ASTM D4161- Sect 7.4, the proposed pipe joints shall be capable of withstanding an external pressure test of 100 psi in both straight alignment and angularly deflected. A test report, certified by an independent testing lab is required with submittals for approval by the Engineer.

3) Stiffness: Minimum pipe stiffness when tested in accordance with ASTM D2412 shall normally be 46 psi or as required per the Engineer. Full engineering calculations confirming the pipe class suitability, sealed by a professional engineer in the State of Tennessee, shall be submitted to the Engineer for approval prior to the manufacturing of the pipe.

4) Experience: A project reference list with project name, owner, and engineer contact and phone numbers of 10 sanitary sewer projects with XX" and larger pipe supplied and installed in US with a 1000 ft minimum per project.

e. Filament Wound Fiberglass Reinforced Polymer Mortar Pipe

1) Pipes: Pipes shall be manufactured and tested in accordance with ASTM D3262 and ASTM 3681 (Strain Corrosion Test.) A valid copy of full test report by an outside third party independent lab, demonstrating a 50 year extrapolated strain corrosion value exceeding the requirements in Table 4 of ASTM D3262. No short term validation test results will be accepted in lieu of above referenced full test report.

2) Joints: Joints shall meet the requirements of ASTM D4161. For project installations depths more than 50 feet over the top of pipe, the proposed pipe joints shall be capable of withstanding an external pressure test of 100 psi in both straight alignment and angularly deflected. A test report, certified by an independent testing lab is required with submittals for approval by the Engineer.

3) Stiffness: Minimum pipe stiffness when tested in accordance with ASTM D2412 shall normally be 46 psi or as required per the Engineer. Full engineering calculations confirming the pipe class suitability, sealed by a professional engineer in the State of Tennessee, shall be submitted to the Engineer for approval prior to the manufacturing of the pipe.

4) Experience: A project reference list with project name, owner, and engineer contact and phone numbers of 10 sanitary sewer projects with XX" and larger pipe supplied and installed in North America with a 1000 ft minimum per project or a cumulative total footage of 10,000 ft of pipe XX" or larger supplied on a minimum of 3 projects installed in North America.

f. Miscellaneous Materials

1) All material used on this project shall be visually examined by the Engineer at the site for conformance to the Specifications.

2) Where reasonable doubt exists that material fails to meet the Specifications, the Engineer may require certified mill test, samples and/or test by an independent laboratory, or other suitable form of verification that the material meets the requirements of the Specifications. All testing costs shall be the responsibility of the Contractor.

## PART 2 - PRODUCTS

### 2.1 PRODUCTS

#### A. GENERAL

1. Material and equipment shall be designed, constructed, and guaranteed to perform the service required and shall conform to the Specifications.
2. Material and equipment that deviates from the Specifications must be approved in writing from the Engineer.

### 2.2 MATERIAL

#### A. Ductile Iron Sewers

1. Ductile iron pipe and fittings shall conform to the requirements of ANSI 21.51/AWWA C-151 and ANSI A21.10/AWWA C-110. Pipe Class shall be 50 unless otherwise indicated on the Drawings. Fittings shall be pressure rated at a minimum of 350 psi. Pipe shall have bituminous coating exterior with epoxy coating or polyethylene lining on the interior.
2. Joints for the ductile iron pipe shall be the slip-type single gasket joints conforming to requirements of ANSI, A21.11 and AWWA C-111. Ductile iron joints shall be rated for 150 psi of operating pressure.
3. Fittings for ductile iron pipe shall be equal to Bell-Tite, Fast-Tite, or Tyton fittings. Mechanical type fittings may be used on short sections of ductile iron gravity sewers if approved by the Engineer or specified on the Drawings. Fittings shall not weigh less than the accompanying pipe and assembled in accordance with manufacturer recommendations.
4. Interior Coating for Ductile Iron Pipe - Ceramic Epoxy Lining
  - a. The standard of quality for amine cured novalac epoxy is Protecto 401 Ceramic Epoxy. The material shall be an amine cured novalac epoxy containing at least 20 percent by volume of ceramic quartz pigment. Requests for substitutions shall be accompanied by a successful history of lining pipe and fittings for sewer service and a certified test report verifying the following properties:
    - 1) A permeability rating of 0.00 when tested according to Method A of ASTM E-96-66 Procedure A with a test duration of 30 days.
    - 2) The following tests must be conducted on coupons from factory lined ductile iron pipe:
      - i. ASTM B-117 Salt Spray (scribed panel) - Results to equal 0.0 undercutting after two years.
      - ii. ASTM G-95 Cathodic Disbondment 1.5 volts at 77 degrees Fahrenheit with no more than 0.5 mm undercutting after 30 days.
      - iii. Immersion Test rated using ASTM D-714-87
        1. 20 percent Sulfuric Acid - No effect after two years.

2. 25 percent Sodium Hydroxide at 140 degrees Fahrenheit - No effect after two years.
  3. 160 degrees Fahrenheit Distilled Water - No effect after two years.
  4. 120 degrees Fahrenheit Tap Water (scribed panel) 0.0 undercutting - No effect after two years.
- iv. An abrasion resistance of no more than 3 mils (0.075 mm) loss after one million cycles using European Standard EN 598: 1994 Section 7.8 Abrasion Resistance.
- 3) Lining Thickness: Lining shall be 40 mils nominal dry film thickness with the number of coats of lining material as recommended by the lining manufacturer.
- 4) Surface Preparation: Prior to abrasive blasting, the entire area to receive the protecting compound shall be examined for oil, grease, etc. Areas with oil, grease, or substances that can be removed by solvent shall be solvent cleaned using the guidelines outlined in DIPRA- 1 Solvent Cleaning. After the surface has been cleaned, areas to receive the protective compounds shall be abrasive blasted using compressed air nozzles with sand or grit abrasive media. The entire surface to be lined shall be struck with the blast media so that all rust, loose oxides, etc., are removed from the surface. Only slight stains and tightly adhering annealing oxide may be left on the surface in accordance with NAPF Standard 500-03. Any area where rust reappears before lining must be blasted again.
- 5) Application
- i. Applicator: The lining shall be applied by a competent firm with a successful history of applying linings to the interior of ductile iron pipe and fittings.
  - ii. Lining: Within 8 hours of surface preparation, the interior of the pipe shall receive 40 mils nominal dry film thickness of Tnemec Perma-Shield PL 431 or approved equal. No lining shall take place when the substrate or ambient temperature is below 40 degrees Fahrenheit. The surface also must be dry and dust free. If flange pipe or fittings are included in the project, the lining shall not be used on the face of the flange.
  - iii. Coating of Bell Sockets and Spigot Ends: The gasket area and spigot end up to 6 inches back from the end of the spigot end must be coated with 6 mils nominal, 10 mils maximum Tnemec Perma-Shield PL 431 or preapproved equal joint Compound. The Joint Compound shall be applied by brush to ensure coverage. The joint compound shall be smooth without excess buildup in the gasket seat or on the spigot ends. Coating of the gasket seat and spigot ends shall be performed after the application of the lining.
  - iv. Number of Coats: The number of coats of lining material applied shall be as recommended by the lining manufacturer. However, in no case shall this material be applied above the dry thickness per coat recommended by the lining manufacturer. The maximum or minimum time between coats shall be the time recommended by the lining material manufacturer. No material

shall be used for lining that is not indefinitely recoatable with the same material without roughening of the surface.

6) Independent Test Laboratory Inspection and Certification:

- i. The thickness for linings for ductile iron pipe and fittings shall be verified using a magnetic film thickness gauge. The thickness testing shall be performed using the method outlined in SSPC-PA-2 Film Thickness Rating.
- ii. The interior lining of all pipes and fittings shall be tested for pinholes with a nondestructive 4,000 volt test. Any pinholes found shall be repaired prior to shipment at no additional cost to the Owner.
- iii. Pipe joints and fittings shall be marked with the date of application of the lining system along with the numerical sequence of application. Records shall be maintained by the Applicator.
- iv. The pipe or fitting manufacturer must supply a certificate attesting to the fact that the Applicator met the requirements of this Specification and lining manufacturer's recommendations for preparation with the material specified.
- v. The results shall be verified by an independent testing laboratory and forwarded to the Engineer.

5. Interior Coating for Ductile Iron Pipe - Polyethylene Lining

- a. The lining material for pipe and fittings shall be virgin polyethylene complying with ANSI/ASTM D1248, compounded with inert filler with sufficient carbon black to resist ultraviolet rays during storage of the pipe and fittings. The polyethylene shall be bonded to the interior of the pipe or fittings by heat. The polyethylene shall be modified for enhanced adhesion to ductile iron surfaces.
- b. Surface areas to be lined shall be blast cleaned comparable to the requirements of SSPC-SP6 or NACE #3. (Note: This is a comparison only since there are no surface preparation specifications for ductile iron pipe. SSPC and NACE surface preparation specifications apply only to steel surfaces and are not directly applicable to ductile iron surfaces.)
- c. Polyethylene linings shall cover the inner surface of pipe and fittings extending from the spigot end to the gasket socket.
- d. Lining in pipes and fittings shall be 40 mils nominal thickness. Minimum lining thickness shall be 30 mils.
- e. An independent inspection shall be conducted as per ASTM G62, Method B. A boil adhesion test shall be performed in accordance with ASTM C541.
- f. Repair Procedure for Damaged Polyethylene Lining
  - 1) Remove any loose fitting.
  - 2) Clean exposed metal surface with power grinder. Abrade lining surface in a 2-inch band surrounding circumference of patched area. Remove resulting dust from surface to the relined.

- 3) Mix coal tar epoxy according to manufacturer recommendations.
- 4) Apply first coat and allow curing per manufacturer recommendations.
- 5) Abrade surface of epoxy with sand paper to ensure good bond between first and second coat. Remove dust resulting from this operation.
- 6) Apply second coat of coal tar epoxy.
- 7) Allow patch to cure according to coal tar epoxy manufacturer recommendations.

#### B. Polyvinyl Chloride (PVC) Sanitary Sewers

1. PVC sewer pipe furnished and installed shall conform to the requirements of ASTM D3034 for SDR35 pipe. Laying lengths shall be regular commercial lengths not to exceed 13 feet.
2. PVC sewer pipe delivered to the project shall bear the mark of an approved testing laboratory showing that such pipe was tested and approved at the manufacturing plant. PVC pipe testing shall conform to ASTM D3034 and certified test reports shall be furnished to the Engineer.
3. Joint Material for PVC Sewer Pipe
  - a. The Contractor shall furnish technical and construction data for PVC jointing material for review and approval by the Engineer prior to incorporating the jointing material into the work.
  - b. PVC joint material shall be flexible of the elastomeric type with push-on joints conforming to the requirements of ASTM D-3212 and assembled in accordance with manufacturer recommendations.

#### C. Reinforced Concrete Sewers

1. Reinforced concrete pipe shall conform to ASTM C-76, Wall B or C, Class 3, 4, or 5 as indicated on the Drawings and furnished with minimum laying lengths of 12 feet pipe with steel end ring joints and 8-foot minimum with rubber and concrete bell and spigot joints unless otherwise approved in writing by the Engineer.
2. Joints for reinforced concrete sewer pipe shall be either steel end ring type conforming to ASTM C443 or ASTM C361, or rubber and concrete joints conforming to ASTM C443 or ASTM C361. Rubber gaskets for either joint shall meet the testing requirements of ASTM C443 or ASTM C361. Optional joint designs shall be submitted to the Engineer for review. Joints shall be tested to ensure water tightness. Assembled gravity sewer pipe joints in straight alignments shall be subjected to an internal pressure of 13 psi (30 feet) pressure head for 10 minutes per ASTM C443. Rubber gaskets shall be extruded or molded and cured in such a manner that any cross section will be dense, homogenous, and free of porosity, blisters, pitting, and other imperfections.
3. Reinforced Concrete Pipe Corrosion Protection
  - a. If required, corrosion resistant additives and/or PVC or HDPE mechanically attached (cast-in) liners shall be utilized in concrete pipe where hydrogen sulfide gas or other industrial caustic materials entering system are prevalent. Non-

corrosive environments shall utilize standard reinforced concrete pipe (pH ranges from 6-12). Corrosive environments shall require the use of a corrosion protection additive such as XYPEX C1000 or preapproved equal (pH less than 5). Highly aggressive environments (pH less than 3 with spikes of 2 or less) shall use a protective mechanical lining.

- b. Lining Material: PVC or HDPE lining systems shall be mechanically cast into concrete pipe wall and be full 360 degree coverage. Lining systems shall be TLOK GSE Studliner or Amer-I-Line or approved equal. Linings shall be welded across the joint to make a continuous liner in the field by a certified welder. In lieu of welded joints strips, special high build epoxy based coatings (20 mil dry) may be applied to the bell and spigot joint edges by certified manufacturer. The liner thickness shall be minimum 1.75 mm.

#### D. Centrifugally Cast Fiberglass Reinforced Polymer Motor Pipe (CCFRPM)

##### 1. Material

- a. Resin Systems: The manufacturer shall use polyester resin systems with a proven history of performance in this particular application. The historical data shall have been acquired from a composite material of similar construction and composition as the proposed product.
- b. Glass Reinforcements: The reinforcing glass fibers used to manufacture the components shall be of the highest quality commercial grade E-glass filaments with binder and sizing compatible with impregnating resins.
- c. Silica Sand: Sand shall be minimum 98 percent silica with a maximum moisture content of 0.2 percent.
- d. Additives: Resin additives such as curing agents, pigment, dyes, fillers, thixotropic agents, etc., when used, shall not detrimentally affect the performance of the product.
- e. Elastomeric Gaskets: Gaskets shall be supplied by approved gasket manufactures and be suitable for the service intended.

##### 2. Manufacture and Construction

- a. Pipes: Manufacture pipe by the centrifugal casing process to result in a dense, non-porous, corrosion-resistant, consistent composite structure. The interior surface of the pipe exposed to sewer flow shall be manufactures utilizing a resin with a 50 percent elongation (minimum) when tested in accordance with ASTM D638. The interior surface shall provide crack resistance and abrasion resistance. Certification from the resin supplier shall be included in the submittals. The exterior surface of the pipe shall be comprised of a sand and resin layer. The layer should provide for UV protection to the pipe exterior.
- b. Joints: Unless otherwise specified, the pipe shall be field connected with fiberglass sleeve couplings that utilize elastomeric sealing gaskets made of EPDM rubber compound as the sole means to maintain joint water tightness. The joints must meet the performance requirements of ASTM D4161. Joints at tie-ins, when needed may

utilize stainless steel, gasket-sealed closure couplings. As a supplement to the testing requirements of ASTM D4161- Sect 7.4, the proposed pipe joints shall be capable of withstanding an external pressure test of 100 psi in both straight alignment and angularly deflected. A test report, certified by an independent testing lab is required with submittals for approval by the Engineer.

- c. Fittings: Flanges, elbows, reducers, tees, wyes, laterals and other fittings shall be capable of withstanding all operating conditions when installed. They may be contact molded or manufactured from mitered sections of pipe joined by glass-fiber-reinforced overlays. Properly protected standard ductile iron, fusion-bonded epoxy coated steel and stainless steel fittings may also be used.

3. Dimensions

- a. Diameters: The actual outside diameter (18-inch to 48-inch) of the pipes shall be in accordance with ASTM D3262.
- b. Lengths: Pipe shall be supplied in nominal lengths of 20 feet. Actual laying length shall be nominal +1, -4 inches. At least 90 percent of the total footage of each size and class of pipe, excluding special order lengths, shall be furnished in nominal length sections.
- c. Wall Thickness: The minimum wall thickness shall be as follows:

Nominal Pipe Diameter (inches)	Minimum Wall Thickness (inches)	
	Minimum Pipe Stiffness 46 (psi)	Minimum Pipe Stiffness 72 (psi)
18	0.39	0.44
20	0.43	0.49
24	0.50	0.57
27	0.54	0.62
30	0.61	0.70
33	0.64	0.74
36	0.72	0.83
42	0.83	0.95
45	0.89	1.02
48	0.94	1.08
51	1.00	1.15
54	1.05	1.21
57	1.10	1.27
60	1.15	1.33
63	1.21	1.39
66	1.27	1.46
69	1.32	1.53
72	1.38	1.59
78	1.48	1.71

Nominal Pipe Diameter (inches)	Minimum Wall Thickness (inches)	
	Minimum Pipe Stiffness 46 (psi)	Minimum Pipe Stiffness 72 (psi)
	84	1.58
90	1.71	1.97
96	1.80	2.08
104	1.95	2.25
110	2.06	2.38

d. End Squareness: Pipe ends shall be squared to the pipe axis with a maximum tolerance of 1/8-inch.

#### 4. Testing

- a. Pipes: Pipes shall be manufactured and tested in accordance with ASTM D3262. As part of the submittals, the strain corrosion test results from products made in the same manufacturing facility are required.
- b. Joints: Coupling Joints shall meet the requirements of ASTM D4161.
- c. Stiffness: Minimum pipe stiffness when tested in accordance with ASTM D2412 shall normally be 46 psi or as required per the Engineer. Full engineering calculations confirming the pipe class suitability, sealed by a professional engineer in the State of Tennessee, shall be submitted to the owner for approval prior to the manufacturing of the pipe.
- d. Strain Corrosion: Pipes shall be manufactured and tested in accordance with ASTM D3262 and ASTM 3681 (Strain Corrosion Test.) A valid copy of full test report by an outside third party independent lab, demonstrating a 50 year extrapolated strain corrosion value of 0.90% in 1 Normal Sulfuric Acid environment typical of conditions found in sanitary sewers. No short term validation test results will be accepted in lieu of above referenced full test report.

#### 5. Customer Inspection

- a. The owner or other designated representative shall be entitled to examine pipes or witness the pipe manufacturing.
  - b. Manufacturer's Notification to Customer: Should the Owner request to see specific pipes during any phase of the manufacturing process, the Manufacturer must provide the Owner with adequate advance notice of when and where the production of those pipes will take place.
6. Packaging, Handling, and Shipping - Packaging, handling, and shipping shall be done in accordance with the Manufacturer's instructions.

#### E. Filament Wound Fiberglass Reinforced Polymer Mortar Pipe

##### 1. Materials

- a. Resin Systems: The manufacturer shall use only approved polyester resin systems with a proven history of performance of in this particular application. The historical data shall have been acquired from a composite material of similar construction and composition as the proposed product.
  - b. Glass Reinforcements: The reinforcing glass fibers to be used to manufacture the components shall be of the highest quality commercial grade of glass filaments suitably treated with binder and sizing compatible with impregnating resins. Pipes for the conveyance of sanitary sewage shall use E-glass CR (Corrosion Resistant) glass.
  - c. The internal liner shall be a glass reinforced thermoset liner suitable for service in a sewer pipe, and shall be highly resistant to exposure to sulfuric acid as produced by biological activity from hydrogen sulfide gases. Pipe shall meet or exceed requirements off ASTM D3681.
  - d. Silica Sand: Sand shall be minimum 98 percent silica with a maximum moisture content of 0.2 percent.
  - e. Additives: Resin additives, such as curing agents, pigments, dyes, fillers, thixotropic agents, etc., when used, shall not detrimentally effect the performance of the product. Calcium carbonate is not be used as a substitute for resin or silica sand.
  - f. Elastomeric gaskets shall be supplied by qualified gasket manufacturers and be suitable for the service intended.
2. Pipe Design - Pipe should be designed to handle all loading conditions in accordance with the AWWA M45 Manual - Fiberglass Pipe Design. Load conditions should include loading from earth, hydrostatic, and live loads.
  3. Manufacturing and Product Construction
    - a. The pipe shall be manufactured using a filament wound - continuous advancing mandrel process utilizing continuous glass fiber reinforcements in the circumferential direction. Both continuous glass fiber roving and chopped roving will be incorporated for high hoop strength and axial reinforcement. A sand fortifier shall be used to provide increased stiffness with placement near the neutral axis in the core. The pipes shall be manufactured in accordance with ASTM D3262. The pipe shall meet the following cell limits: Type 1, Glass-fiber-reinforced thermosetting polyester resin mortar (RPMP polyester), Liner 1, and Grade 1.
    - b. Reka Couplings: The filament wound fiberglass pipe shall utilize filament-wound Reka Couplings. The Reka Coupling shall use 2 gaskets with 4-6 sealing fins (depending on diameter) and shall be located in a recessed groove approximately 1.5 inches from each edge. The sealing gaskets will be the sole means to maintain joint water tightness. An elastomeric pipe stop will be located in a groove in the middle of the Reka Coupling between the sealing gaskets. The joints shall utilize elastomeric gaskets meeting the performance requirements of ASTM D4161. The couplings shall be manufactured using the same process as the pipe. For project installations depths more than 50 feet over the top of pipe, the proposed pipe joints

shall be capable of withstanding an external pressure test of 100 psi in both straight alignment and angularly deflected. A test report, certified by an independent testing lab is required with submittals for approval by the Engineer.

- c. Fittings: All fittings shall be fabricated from pipe meeting the requirements of these standards. Ductile iron, stainless steel or fusion bonded epoxy coated steel fittings may also be used.
- d. Acceptable manufacturer: Manufacturer of pipe and fittings shall employ manufacturing methods and material formulations used in the manufacture of glass-fiber-reinforced polymer pipe for a minimum of fifteen years. A project reference list with project name, owner, and Engineer contact and phone number of 10 sanitary sewer project with XX" and larger pipe supplied and installed in North America with 1000 ft minimum per project or a cumulative total footage of 10,000 ft of pipe XX" or larger supplied on a minimum of 3 projects installed in North America.

#### 4. Dimensions

- a. Diameters: The outside diameter of pipe shall be per the ASTM D3262-Table 3.
- b. Lengths: Pipe shall be supplied in nominal lengths of 10 to 40 feet. Actual lay length shall be nominal  $\pm 1$ -inch. Special short lengths may be used where surface geography or installation conditions require shorter lengths.
- c. Wall Thickness: The average wall thickness of the pipe shall not be less than the nominal wall thickness published in the manufacturer's literature, and the minimum wall thickness at any point shall not be less than 87.5 percent of the nominal wall thickness.
- d. End Squareness: All points around each end of a pipe unit shall fall within  $\pm 1/4$ -inch or  $\pm 0.5$  percent of the nominal diameter of the pipe, whichever is greater, to a plane perpendicular to the longitudinal axis of the pipe.

#### 5. Testing

- a. Pipes: Pipe shall be manufactured in accordance with ASTM D3262. As part of the submittals, the strain corrosion test results from products made in the same manufacturing facility are required.
- b. Joints: Joints shall meet the requirements of ASTM D4161.
- c. Stiffness: Minimum pipe stiffness when tested in accordance with ASTM D2412 shall normally be 46 psi or as specified per the Engineer. Full engineering calculations confirming the pipe class suitability, sealed by a professional engineer in the State of Tennessee, shall be submitted to the Engineer for approval prior to the manufacturing of the pipe.
- d. Strain Corrosion: Pipes shall be manufactured and tested in accordance with ASTM D3262 and ASTM 3681 (Strain Corrosion Test.) A valid copy of full test report by an outside third party independent lab, demonstrating a 50 year extrapolated strain corrosion which exceeds the requirements in Table 4 of ASTM D3262 when tested in accordance with ASTM D3681.

6. Customer Examination - The Owner or other designated representative shall be entitled to examine pipes and witness the manufacturing process.
7. Packaging, Handling, and Shipping - Packaging, handling and shipping shall be performed in accordance with the Manufacturer's instructions.

F. Six-Inch Tee Connections for House Services - Construction, Installation and material of pipe containing tee openings and the joint materials for the same shall be in conformance with the requirements of the Specifications for PVC or DIP sewer where installed. All tees on concrete pipe shall be manufactured by coring the reinforced concrete pipe and cement epoxying a PVC hub on the pipe for full depth of the pipe wall using a Kor-N-Tee resilient compressive fitting.

G. Six-Inch House Services - The furnishing, constructing and installing of all materials and/or methods used in the construction of six-inch house sewer services shall be as specified in the applicable provisions of this Section of the Specifications and as shown on Drawings.

H. Service Reconnections - The furnishing, constructing and installing of all materials and/or methods used in the construction of reconnecting live sanitary services shall be as specified in this Section of the Specifications and as shown on the Drawings.

I. Polyvinyl Chloride Sewer Cleanout Assemblies - Polyvinyl Chloride (PVC) sewer pipe and fittings furnished and installed on this project for cleanout assemblies shall be in conformance of this section using flexible joints if replaced from the main. If a clean-out assembly is inserted into an existing lateral, the PVC pipe and fittings shall conform to ASTM D1785, Schedule 40 PVC1120 with D2466 solvent welded fittings per Metropolitan Plumbing Code.

J. Manholes and Appurtenances

1. Standard Manhole Sidewall

- a. Standard manhole sidewall shall be constructed of concrete of the following types: Precast concrete rings; Precast concrete manhole sidewalls with base; Precast concrete monolithic manhole sidewall; Precast concrete monolithic manhole with base; and Poured-in-place concrete monolithic manhole sidewall
- b. Concrete for precast concrete manhole sidewall shall be Class A as specified in Section 03300. All precast concrete manhole sidewall shall conform to the requirements of ASTM C-478.
- c. All joints shall conform to Section 8 of ASTM C 361. Refer to subparagraph 6, Sealant and Waterproofing hereinafter for sealant requirements in joints.

2. Concrete Manhole Bases and Fillets - Concrete manhole bases and fillets may be precast with the manhole sidewall or poured-in-place conforming to the following requirements:

- a. Precast Manhole Bases and Fillets - All materials and methods used to precast manhole bases and/or fillets shall conform to the applicable provisions for precast manhole sidewall as set out in these Specifications.

- b. Poured-in-Place Manhole Bases and Fillets - Concrete for poured-in-place plain concrete base and fillets shall be Class A as specified and conforming to the requirements of P.C.A. Specifications for Plain and Reinforced Concrete.

Class of Concrete	A
Gals. of water per sack of cement	5.5
Min. bags cement per cubic yard of concrete	5.75
Min. 28 day strength 1 cylinder	2,800 lbs./sq. inch
Min. 28 day strength average for 5 cylinders	3,500 lbs./sq. inch
Slump in inches	2-4

3. Manhole Frames and Covers

- a. Manhole frames and covers shall be made of cast iron conforming to the details shown on the Contract Documents and meeting the requirements of ASTM A-48, Class 30.
- b. All casting shall be made accurately to the required dimensions and shall be sound, smooth, clean, free from blisters, and other defects. Defective castings that have been plugged or otherwise treated to remedy defects shall be rejected. Contact surfaces of frames and covers shall be machined so that the covers rest securely in the frames with no rocking and with the covers in contact with the frames for the entire perimeter of the contact surface.

4. Manhole Drop Pipe Assembly

- a. All drop pipe assemblies must be approved by MWS Engineer.
- b. Pipe, specials, and fittings used in the construction of the manhole drop assembly shall conform to the details shown in the Contract Documents.
- c. The support for outside drop assemblies shall be concrete and conform to the details shown in the Contract Documents.
- d. Concrete for the base and support of drop assemblies shall be Class A as specified herein.
- e. Standard drop pipe assemblies shall be external to the manhole unless approved by the Engineer. Upon approved, inside drop assemblies shall be constructed and supported as detailed in the Contract Documents.

- 5. Pipe Resilient Connectors to Manholes - Resilient connectors between manholes and pipes such as Kor-N-Seal or A-Lok shall be installed in the precast or cored opening manhole wall. The resilient connector shall meet the requirements set forth in ASTM C-923. For Kor-N-Seal type connectors an external band made entirely of corrosion resistant stainless steel shall be used to seal around the pipe.

6. Sealant and Waterproofing

- a. Sealant to be used in joints shall be an approved flexible plastic gasket similar to Ram-Nek. A double seal of Ram-Nek shall be used at each joint.

- b. Manhole waterproofing shall be XYPEX C1000 (dye) or equal concrete waterproofing admixture and shall be added to concrete during the batching operation. Colorant (dye) shall be added at the factory to verify the XYPEX admix is added to the concrete.
7. Stubouts - Stubouts shall be the bell or hub end of a joint of pipe conforming to the requirements of sewer main pipe.
8. Manhole Steps
- a. Manhole steps shall be inserted and securely embedded in the manhole sidewall with a non-skid design of either plastic coated steel or aluminum alloy material.
  - b. Aluminum alloy manhole steps shall be Alcoa aluminum-magnesium silicide type alloy conforming to Federal Specifications QQ-A-200/8 or approved equal.
  - c. Plastic coated steel manhole steps shall be constructed of  $\frac{1}{2}$ -inch steel reinforcing rods encapsulated in polypropylene plastic.
9. Vent Pipe Assemblies - The pipe shall be Schedule 40 steel pipe or Class 52, ductile cast iron pipe, cement mortar lined. Ductile iron pipe and fittings shall be commercial blast cleaned (SSPC-SP6) and shop primed with one coat of Inertol #621 red primer.

K. Concrete Encasement - Concrete for concrete encasement and/or cradle shall be Class B as specified in Section 03300.

L. Grouting of Abandoned Sewers - The concrete shall be in accordance with Section 03300. Contractor may use concrete that has a slump of up to twelve inches and an aggregate of 3/8-inch stone to facilitate pouring the concrete. However, concrete shall still have minimum 28-day strength of 2000 lbs. per square inch.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

#### A. Sanitary Sewer

1. The Contractor shall be responsible for setting grade stakes, lines, and levels. The Contractor shall be responsible for the preparation of cut sheets. The Contractor shall provide level, level rod, and tripod on the job site at all times for the purpose of checking grades, as deemed necessary by the Engineer.
2. All grade and alignment stakes for construction shall be set by a land surveyor registered to practice in the State and associated costs shall be borne by the Contractor. The requirement for this work to be performed by a registered land surveyor may be waived by the Engineer in the event the Contractor desires to utilize his own personnel who are qualified to set the grade and alignment stakes. The Contractor shall assume all responsibility for the accuracy of the grade and alignment stakes.
3. The Contractor may use batter boards or a properly calibrated beam device. No claim for extra work will be allowed for alleged inaccuracy of the laser beam device. Grade hubs for laser beams shall not exceed 100 feet apart with centerline hubs every 50 feet to check laser and grade between manholes.

4. If the Contractor elects to use batter boards, he shall provide and maintain on the work at all times a gauge rod of sufficient length to reach from the invert of the sewer pipe being laid to the top line strung on the three batter boards. The gauge rod shall be graduated and numbered each foot of its entire length. The gauge rod shall be equipped with either a plumb line or two spirit levels to ensure a truly vertical gauge rod at the time a reading is taken and pipe is being set.
5. One week prior to the commencement of trench excavation, the Contractor shall prepare and submit to the Engineer for review 5 copies of detailed Cut Sheets showing the beginning and ending manholes; the distance between manholes; the grade, size and type of line; the depth of cut; etc. The form of Cut Sheet shall be provided to the Contractor. All expense for the preparation of Cut Sheets shall be borne by the Contractor and be included in the unit price bid per foot of pipe.
6. Cut Sheets must be reviewed by the Engineer and approved in writing before trenching operations may be permitted. It shall be the responsibility of the Contractor to prepare Cut Sheets 1 week in advance of his anticipated trenching schedule.
7. The junction of two or more sewers shall be made in strict conformance with the Contract Drawings. The cost of all connections shall be included in the Contract price for the new sewers unless specifically provided in the Contract.
8. New sewer connections with existing sewers shall be made within a manhole. Where an existing manhole is the point of connection for new a sewer, it shall be repointed and any loose bricks or blocks in the walls of the old existing manhole shall be re-laid. The Contractor shall reconstruct fillet (invert) of the manhole to accommodate the new connection. The cost of such work shall be included in the Contract price for new main sewer unless other payments are specifically provided for in these specifications.
9. Outside manhole drop assemblies shall be used to connect a new sewer to an existing manhole.
10. Where no manhole exists at the point of connection, a new manhole shall be constructed of the size and type shown on the Contract Drawings. Payment for such additional manholes will be made at the unit price in the Contract for new manholes that includes all work necessary to make the connection.
11. Connections of new sewers to existing sewers when encountered in construction and not shown on the Contract Drawings shall be made when ordered by the Engineer. Such connections shall be made within a manhole except for house sewer and drain connections. When such sewer connections are made within an existing manhole, any added work involved will be paid in accordance with the procedure outlined in the conditions of the Contract. If the Engineer orders such connections be made in a new manhole, the new manhole will be paid at the prices established in the Contract with the price including all work necessary to make the connections.
12. When connections are made with live sewers, any portion of the work shall not be built under water. A flume or dam must be installed and pumping maintained if necessary to keep the new work in the dry until completed and concrete or mortar has set up.

13. Junctions for future sewer connections indicated on the Contract Drawings on precast concrete manholes shall be provided with a 2-foot - 0-inch long stubout connected to the manhole with a pipe resilient connector. The stubout shall be sealed by means of an approved stopper.

14. Pipe Laying

- a. Installation of pipe should conform to ASTM D-2321 and these Specifications. In case of a conflict between these Specifications and ASTM D-2321, the more stringent requirements shall apply. Each pipe shall be laid on an even, firm bed, so that no uneven strain will come to any part of the pipe. Pipes shall not bear on the sockets. Bell holes for bell and spigot pipe shall be dug at each point. Each pipe shall be laid in the presence of the Resident Project Observer. The bell end of the pipe shall be laid upgrade.
- b. The foundation within the trench of the sewer pipe shall be as specified in these Specifications.
- c. The interior of the sewer shall be cleaned of all dirt, jointing material, and superfluous materials.
- d. Proper and suitable tools and equipment for the safe and convenient handling and laying of the pipes and fittings shall be used.
- e. Pipes shall be completely shoved home.

15. Pipe Installation in Tunnel

- a. Prior to installing the sewer pipe, the Contractor shall verify that the primary liner has been constructed so that the sewer pipe may be placed in conformance with specified tolerances.
- b. Tolerances from lines and grades shown on the Drawings for the sewer pipe installed in the tunnel are plus or minus 3 inches in horizontal alignment and plus or minus  $\frac{1}{2}$ -inch in elevation.
- c. The Contractor shall handle and transport pipe into the tunnel in a manner that prevents damage to the pipe, joints, gaskets, and plastic liner.
- d. The Contractor shall provide adequate support to establish final pipe grade. Each end of the pipe shall be supported such that the weight of each length of pipe is self supported. Support may include screened concrete, steel beam, or other methods as designed by the Contractor's Engineer. The Contractor shall secure the pipe support to the pipe or primary liner. If concrete is used for pipe support, the Contractor shall cure it a minimum of 12 hours prior to setting pipe.
- e. The Contractor shall joint pipe segments to properly compress the gaskets and allow for the correct final positioning of the pipe for line and grade. The Contractor shall closely align pipes by bringing them loosely together by means of hydraulic jacks, locomotives, pipe mobiles, or winches. Once pipes have been loosely joined, the Contractor shall pull them home by means of a hydraulic device or other similar method suitably protecting pipe and joints against damage. Impact jointing such as ramming with locomotives or other mechanical equipment is not permitted.

- f. The Contractor shall install pipe blocking systems and secure blocking rigidly in place so that it cannot be dislodged during pipe placement and grouting operations.
  - g. The Contractor shall lubricate pipe joints evenly around the gaskets and steel end rings. Lubricant shall not be allowed to dry prior to joining pipe. Excess lubricant shall be cleaned of each joint prior to grouting of joint.
  - h. Pipe damage during installation shall be repaired or removed based on the extent of damage and the Engineer's requirements. The Engineer's decision shall be final.
  - i. Joints shall be made watertight with particular care taken to prevent misalignment or damage to the joint to be installed in the tunnel.
  - j. If the joint deflection exceeds the manufacturer's recommendations for deflection on long radius curves, the Contractor shall provide beveled pipe, radius pipe, or shorter lengths of pipe per recommendations by the manufacturer.
16. Ductile Iron Pipe and Fittings with Special Lining
- a. Burial: The bedding and backfill of pipe and fittings shall be in accordance with these Specifications.
  - b. Pipe Handling: All specially lined pipes require special handling from the outside of the pipe with straps or chains. No forks or hooks shall be used inside the pipe after the lining has been applied. Field unloading of pipe materials shall be carefully performed; likewise, stenciled notations (at a minimum four per pipe joint and two per fitting) shall specify these handling instructions.
  - c. Jointing: See Ductile Iron Pipe requirements hereinbefore.
  - d. Field Testing: See Ductile Iron Pipe testing requirements hereinbefore.
17. Centrifugally Cast Fiberglass Reinforced Polymer Mortar Pipe
- a. Burial: The bedding and burial of pipe and fittings shall be in accordance with these Specifications.
  - b. Pipe Handling: Use textile slings, other suitable materials or a forklift. Use of chains or cables is not recommended.
  - c. Jointing:
    - 1) Clean ends of pipe and coupling components.
    - 2) Apply joint lubrication to pipe ends and elastomeric seals of coupling. Use only lubricants approved by the pipe manufacturer.
    - 3) Use suitable equipment and end protection to push or pull the pipes together.
    - 4) Do not exceed forces recommended by the manufacturer for coupling pipe.
    - 5) Join pipes in straight alignment, then, deflect to required angle. Do not allow the deflection angle to exceed the deflection permitted by the manufacturer.
  - d. Field Testing: Testing shall be as specified hereinbefore.
18. Filament Wound Fiberglass Reinforced Polymer Mortar Pipe

- a. Burial: The bedding and burial of pipe and fittings shall be in accordance with these Specifications.
- b. Pipe Handling: Use textile slings, other suitable materials of a forklift. Use of chains or cables is not recommended.
- c. Jointing:
  - 1) Clean ends of pipe and coupling components.
  - 2) Apply joint lubrication to pipe ends and electrometric seals of coupling. Use only lubricants approved by the pipe manufacturer.
  - 3) Use suitable equipment and end protection to push or pull the pipes together.
  - 4) Do not exceed forces recommended by the manufacturer for coupling pipe.
  - 5) Join pipe in straight alignment, then, deflect to required angle. Do not allow the deflection angle to exceed deflection permitted by the manufacturer.
- d. Field Testing - Testing shall be as specified hereinbefore.

**B. 6-Inch Tee Connections**

- 1. This item shall include the furnishing and installing 6-inch tee connections at locations shown on the Drawings or as specified by the Engineer during construction.
- 2. Construction, installation, and material of pipe containing tee openings and joint materials shall be in conformance with the requirements of the Specifications for that portion of the main sewer. Where provided for future house sewer service connections and as directed by the Engineer, the sewer service line shall be extended a minimum of 4 feet and capped as specified in these Specifications.

**C. 6-Inch House Sewer Services**

- 1. This item shall include furnishing and installing 6-inch house sewer service sanitary sewers at the locations as shown on the Drawings or as directed by the Engineer during construction. It shall also include bends, caps, and joint material.
- 2. The furnishing, constructing, and installing of materials and/or methods used in the construction of 6-inch house sewer services shall be as specified in these Specifications and as shown on Drawings.
- 3. The location of all 6-inch house sewer services shall be as directed by the Engineer during construction. The slope shall not be less than 1/8-inch per foot.
- 4. The pipe material and method of jointing shall be the same as specified for the main sewer.
- 5. Where directed by the Engineer for future house sewer services, the Contractor shall saw off the bell of the last joint of 6-inch sewer pipe laid on each service line and cap the end of each service line with a Quik Cap flexible (PVC) cap (Fernco or approved equal) with an external band made entirely of corrosion-resistant stainless steel to seal around the pipe. No additional payment will be allowed for cutting and capping the service pipe.

D. Reconnections of Live Sanitary Services

1. **General** - This item shall include the furnishing of all materials and performing all work to reconnect each live sanitary sewer service to the new sanitary sewer collector lines. The Contractor shall be responsible to determine if a service is live. No payment will be made for reconnecting a dead service. After separation of the storm and sanitary sewers, the Owner reserves the right to sample and test storm water discharges. If tests reveal fecal coli form, which would be an indication of a sanitary sewer connection(s) remaining on the storm sewer, the onus is on the Contractor to show all live sanitary reconnections have been made regardless of the level of effort necessary to so prove.
2. **Cleanout Assembly** - Each reconnected service shall be provided with a 6-inch single cleanout assembly as per details shown on the Drawings. Cleanouts shall be complete as shown on Details.
3. **Reconnection** - Reconnections of dissimilar pipes shall be made with a corrosion resistant coupling with stainless steel hose clamps (Fernco or approved equal). Reconnection shall be as per Details shown on the Drawings.

E. Manholes and Appurtenances - This item shall include the furnishing of all materials and doing all work necessary for the complete construction of standard and/or special manholes of the types, sizes, shapes, dimensions, and at the locations shown on the Drawings.

1. **Manhole Bases and Fillets**

a. **Precast Manhole Bases**

- 1) The Contractor shall install the precast concrete manhole base upon a crushed stone (No. 67, 57, or approved equal) bed that is a minimum of 6 inches thick. This bed shall be brought to the required grade. The Contractor shall ensure that the bed is level and even so that when the precast unit is set in place, the manhole sidewall will be installed plumb and the concrete manhole base is in full contact upon the gravel base.
- 2) The precast manhole base shall be a minimum of 6 inches in thickness. For 48-inch diameter manhole and 8-inch for 60-inch and 72-inch diameter manholes. For units that require the fillets to be poured-in-place, a minimum of 2 inches shall be allowed from the inside of the base to the invert of the downstream pipe for the construction of the fillet.
- 3) Backfilling operations may begin after the installation of the precast manhole sidewall with base has been completed. After completion of the backfilling operations, traffic may be allowed on the structure.

b. **Poured-In-Place Manhole Bases and Fillets**

- 1) Concrete shall be adequately protected from injurious action of the sun by wetting, covering with water-saturated cover, or other methods approved by the Engineer.
- 2) In cold weather, concrete shall be mixed and placed only when the temperature is at 40 degrees Fahrenheit or above, and rising, unless specifically authorized in

writing by the Engineer, in which event all materials shall be heated in a manner approved by the Engineer. In freezing weather, suitable means shall be provided for maintaining the concrete at a temperature of at least 50 degrees Fahrenheit for a period not less than 72 hours after placing. Salt, chemicals, or other foreign materials shall not be mixed with the concrete for the purpose of preventing freezing, unless approved by the Engineer.

- 3) Poured-in-place manhole bases shall be allowed to set a minimum of 24 hours before installing the manhole sidewall.
- 4) The monolithic concrete or the lower section of the precast ring sidewall shall be installed on the manhole base with a bond of cement mortar.
- 5) The bond shall be prepared by placing a minimum of 3 inch thick bead of cement mortar on the manhole base and lowering the sidewall unit onto the mortar. The mortar forced from beneath the sidewall shall not be removed, but shall be worked to the manhole sidewall to form a fillet or chamfer around the base of the sidewall.
- 6) The Contractor shall ensure that the manhole sidewall is installed plumb and truly vertical and the concrete manhole base is finished to a horizontal surface.
- 7) When approved by the Engineer, the manhole sidewall may be set on concrete block supports and the required base poured up to and around the manhole sidewall. The base shall then be allowed to set for 24 hours. The Contractor shall prevent concrete being poured up to or around the resilient pipe line connector.

c. Fillets

- 1) Except as otherwise specified, fillets in manholes shall be tapered uniformly between the inverts of the inlet pipe and the outlet pipe. Fillets in junction manholes shall be constructed with curved channels for side streams to minimize turbulence as shown on the Details. Fillets in end manholes shall be shaped to drain to the discharge pipe.
- 2) In cases where the invert of inlet pipes are 6 inches or more above the invert of the outlet pipe, the flow line of the fillet at the inlet side shall not be greater than 6 inches above the invert of the outlet pipe to provide clearance for maintenance or testing equipment.
- 3) Fillets shall be neatly and uniformly shaped; have a brushed finish; and be constructed of concrete. Cement mortar shall not be used to obtain the required shape and finish.
- 4) The cost of manhole fillets shall be included in the unit price of manholes with no separate payment allowed.
- 5) The area on the inside of the manhole around the juncture of the sidewall and the fillet shall be waterproofed as specified in these Specifications.

2. Manhole Sidewall

a. Precast Manhole Sidewall

- 1) The Contractor shall order the precast manhole sidewall to meet the required field conditions. The height of the unit in place shall allow the adjusting rings to be placed on top of the manhole transition section prior to setting the casting. A minimum of 2 inches and/a maximum of 10 inches of precast concrete adjustment rings will be allowed. The maximum distance from top of casting to the start of corbell section shall be 18 inches. Precast concrete adjusting rings must be used.
- 2) The corbell section of the manhole sidewall shall be cast in the shape of a concentric cone.
- 3) At joints of precast manhole sidewall, an approved flexible, plastic gasket material similar to Ram-Nek or rubber gasket conforming to ASTM C361 shall be applied to the joint surface prior to the placement of the next manhole section. Two rolls of flexible gasket material shall be used to fill the void in the joint.
- 4) The Contractor shall ensure that backfill material is placed around the manhole sidewalls in equal levels simultaneously.
- 5) Pipe line connections to the manhole sidewall shall be made with resilient connectors.

b. Poured-in-Place Concrete Monolithic Sidewall

- 1) The Contractor shall place the forms so the manhole casting is set to match the finished grade of the adjacent street and/or ground line with allowance of a 2-inch adjustment ring.
- 2) The corbell section of the manhole sidewall shall be cast in the shape of a concentric cone.
- 3) The Contractor shall obtain and have tested concrete cylinders in compliance with ASTM C-173, ASTM C-31 and ASTM C-39 at an approved testing laboratory. The Contractor shall instruct the testing laboratory to forward copies of the test reports to the Engineer and the Owner.
- 4) The maximum depth of manholes shall not exceed 20 feet. The minimum wall thickness for 48-inch inside diameter manholes shall be 6 inches. The minimum wall thickness for 60-inch and 72-inch inside diameter manholes shall be 8 inches.
- 5) The base shall be Class C concrete, vibrated on firm subgrade foundation of suitable crushed stone bedding. The base shall have a minimum diameter 8 inches greater than the outside diameter of the manhole and a minimum thickness of 8 inches.
- 6) The first placement of base concrete shall consist of approximately 1/2 cubic yards of concrete deposited evenly around the walls and vibrated until a minimum slope of 60 degrees is developed from the bottom of the forms to the bearing surface both inside and outside of the manhole. Additional concrete must be deposited in evenly distributed layers of 18 inches with each layer

vibrated to bond to the preceding layer. The wall spacers must be raised as the placements are made with the area from which the spacer is withdrawn while being vibrated.

- 7) If cold joints are necessary, a formed groove and reinforcing dowels (#5 bars 36 inches long on 12-inch centers) shall be required in the top of the first placement for shear protection. Immediately before the second placement is made, the surface of the cold joint shall be thoroughly cleaned and wetted with a layer of mortar placed on the surface.
  - 8) The forms may be removed 24 hours after placement.
  - 9) The monolithic manholes shall be backfilled to same level simultaneously. The manholes shall not be backfilled until they reach 75 percent of the specified design strength. An Engineer approved gravel backfill material shall be placed adjacent to the manholes in areas where swelling clays exist.
  - 10) A resilient connector shall be utilized to connect pipe to manhole sidewall.
3. Manhole Frames and Covers - The manhole frame for the cover shall be set on the manhole sidewall in a full bed of mastic and secured to the barrel with four 5/8-inch anchor bolts at the required elevation. Where manholes are constructed in paved areas or fill slopes, the surface of the frame and cover shall be tilted to conform to the slope, crown, or grade of the existing surface. Vertical adjustments to new and existing manhole frames and covers will be exclusively with concrete adjustment rings in available heights or mortar when adjustments less than 2 inches are required.
4. Manhole Drop Pipe Assembly
- a. Where the difference in invert elevations of an entering sewer and a discharging sewer intercepting in the same manhole is 2 feet or more, a drop manhole assembly shall be constructed on the entering sewer.
  - b. The cost of furnishing, constructing, and installing manhole bases, fillets, sidewalls, castings, and all other work necessary for a complete creek bottom manhole installed to the Details as shown in the Drawings and shall be included in the unit price for Creek Bottom Manholes with no separate payment allowed.
5. Pipe Resilient Connectors to Manholes
- a. Connections of pipe to manhole sidewalls shall be made with resilient connectors. Openings in the manhole sidewall for the pipe shall be precast or cored to provide required size and location. The hole shall be manufactured to allow for lateral and vertical movement and angular adjustments through a range of 20 degrees. A resilient connector between the manhole and pipes such as Kor-N-Seal or A-Lok shall be installed in the precast or cored openings. Seals shall be installed in the precast or cored opening. The resilient connector shall meet the requirements set forth in ASTM C-923. The insulator ring provided by the manhole supplier must be used to prevent cosmetic dressing mortar to set inside the resilient connector creating an adverse rigid connection. For Kor-N-Seal type boots, an external band made entirely of corrosion resistant stainless steel shall be used to seal around the

pipe. A torque wrench, as specified by the manhole supplier, must be used to seat the resilient connector to pipe.

- b. The void between the pipe and the connector shall be filled with an approved flexible gasket material.
- c. Resilient connectors shall be considered an integral part of the manhole sidewall with no separate payment allowed.

#### 6. Sealing

- a. The sealing of the joints in the manhole sidewall and inverts of the manhole shall conform to the following specifications for waterproofing and sealing. Safety regulations and precautions set out by the paint manufacturer and OSHA shall be strictly observed.
- b. All joints between the sections of precast manhole sidewalls shall be sealed with two rolls of approved flexible plastic gasket similar to Ram-Nek and applied to the joint surface prior to the placement of next manhole section.
- c. For manholes installed on a poured-in-place base, after completion of manhole fillet, the area where the inside manhole sidewall joins the manhole fillet shall be waterproofed by applying a sealant. This will not be required on manholes where the base is precast or poured-in-place monolithically with the manhole sidewall.
- d. The area to be waterproofed shall extend up the manhole sidewall and into the manhole fillet 6 inches from the juncture of the sidewall and the fillet.
- e. Manhole waterproofing shall be XYPEX C1000 (dye) or preapproved equal concrete waterproofing admixture and shall be added to concrete during the batching operation. Colorant (dye) shall be added to verify the XYPEX admix is added to the concrete. Admix should meet the Army Corps of Engineers CRD-C48 Permeability of Concrete at 7 bars (224 feet water head).
- f. When specified, the Contractor shall apply by brush or spray a penetrant coating similar to the inorganic polymer Durpal. This material shall act as a prime coat and surface stabilizer. After the material has cured, the areas shall be coated with at least two coats of sealant: one grey coat and one white coat of Portland cement slurry similar to Drycon Grey and Drycon white that consists of Portland Cement and finely graded mineral fillers and inorganic co-polymer additives that will prevent seepage of water through manhole wall under hydrostatic pressure. These two coats must be applied by brush to the dampened surface and be able to withstand a hydrostatic pressure of 7 psi (16 feet of water) and shall be applied at right angles to each other. A final coat will be inorganic polymer solution similar to Duripal-H having a non-silicone base. This final coat will be applied by spraying or brushing the liquid over the final white coat of sealant to provide resistance against chemical attack.
- g. Sealing shall be considered an integral part of the manhole sidewall and no separate payment will be allowed.

7. Stubouts - Provisions for future sewers will be provided by installing a 24-inch long stubout to the size, line, and grade indicated. Stubouts shall be the bell or hub end of a joint of pipe that conforms to the requirements of the main sewer. The bell or hub shall be plugged with a disk stopper of the same material and sealed with the same joints as specified for the main sewer. All cost involved in placing stubouts shall be included in the unit price for manhole sidewall and no separate cost will be allowed.
8. Manhole Steps - Manhole steps shall be inserted and securely embedded in the manhole sidewall. Manhole steps shall be considered as an integral part of the manhole sidewall and no separate payment will be allowed.
9. Vent Pipe Assemblies
  - a. The vent pipe shall be located out of a travel way; in back of a curb or sidewalk; or as called for in the Drawings. The vent pipe is to be painted with one coat of red lead primer such as Phenolic Resin Varnish Base Inertol #621 and then 2 coats of epoxy ester intertol ponkote enamel or TNEMEC series N69 HiBuild Epoxoline top coated with TNEMEC 1074 Endura Shield. Primer shall be allowed to dry 72 hours and be thoroughly dry before recoating. The top coat of paint shall be dark green. The top of the vent pipe shall not be less than 9 feet above the existing ground line or set to the elevation as indicated on the Drawings.
  - b. Concrete foundations for manhole vent pipe assemblies shall be Class A concrete as specified in these Specifications. Forms will not be required unless the foundation is located in backfill materials.

F. Concrete Encasement

- a. Concrete for concrete encasement and/or cradle shall be Class B conforming to the requirements of P.C.A. Specifications for Plain and Reinforced Concrete.
- b. All concrete shall be adequately protected with methods satisfactory to the Engineer.
- c. Concrete shall be mixed and placed only when the temperature is 40 degrees Fahrenheit or above and rising, unless specifically authorized by the Engineer. During freezing weather, suitable means shall be provided for maintaining the concrete at a temperature of at least 50 degrees Fahrenheit for a period not less than 72 hours after placing. Salt, chemicals, or other foreign materials shall not be mixed with the concrete for the purpose of preventing freezing, unless approved by the Engineer.
- d. Concrete shall be placed before initial set has occurred and in no event after it has contained its water content for more than 30 minutes.
- e. Concrete shall not be placed on soft or dry soil.
- f. Freshly placed concrete shall be protected from heavy rain, flowing water, mud deposits, and other injurious conditions.
- g. The Contractor shall ensure that when placing concrete cradles or encasements that the sewer pipe is not moved from its proper grade and alignment.

- h. Imperfect or damaged work, or any material damage before final acceptance, shall be satisfactorily replaced by the Contractor at his own expense. Removal and/or replacement of concrete work shall be done in a manner that will not impair its strength.

3.2 CONSTRUCTION TESTING - It is the intent of these Specifications to secure pipe lines with a minimum amount of leakage. All gravity pipe lines shall be tested for infiltration and exfiltration. All leakage testing shall be performed by the Contractor under the observance of the Engineer.

A. Testing of Gravity Sewers

1. Visual Tests

- a. Upon completion of the construction, or earlier if the Engineer deems advisable, the Engineer will make a visual examination of the sewer and construction site. The Contractor shall immediately repair all leaks and defects found by such examination.
- b. In addition to general cleanup and leakage, the following standards shall be used to determine failure or defects of this project.
- c. Sewers must be built 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 will drain so that no remaining puddle of water will be 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.
- d. The Contractor will be held strictly responsible that all parts of the work shall bear the load of the backfill. If longitudinal and or transverse cracks develop within 1 year from the date of acceptance of the work the Contractor will be required to address as follows; Longitudinal and or transverse cracks with a width less than 0.01-inch are considered hairline and minor and no remediation or repair is required. Seal cracks that are greater than 0.01 inch in width and less than 0.10 inch in width if there is no displacement across the crack and the soil pH is less than 5.5. Contractor shall replace or remediate pipes having longitudinal and transverse cracks that exhibit displacement across the crack greater than 0.10" and or a crack is greater than 0.10-inch in width.

2. Low Pressure Air Tests

a. Positive Pressure Test

- 1) Upon completion of construction, or earlier if the Engineer deems advisable, the Contractor shall provide the necessary equipment and labor to perform low positive pressure air tests in accordance with the provisions of ASTM C 924, ASTM C1103, or ASTM F-1217 as appropriate for size and material type.
- 2) This test shall be performed in the presence of the Engineer and shall be performed on all types of gravity sewer pipe materials. This test shall also include house sewer services to the cleanout assembly and service lines from

manholes. It is imperative that plugs be installed and braced to prevent blowouts. A 6 psi pressure relief device must be used. No one shall be allowed in or near the manholes during pressurization, testing, or depressurization.

- b. Negative Pressure Test - Upon completion of construction, or earlier if the Engineer deems advisable, the Contractor will provide the necessary equipment and labor to perform low negative pressure air tests in accordance with the provisions of ASTM C1214. This test shall be performed in the presence of the Engineer and shall be performed on all types of gravity sewer pipe materials 36" and smaller. This test shall also include the house sewer services to the cleanout assembly and service lines from manholes. It is imperative that plugs be installed and braced to prevent blowouts. A 6 psi pressure relief device must be used. No one shall be allowed in or near the manholes during pressurization, testing, or depressurization.
- c. Individual Joint Testing: For pipes large enough to enter, individual joints may be pressure tested with a portable tester to 5 psi max. with air or water in lieu of line air testing.

### 3. Infiltration

- a. All leakage testing shall be performed by the Contractor under the observance of the Engineer.
- b. Leak testing shall be visually observed after dewatering operations have been discontinued a minimum of 48 hours or until groundwater has been allowed sufficient time to reach its natural elevation. Any leakage found during this operation shall be corrected.
- c. Adequate bulkheads, or plugs, shall be installed at each end of the sewer in preparation for testing. The Contractor shall submit the type of bulkhead, or plug, to be used to the Engineer for review. After testing, the bulkheads, or plugs, shall remain in place until the section of sewer is to be placed in service, at that time the Contractor shall remove the bulkheads or plugs.
- d. All leak testing shall be performed prior to joints being grouted.
- e. No measurable leakage will be acceptable with any approved pipe materials.
- f. No measureable infiltration will be acceptable with any approved pipe materials.

- 4. Internal TV Observation - The Department of Water Services may conduct an internal observation of the sewer with a Television instrument at no cost to the Contractor. The Contractor will be responsible for correcting all deficiencies discovered by this TV observation at no additional cost to The Metropolitan Government.

### 5. Deflection Tests

- a. No pipe will be accepted that has deflected more than 5 percent.
- b. Polyvinyl chloride (PVC), Centrifugally Cast Fiberglass Reinforced Polymer Mortar (CCFRPM), and Filament Wound Fiberglass Reinforced Polymer Mortar (FWFRPM) Sewer Pipe shall pass a go/no go mandrel test or laser video deflectometer inspection. The test shall be conducted after the pipe is in place and not less than

30 days after the pipe has been completely backfilled. The sewer line shall be thoroughly cleaned before testing. Any section that fails to pass shall be repaired by rebedding or replacement of the pipe and retested to satisfaction of the Engineer. The mandrel will be provided by the Owner or the Contractor may provide a mandrel approved by the Engineer. The mandrel shall be pulled by hand freely through the sewer pipe from manhole to manhole. The mandrel shall be sized appropriately for each pipe material.

- B. Testing of ductile iron gravity sewers shall be in accordance with these Specifications.
- C. Service connections and 6-inch house sewer service lines shall be included and must satisfy tests specified for the main sewer.
- D. Manhole Vacuum Test
  - 1. The Contractor shall be required to subject manholes to a vacuum test of at least 10 inches Hg prior to acceptance by the Engineer. The test shall be conducted to include the manhole frame and will be considered acceptable if the vacuum remains at 10 inches Hg. or drops to no less than 9 inches Hg within 1 minute. If the manhole fails the initial test, the Contractor shall locate the leak and make appropriate repairs acceptable to the Engineer. If the manhole being tested is subject to existing water table elevation above the invert of the lowest pipe opening, the vacuum pressure should be reduced by the amount of external pressure being exhibited on the pipe connection to avoid compromising the pipe to manhole connection system.
  - 2. The Contractor shall be required to furnish equipment necessary for manhole vacuum tests including the manhole sealing apparatus, gauges, pumps, plugs, and operating personnel.
  - 3. The cost of this work shall be merged into the unit price bid for manholes, and no additional payment shall be allowed.

### 3.3 MAINTENANCE

- A. On completion of each individual sewer line or 1,500-foot segment, the Contractor shall begin cleanup and property restoration prior to installation of another line, unless written permission is obtained from the Owner and/or Engineer. This permission will only be given if the following conditions and situations exist: The Contractor maintains a sufficient cleanup crew on the project at all times, weather permitting, and that the progress shall be at least equal to the pipe laying progress on the project. The cleanup must be maintained not more than one line or 1,500 feet, whichever is less, behind the pipe laying crew. This shall be subject to weather and ground conditions.
- B. Conditions permitting, cleanup and property restoration shall begin and be prosecuted to completion on a timely basis. Failure by the Contractor to prosecute and complete property cleanup and restoration on a timely basis will result in the withholding of 15 percent of the payment due for that part of the completed pipe sewer for which cleanup and property restoration has not been accomplished. This 15 percent withholding constitutes payment for work not completed. This amount shall be in addition to the retained percentage for work completed. This withholding of 15 percent will continue on subsequent payment estimates until such time as cleanup and property restoration is in compliance.

- C. Cleanup and restoration of areas and facilities disturbed by construction operations shall be considered an integral part of the excavation work, and no separate payment will be allowed.

END OF SECTION