

## SECTION 02530

### SANITARY SEWERAGE COLLECTION FACILITIES

#### **PART 1 – Description**

##### **1.01 Summary**

- A. This Section covers the furnishing and installation of all materials, labor, tools, and equipment to construct complete, in-place sanitary sewer mains, sewer service lines, and all appurtenances in accordance with the requirements of the Contract Documents, and as specified herein.
- B. The Contractor shall also do the excavating of all kinds of materials encountered, furnish or compact foundations where required, furnish and install all timbering, sheeting and bracing necessary or proper to safely support all work, remove all water, protect, repair, relocate, maintain, and restore all subsurface, surface, and overhead structures directly or indirectly disturbed, injured, or affected by his operations, and furnish all other appurtenant items and services necessary or specified.

#### **PART 2 - Materials**

##### **2.01 Submittals**

Before the fabrication of the pipe and manholes is started, the contractor shall submit for review, drawings showing the pipe lengths, complete laying schedule, joint details, special sections, and other additional details, such as fittings. All pipe and manholes furnished shall be fabricated in accordance with the reviewed drawings. Manufacturer's certificates of compliance and installation recommendations shall be provided to the City prior to construction

##### **2.02 Materials**

- A. The materials used in this work shall all be new and conform to the requirements for class, kind, size, and material as specified herein.
  - 1. A copy of the manufacturer's installation recommendations for each kind of pipe used must be provided to each foreman and inspector prior to construction and must be followed during construction unless otherwise instructed.
  - 2. When required by the Engineer, the Contractor shall furnish certification by the manufacturer of the pipe to be furnished on this project, certifying that the pipe and fittings comply with the applicable specifications.
  - 3. All pipe shall be clearly marked with type, class, and/or thickness as applicable. Lettering shall be legible and permanent under normal conditions of handling and storage.
  - 4. Except in locations where the soils are contaminated by hydrocarbons and other locations designated by the City, all sewer main piping shall be polyvinyl chloride pipe (PVC).
- B. Polyvinyl Chloride Pipe (PVC) and Fittings

1. PVC pipe and fittings shall conform to ASTM D-3034, SDR 26 (4-inch through 15-inch) (100mm – 375 mm) Type PSM or ASTM F679, Type I, SDR 35 (18-inch through 36-inch) (450mm – 914mm).
2. Each joint of pipe shall be marked with the size, SDR, “Sewer Pipe”, and code number. The pipe and fittings shall have bell and spigot joints with approved gaskets conforming to ASTM F-477. The spigot end shall be marked so that the installer and the inspector can determine when the pipe is properly installed.
3. All PVC pipe and fittings shall be manufactured from virgin, National Sanitation Foundation (NSF) approved resin conforming to ASTM D-1784.
4. All PVC pipe joints will be gasketed bell and spigot push-on type conforming to ASTM D 3212, unless directed otherwise in these specifications. Gaskets will be part of a complete pipe section and purchased as such. Lubricant will be as recommended by the pipe manufacturer.

#### C. Ductile Iron Pipe (DIP)

1. Ductile iron pipe shall conform to the requirements of AWWA C151, laying condition type 5. The minimum design thickness shall be pressure Class 350. All pipe shall be clearly marked with manufacturer’s name, DI or ductile, weight, class or nominal thickness, and casting period. Unless otherwise specified, joints will be push-on gasket type conforming to the requirements of ANSI A 21.11 and AWWA C111.
2. The interior of the pipe shall be epoxy lined or polyurethane lined to a nominal thickness of 40 mils in general conformance to AWWA C-210, C-213, or C-550. The bell gasket area and the spigot ends shall have a nominal interior thickness of 6 mils in order to alleviate assembly problems. The pipe exterior shall be a tar or bituminous seal coating at least one mil thick. The coating shall adhere to the pipe and spotty or thin coating, or poor adhesion, shall be cause for rejection of the pipe.
3. Fittings will conform to the requirements of ANSI A21.10.
4. When specified, Mechanical Joints will conform to the requirements of ANSI A 21.11. Flanged joints will conform to the requirements of ANSI A21.15. Flexible joint ductile iron pipe for stream crossings applications will conform to ASTM A 536 and will be Grade 70-50-05. Steel retainer rings will conform to ASTM A 148 for Grade 90-60.

#### D. Corrugated PVC Pipe with Smooth Interior 12 to 36 inch

1. Pipe and fittings shall be homogeneous throughout and free from visible cracks, holes, foreign inclusions or other injurious defects. Pipe shall be manufactured to 46 psi stiffness when tested in accordance with ASTM Test Method D2412. There shall be no evidence of splitting, cracking or breaking when the pipe is tested per ASTM Test Method D2412. The pipe shall be made of PVC compound having a minimum cell classification of 12454B as defined in ASTM Specification D1784.
2. Pipe shall be A-2000 as manufactured by Contech Construction Products or approved equal.

All other manufactures of Corrugated PVC pipe shall be pre-qualified at least 10 days prior to bid opening to be considered as approved material suppliers. Pre-qualified submittals shall demonstrate a minimum of 5 years experience of manufacturing proposed pipe material, pipe performance history including a project installation list with at least ten successful sanitary sewer installations in excess of 20,000 LF per project, product literature and installations recommendations..

3. All fittings for PVC corrugated sewer pipe with a smooth interior shall conform to ASTM F949, Section 5.2.3. To insure compatibility, the pipe manufacturer shall provide all fittings.
4. All joints shall be made with integrally-formed bell and spigot gasketed connections. The manufacturer shall provide documentation showing no leakage when gasketed pipe joints are tested in accordance with ASTM Test Method D3212. Elastomeric seals (gaskets) shall meet the requirements of ASTM Designation F477.

#### E. Corrugated PVC Pipe with Smooth Interior 8 to 10 inch

1. Pipe and fittings shall be homogeneous throughout and free from visible cracks, holes, foreign inclusions or other injurious defects. Pipe shall be manufactured to 115 psi stiffness when tested in accordance with ASTM Test Method D2412. There shall be no evidence of splitting, cracking or breaking when the pipe is tested per ASTM Test Method D2412. The pipe shall be made of PVC compound having a minimum cell classification of 12454B as defined in ASTM Specification D1784.
2. Pipe shall be A-2026 as manufactured by Contech Construction Products or approved Equal. All other manufactures of Corrugated PVC pipe shall be pre-qualified at least 10 days prior to bid opening to be considered as approved material suppliers. Pre-qualified submittals shall demonstrate a minimum of 5 years experience of manufacturing proposed pipe material, pipe performance history including a project installation list with at least ten successful sanitary sewer installations in excess of 20,000 LF per project, product literature and installations recommendations.
3. All fittings for PVC corrugated sewer pipe with a smooth interior shall conform to ASTM F949, Section 5.2.3. To insure compatibility, the pipe manufacturer shall provide all fittings.
4. All joints shall be made with integrally-formed bell and spigot gasketed connections. The manufacturer shall provide documentation showing no leakage when gasketed pipe joints are tested in accordance with ASTM Test Method D3212. Elastomeric seals (gaskets) shall meet the requirements of ASTM Designation F477.

#### F. Sewer Service Pipe Within the Public Right-of-Way

1. Service pipe materials shall be extra heavy cast iron pipe, PVC sewer pipe (ASTM D2665 Schedule 40 or ASTM D3034, SDR 35 26) or ABS sewer pipe (ASTM D2661).
2. An approved watertight commercial adapter joint shall be used to connect the service pipe to the sewer main wye.

#### G. Reducing Wyes

1. Service connections to the main line shall be made with monolithic reducing wyes installed in the main line.
2. The reducing wye fittings shall meet ASTM D3034, SDR 26 (4-inch through 15-inch) (100mm – 375 mm) or ASTM F679, Type I, SDR 26 (18-inch through 27-inch) (450mm – 675mm).

#### H. Manholes

1. All manholes and other precast items shall be manufactured in a plant that is certified by the National Precast Concrete Association. Manufacturer's certificates of compliance and installation recommendations shall be provided to the Engineer and City prior to construction.
2. All manholes shall be constructed with concentric precast concrete sections without steps unless otherwise approved. Precast concrete manhole sections shall be manufactured to standards at least equal to or greater than the requirements of the Standard Specifications for Precast Reinforced Concrete Manhole Sections, ASTM Designation C478. The minimum internal diameter for sanitary manholes shall be forty-eight inches (48") (1.2m) unless shown otherwise. Manholes shall conform to all requirements as shown on the detail drawings. Precast manhole joints shall be made water-tight with Ram-Nek material or an approved gasket at each joint. The Ram-Nek and primer must be used in accordance with the manufacturer's instructions.
3. Rubber gaskets used for precast manhole joints shall be designed in accordance with ASTM C361, C478, C443, and AASHTO M 315-94. All lifting holes must be grouted in after placement. All concrete for manholes and drop manhole encasement shall be Class AS. Portland Cement used in manufacturing reinforced manholes shall be Type II, ASTM C 150.
4. The concrete base shall be cast-in-place or precast concrete of the size and depth shown on the drawings. Concrete used for bases shall have a twenty-eight (28) day compressive strength of at least four thousand pounds per square inch (4,000psi) (27,600 kPa). Approved precast concrete bases will be allowed if provided with an integral groove for barrel placement. Precast concrete bases shall conform to ASTM C478. Manholes with the base monolithically poured with the bottom barrel are also acceptable and preferred.
5. For sewer manholes four (4) to six (6) feet in diameter and less than twenty (20) feet deep, precast reinforced manhole base sections shall be a minimum of 8 inches thick. For sewer manholes greater than six (6) feet in diameter or more than twenty (20) feet deep, precast reinforced concrete manhole base sections shall be a minimum of 12 inches thick. All precast manhole base sections shall be reinforced with #4 steel reinforcement bars placed 6 inches on center each way and at mid depth of the slab, unless shown otherwise on the plans.
6. All manholes (proposed or existing) with force mains (proposed or existing) discharging into them shall be coated according to this specification. Manholes for automatic air (or air/vacuum) release valves on sewer force mains shall also be coated according as per this section.

- a. For existing manholes, Quadex QM-1s Restore cementitious coating as distributed by Quadex, Inc., North Little Rock, Arkansas, U.S.A. is specified as the standard of quality. Other coating material of equal or better quality, as determined by the Engineer, may be used instead. The material shall be a high strength, cement based polypropylene fiber reinforced shrinkage compensated mortar enhanced with NSG (nepheline synte granite). The material shall have high early and ultimate compressive, flexural, and bond strengths. The material shall have proven resistance to a broad range of corrosive chemicals, including sulfuric acid created by hydrogen sulfide gas as well as other chemicals typically found in sanitary sewers. The material shall also have a low permeability.
  - b. For new manholes, the protective coating shall be Sauereisen SewerGard polymer lining as distributed by Sauereisen, Pittsburgh, Pennsylvania, U.S.A. as the standard of quality. Other polymer coating systems of equal or better quality, as determined by the Engineer and approved by the Owner, may be used instead. The material shall be an impermeable, high strength, corrosion-resistant, fiber-filled or aggregate-filled epoxy material specifically designed to protect concrete surfaces of municipal wastewater treatment structures and collection systems from chemical attack and physical abuse. The material shall prohibit water infiltration and shall have proven resistance to a broad range of corrosive chemicals, including sulfuric acid created by hydrogen sulfide gas as well as other chemicals typically found in sanitary sewers. The material shall be suitable for application over damp or dry concrete surfaces without the use of a primer. The material shall have a non-sagging consistency to permit application on vertical and overhead surfaces.
  - c. Manufacturer & Installer - Coating materials shall be as manufactured by Quadex, Inc., Sauereisen, or approved equal. Installation shall be performed by an installer approved by the material's manufacturer using workers experienced in the application of the coating to be used.
7. Precast manhole inverts shall be constructed using a secondary invert forming system designed to provide a finished invert that aligns precisely with the incoming pipelines, incorporating a finished flow depth of 0.75 diameter of the largest pipe. The completed precast invert shall include an alignment bench for each pipe, and provide for uniform horizontal and vertical transition through the manhole in accordance with drawings. Provide 0.1' (30mm) minimum fall between inlet and outlet. After the installation of the pipelines into the manhole, the interior annular space around the outside of the pipe shall be sealed with grout. Manhole couplings or other acceptable water stops (i.e. PVC pipe gasket stretched over outside of pipe, Ram-Nek, etc.) must be used when connecting PVC pipe to manholes. The acceptable tolerances for manhole inverts are one-quarter inch (1/4") (6.25mm) in any dimension and within 2 degrees for alignment. The invert forming system shall be "A-Lok Tru Contour", or approved equal.
  8. Manhole frames and covers shall be Neenah R 1643 or approved equal. Cover and frame seat shall be machine finished to prevent any rocking of cover in its associated frame. Cover shall have the word "SEWER" clearly cast on its surface. Manhole cover shall be minimum of 7.5 inches in height, have a minimum inside clearance of 24 inches in diameter and shall be considered heavy duty with 1.5 inch thick cover.

- a. When required, self-sealing, waterproof frames and covers meeting Neenah R-1916-F or D&L Supply E-1926 or approved equal shall be used.
9. For manholes with depths of six feet (6') (1.8m) or less, all of the precast manhole sections shall be of the specified diameter and shall have a flat, precast concrete top.
10. Manholes located in the 100 year floodplain and more than three feet (3') above final grade shall have a flat, precast top and self-sealing waterproof frame and cover.

## I. Force Mains

1. Ductile Iron Pipe (DIP)
  - a. See specifications for ductile iron pipe in Section 2.02 Materials C.
2. High Density Polyethylene (HDPE) Pressure Pipe and Fittings
  - a. High Density Polyethylene Pipe (HDPE) shall be manufactured from virgin extra high molecular weight, high density PE3408 polyethylene pipe grade resin to a minimum cell classification of PE345434C as determined by ASTM D3350. No post consumer recycled polyethylene materials shall be allowed. The minimum material classification shall conform to III C5 P34 as determined by ASTM D1248.
  - b. All HDPE pipe and fittings shall conform to ASTM F714 and ASTM D3261, respectively, and have a Standard Dimension Ratio (SDR) of 17.
  - c. Successive joints of HDPE pipe shall be joined by heat fusion at a fusion pressure of 75 psi and temperature of 400° F. All such connections shall be performed in strict accordance with the manufacturers instructions
3. Polyvinyl Chloride (PVC) Pressure Pipe and Fittings
  - a. Polyvinyl chloride (PVC) pressure pipe shall be SDR-21 Class 200 and conform to the ASTM D2241 standard, be UL listed and approved by the National Sanitation Foundation, and shall be white in color. The outside diameter shall be identical to steel pipe. PVC pipe pressure class shall be equal to or greater than twice the maximum calculated pressure of the force main.
  - b. PVC Pressure Pipe shall be designed and tested in accordance with ASTM D1598, D1599, and D2152.
  - c. Fittings for PVC pressure pipe shall be ductile-iron, and shall conform to AWWA C153, unless otherwise specified. Fitting joints shall be mechanical joints. Bolts and nuts for mechanical joints, or flanged ends will be of a high strength corrosion resistant low-alloy steel and shall conform to AWWA C111. Flange bolts and nuts for above ground installation shall conform to Appendix A of AWWA C115. Flange bolts and nuts for below ground installation shall be 316 stainless steel. All fittings shall be epoxy coated and lined unless stainless steel is used. Polyethylene wrap or

encasement of metal fittings shall conform to AWWA C105. Joint tape shall be self sticking PVC or 10-mil-thick polyethylene.

- d. Joints: PVC water pipe shall be furnished with an elastomeric gasket at each joint and an integral thickened bell as part of each joint. Pipe and fittings must be assembled with a non-toxic lubricant. Provisions must be made at each joint for expansion and contraction. Refer to ASTM F477, D3139 and D3212. Where joints are to be restrained, use mega-lug type fitting.

#### 4. Air-Vacuum Release Valve

- a. Air Vacuum Release Valves shall be manufactured and tested in accordance with American Water Works Association (AWWA) Standard C512. Manufacturer shall have a quality management system that is certified to ISO 9001:2000 by an accredited, certifying body. The valve body, cover, and baffle shall be constructed of ASTM A126 Class B cast iron. The float, guide shafts, and bushings shall be constructed of Type 316 stainless steel. Non-metallic guides and bushings are not acceptable. Resilient seats shall be Buna-N.
- b. Valve sizes 3 in.(75 mm) and smaller shall have full size NPT inlets and outlets equal to the nominal valve size with a 2 in. (50 mm) inlet on 1 in. (25 mm) valve. The body inlet connection shall be hexagonal for a wrench connection. The valve body shall have 2 in. NPT cleanout and 1in. NPT drain connections on the side of the casting.
- c. Valve sizes 4 in. (100 mm) and larger shall have bolted flange inlets with NPT outlets. Flanges shall be in accordance with ANSI B16.1 for Class 125 iron flanges.
- d. The valve shall have three additional NPT connections for the addition of backwash accessories.

#### 5. Air-Vacuum Release Valve Vault

- a. Air Vacuum Release Vault shall be precast or cast in place. Concrete shall meet the requirements as specified in Section 03050. The vault shall be placed on Foundation Material as specified herein or as per the detail.
- b. Vault frames and covers shall be Neenah R 1578 or approved equal. Cover and frame seat shall be machine finished to prevent any rocking of cover in its associated frame. Cover shall have the word "SEWER" clearly cast on its surface. Manhole cover shall be a minimum of 6 inches in height, have a minimum inside clearance of 36 inches in diameter and shall be considered heavy duty with 1.5 inch thick cover.

#### 6. Eccentric Plug Valve

- a. Eccentric plug valves and actuators shall meet or exceed the latest revisions of AWWA C517 and other applicable standards. Flanged ends shall be per ANSI B16.1 and mechanical joint ends per AWWA C111. Eccentric plug valves and actuators shall be model PEF as manufactured by DeZURIK, Inc. or pre-approved equal.

- b. Plugs shall be solid one piece, cast of ASTM A536 ductile iron. The plug shall have a cylindrical seating surface eccentrically offset from the center of the shaft. Plug shall not contact the seat prior to 90% closed. Plug facing shall be Chloroprene (CR), or other resilient facing suitable for wastewater, mixed liquor or sludge service.
- c. Bodies shall be of ASTM A126 Class B cast iron. Port area shall be 100% of standard class pipe area. Bearings shall be sleeve type and made of sintered, oil-impregnated permanently lubricated type 316 stainless steel per ASTM A743 Grade CF8M.
- d. Seats shall be 1/8" thick welded overlay of not less than 95% pure nickel. Seat shall be at least 1/2" wide and raised. The raised surface shall be completely covered with nickel to insure that the resilient plug face contacts only the nickel seat.
- e. Adjustable Packing shall be of the multiple V-ring type, with a packing gland follower. Shaft seals shall permit inspection, adjustment or complete replacement of packing without disturbing any part of the valve or actuator assembly except the packing gland follower.
- f. Grit Excluders made of PTFE shall be provided to prevent the entry of grit and solids into the bearing areas.
- g. Valves shall provide drip-tight shutoff in either direction up to the valves operating pressure. Pressure ratings shall be bi-directional and 175 psi (1,207 kPa) on sizes 3"-12" (80-300mm) and 150 psi (1,034 kPa) for 14"-36" (350-900mm). Every valve shall be given a certified hydrostatic and seat test, with test reports being available upon request.
- h. Each valve shall be furnished with an actuator. Means of actuation shall be by hand lever, chain lever, worm gear operator, pneumatic cylinder, hydraulic cylinder, electric motor or air motor as indicated on the Plans. Operator accessories such as hand wheels, chain wheels and chains, 2" operating nuts, extension stems, floor stands, and bonnet extensions shall be provided as indicated on the Plans.
- i. Worm gear actuators shall be provided on all valves six inches and larger and on all buried valves. Actuators shall be enclosed in cast iron housing, with outboard seals to protect the bearings and other internal components. The actuator shaft and gear quadrant shall be supported on permanently lubricated bronze bearings.
- j. Buried actuators shall be 90% grease filled. Input shaft and fasteners shall be stainless steel. Actuator mounting brackets shall be totally enclosed.
- k. All plug valves shall be thoroughly cleaned of all dirt, dust oil, grease and other foreign matter. This work shall be done with care to avoid damage to inside coating.
- l. All plug valves shall be tested for pressure and leakage in accordance with AWWA C600.
- m. An epoxy coating shall be applied to the interior and exterior ferrous surfaces of the valve except for finished or seating surfaces.



- n. All valves shall have the name or monogram of the manufacturer, the year the valve casting was made, the size of the valve, and the operating pressure cast onto the body of the valve.

## 7. Valve Boxes

- a. Cast iron valve boxes shall be installed for all valves installed underground. Casting shall be manufactured of clean, even grain grey cast iron conforming to ASTM A48, Class 20B, Gray Iron Castings; and shall be smooth, true to pattern, free from blowholes, sand holes, projections and other harmful defects.
- b. The valve box shall be coated with a single thin coat of coal tar pitch varnish before machining so that machined seating surfaces will be free of any coating.
- c. Valve boxes shall have a minimum 5¼ inch shaft, a weight of at least 60 pounds and a wall thickness of at least ¼". Valve boxes shall be of a two-piece design including bottom section and top section with lid and shall be adjustable to fit the depth of earth cover over the valve. Three-piece valve boxes will be allowed for excessively deep valves.
- d. Valve boxes shall be accurately centered over valve operating nuts and backfill shall be thoroughly tamped around them. They shall be set vertically plumb and properly adjusted so that the tops of boxes will be at grade in any paving, walk, road or ground surface.
- e. Valve boxes shall be designed so as to prevent the transmission of surface loads directly to the valve or piping. Valve boxes inside paving, walks, or road surfaces shall not be set on the valves but shall be supported on crushed stone fill.
- f. The seating surface of both the lid cover and the top section of the valve box shall be cast so the cover will not rock after it has been seated and will fit tightly with little or no play in the fit. Valve boxes shall have the word "SEWER" cast into the covers.
- g. Wherever valve boxes fall outside of the roadway, the top of the box shall be set in a concrete slab 18"x18"x6" thick (or 18" diameter x 6" thick) with the top of the slab and box flush with the top of the ground. This provision shall apply to all new and all existing valve boxes which fall within the limits of the contract, unless otherwise stated on the plans or ordered by the Engineer.
- h. Valve boxes shall have extension stems, where necessary, when operating nut is raised to be within 4 feet of the existing grade. Extensions must be securely attached to the operating nut so the shaft will not pull off of the operator.

## J. Granular Materials

1. Granular materials furnished for foundation, bedding, encasement, or other purposes as may be specified, shall consist of any material or synthetic mineral aggregate such as sand, gravel, crushed rock, crushed stone or slag, that shall be so graded as to meet the gradation requirements specified herein for each particular use.

2. Granular Material Gradation Classifications

- a. Granular materials furnished for use in Foundation, Bedding, or Encasement installations shall be:

SIEVE SIZE	MATERIAL USE DESIGNATION	
	Percent Passing	
	FOUNDATION	BEDDING & ENCASEMENT
1 INCH (25MM)	100	100
3/4 INCH (20MM)	85-100	90-100
3/8 INCH (9.5MM)	30-60	20-55
NO. 4 (4.75MM)	0-10	0-10
NO. 8 (0.075MM)	0-5	
NO. 200 (0.075 MM)		0-15

- b. Other gradations may be used if written approval is obtained from the City Engineer.
- c. Other approved material for bedding and encasement shall consist of sand, sandy gravel, or fine gravel having a maximum size of three-quarter inch (3/4") (20mm), uniformly graded and a maximum plasticity of 6 as determined by AASHO T-89 and T-90.
- d. Certified copies of all sieve analysis and plasticity analysis for the above materials shall be submitted to the City Engineer and approved before construction starts. Other sieve or plasticity analysis may be required during construction as directed by the City Engineer.

3. Granular Material Use Designations

- a. Granular materials provided for Foundation, Bedding, or Encasement use as required by the Contract, either as part of the pipe item work unit or as a separate Contract Item, shall be classified as to use in accordance with the following:

Material Use Designation	Zone Designation
Granular Foundation	Placed below and to the midpoint of the pipe as replacement for unsuitable or unstable soils, to achieve better foundation support.
Granular Bedding	Placed from four inches (4") (100mm) below the pipe to the pipe midpoint to facilitate proper shaping and achieve uniform pipe support. When foundation material is required, the granular bedding shall be of foundation material gradation.

Granular Encasement Placed below an elevation one foot (1') (300mm) above the top of pipe, after pipe installation, for protection of the pipe and to assure proper filling of voids or thorough consolidation of backfill

K. Select Backfill

1. Job excavated and imported select backfill material shall be free from debris, organic material, and stones larger than three inches (3") (75mm) in diameter. Contractor shall be responsible, at his expense, for separating debris, organic material and stones larger than three inches (3") (75mm) in diameter.
2. Select material that the Engineer directs to be used shall be the same gradation as bedding and encasement material.
3. No asphalt chunks or concrete may be used as select backfill.

L. Ground Water Barriers

1. Low permeability ground water barriers shall be used where directed. Barrier material shall meet soil classification GC, SC, or CL per the Unified Soil Classification System and shall have a liquid limit less than 50.
2. The barrier material shall be compacted to 95 percent of maximum density.
3. Job excavated material meeting one of the above soil classifications and free from stones, organic matter, and debris may be used.

M. Steel Casing Pipe

1. Casing pipe will conform to ASTM A 139. Minimum yield strength will be 35000 psi. Wall thickness will meet the requirement of the latest revision of the American Railway Engineering Association manual of Recommended Practices unless otherwise specified. Wall thickness will be:

Nominal Thickness (inches)	Nominal Diameter (inches)
0.188	Less than 14
0.219	14 and 16
0.250	18 inches
0.281	20
0.312	22
0.244	24
0.375	26
0.406	28 and 30
0.438	32
0.469	34 and 36
0.500	38, 40, and 42

2. When casing is installed without a protective coating and is not cathodically protected, the wall thickness shown above will be increased to the nearest standard size that is the minimum of 0.063 inches greater than the thickness shown. This requirement does not apply to casing diameters less than 12 ¾ inches.

## **PART 3 Execution**

### **3.01 Excavation and Preparation of Trench**

- A. When cutting into existing roads, streets, alleys, or other public rights-of-way, the Contractor, shall obtain the proper licenses, cut permits, etc. from the appropriate authority when applicable.
- B. When trench excavation requires the removal of curb and gutter, concrete sidewalks, or asphaltic or concrete pavement, the pavement or concrete shall be cut in a straight line parallel to the edge of the excavation by use of a spadebitted air hammer, concrete saw, or similar approved equipment to obtain a straight, square, clean break. Cuts shall be located at standard joint locations when possible.
- C. When crossing existing or prospective cultivated areas, gravel streets or other developed surfaces the Contractor shall strip the cover material to full depth of the existing surfacing. This surfacing shall be stockpiled and placed back over the trench after backfilling to the extent that it is acceptable and usable for that purpose. New material shall be provided as necessary. Topsoil shall be removed to full depth of the topsoil, or to a maximum depth of twelve inches (12") (300mm), whichever is less.
- D. The disturbed area from construction shall be confined within the construction limits.
  1. The trench shall be dug only as far in advance of the pipeline as work can be reasonably completed that day. The sides of the trench shall be sloped and/or braced in accordance with the current OSHA Rules and Regulations and the trench drained so that workers can work safely and efficiently. All work must be done in a dry trench and no water will be permitted to discharge down the pipe previously laid. A sewer plug shall be installed at the connection to existing sewer system. Discharge of pumps shall be to approved natural drainage channels or storm sewers.
- E. Pipe crossings under sidewalks or curbs may be made by tunneling only if approved by the Engineer. If the Contractor elects to remove a portion of the sidewalk or curb, he must use a concrete saw for making neat joints corresponding to existing joints, compact the backfill as specified, and pour a new concrete sidewalk or curb section in accordance with the applicable sections of these specifications.
- F. During excavation, materials suitable for backfilling shall be piled in an orderly manner a sufficient distance from the banks of the trench to avoid overloading and to prevent slides or cave-ins. All excavated materials shall be stored and retained at least two feet (2') (600mm) or more from the edge of the trench in accordance with Tennessee Occupational Health and Safety Rules and Regulations for Construction. Excavated material must not be piled over nearby existing parallel trench lines unless adequate precautions are taken by the Contractor to prevent sidewall failure. Ready access to existing fire alarm boxes, fire hydrants, valves, manholes, and other appurtenances must be maintained.

1. When making excavations, the various materials excavated shall be piled separately. All concrete and bituminous materials, any soils, which cannot be properly compacted, and all other deleterious materials shall be immediately removed from the construction site and properly disposed of in accordance with applicable laws.
- G. Surface drainage of adjoining areas shall be unobstructed. Grading shall be done as may be necessary to prevent surface water from flowing into excavations, and any other water accumulating therein shall be promptly removed. Under no circumstances shall water be permitted to rise in open trenches until after the pipe has been placed, tested, and covered with backfill. Any pipe having its alignment or grade changed as a result of a flooded trench shall be reinstalled. Gutters shall be kept clear or other satisfactory provisions made for street drainage at all times.
- H. The bottom of the trenches shall be accurately graded to the line and grade shown on the drawings. Bedding material shall be added four inches (4") (100mm) minimum to provide uniform bearing and support for each section of pipe at every point along its barrel length with bell holes dug for bells. Care must be taken to avoid over excavation. Unauthorized over-depths shall be backfilled with approved bedding material at the Contractor's expense. All bedding material added shall be moistened and compacted to a minimum of 95% density as determined by ASTM D698. The finished trench bedding beneath the pipe shall be prepared accurately by means of hand tools.
1. The bottom of all excavations shall be neat and clean, and graded accurately to the line and grade shown on the drawings. Suitable methods shall be used to produce an excavated surface without disturbance to the underlying material by compacting soil material to at least 95% Standard Proctor, ASTM D698.
  2. If in its natural state the material at the bottom of the trench is soft and, in the opinion of the Engineer, cannot support the pipe, a further depth and/or width shall be excavated as directed by the Engineer and refilled with foundation material to the midpoint of the pipe. Other approved methods may be used to assure a firm foundation.
  3. Foundation material used to dewater the trench or to replace a wet material shall be considered incidental to construction.
- I. Ledge rock, boulders, and large stones shall be removed to provide a clearance of at least six inches (6") (150mm) below the outside barrel of pipe and allow a clear width of six inches (6") (150mm) on each side of the pipe. The space between the bottom of the trench in bedrock or rocky areas and the bottom of the pipe shall be backfilled with suitable granular material in three-inch (3") (75mm) uncompacted layers and thoroughly tamped before pipe is installed.
- J. All excavated material shall be piled within the construction limits or in a location obtained by the Contractor and accepted by the Engineer in a manner that will not endanger the work and that will avoid obstructing sidewalks, driveways, and fire hydrants.
- K. The width of the trench shall be such to provide adequate working room for workers to install the pipe in the specified manner. The trench in the pipe zone and to one foot (1') (300mm) above the pipe zone shall be adequate in width to allow for proper compaction but shall in no case be

wider than the pipe diameter plus three feet (3') (900mm).

- L. Where the trench is not located near existing utilities, buildings or other structures, and where water and other conditions permit, the Contractor may omit sheeting and bracing of the excavation. In this event, sides of the trench if in unstable or soft material or five feet (5') (1.5m) or more in depth, shall be sloped to protect the workers working within them in accordance with current Occupational Safety and Health Rules and Regulations for Construction.
- M. The Contractor shall provide safety boxes or sheeting and bracing necessary to confine his work within the construction limits, to provide safe working conditions, to prevent damage and delay to the work, and to prevent the disturbing or settlement of adjacent road surfaces, foundations, structures, utility lines or railroad tracks. The Contractor shall be responsible for the strength and sufficiency of all sheeting and bracing.
- N. Any damage to the work under this contract or to adjacent structures or property caused by settlement, water or earth pressures, slides, cave-ins, or other reasons due to failure or lack of sheeting and bracing, or improper bracing, or through negligence or fault of the Contractor in any manner, shall be repaired by the Contractor without delay and at his expense. Bracing shall be so arranged as to provide ample working space, so as not to interfere with the work, and so as not to place any strain on the structures being constructed, until such structures are of sufficient strength to withstand such strain. No sheeting and bracing shall be removed until the construction has proceeded far enough to provide ample strength for its safe removal.
  - 1. Sheeting or bracing may be left in place in the trench at the discretion of the Engineer. Any sheeting or bracing left in place shall be cut off approximately three feet (3') (900mm) above the top of the pipe or two feet (2') (600m) below finish grade, whichever is lower, and the cut-off portion removed. All sheeting or bracing left in place shall be accurately located and shown on the "Record Drawing" (See Division 600 Section 601.12 of these specifications.)
- O. The Contractor shall be responsible for enforcing safety and maintaining safe working conditions in all trenching, and shoring operations to conform to OSHA regulations.
- P. The Contractor, if required by site conditions, shall provide a dewatering operation. The Contractor shall provide and maintain adequate dewatering equipment to remove and dispose of all surface water and groundwater entering the excavations, trenches, or other parts of the work.
  - 1. All trench excavations which extend down to or below groundwater shall be dewatered by lowering and keeping the groundwater level beneath such excavations twelve inches (12")(300mm) or more below the bottom of the excavation.
  - 2. Surface water shall be diverted or otherwise prevented from entering excavated areas or trenches to the greatest extent practicable without causing damage to adjacent property.
  - 3. The Contractor shall be responsible for the conditions of any pipe or conduit which he may use for drainage purposes, and all such pipes or conduits shall be left clean and free of sediment.
  - 4. In areas where dewatering is required, the Contractor will comply with the following requirements:

- a. All discharges from dewatering systems, including well points, dewatering wells, pumps in the bottoms of the trenches, etc. will require a permit from the Tennessee Department of Environment and Conservation (TDEC). Before starting any construction, the Contractor shall submit an application to discharge to the TDEC along with a proposed dewatering plan for review. The application shall be submitted on “National Pollutant Discharge Elimination System, Application to Discharge from a Construction Project, Short Form E”. If the dewatering plan is revised during construction, the Contractor shall immediately send a revised plan to the DEQ.
- b. One copy of the initial application, dewatering plan, and of the permit authorizing the discharge must be provided to the City Engineer with the application for an excavation permit. Copies of any revisions to the dewatering plan shall be immediately provided to the City Engineer.

Q. Trenching and tunneling standards near trees.

1. Trenches should be routed outside the tree protection zone or critical root zone (CRZ). For trees less than 6” diameter at breast height (DBH), defined as 4.5’ about average ground level, that are to be retained, no trenching should occur within the dripline or tree protection/critical root zone as defined by the City of Lakeland Tree Management Ordinance. For trees 6” DBH and less than 20” DBH no trenching should occur within an area equal to 1’ radius for every inch of DBH or within the tree protection/critical root zone as defined by the City of Lakeland Tree Management Ordinance. For trees 20” DBH and greater, no trenching should occur within an area equal to 1.5’ of radius for every inch of DBH or within the tree protection/critical root zone as defined by the City of Lakeland Tree Management Ordinance.
2. Soil removed from the trenches should be placed on the side away from the trees and replaced as soon as possible. The width of the trench should be minimized. The use of trench walls should be considered rather than sloping sides when working around trees.
3. If placement of utilities or other infrastructure is unavoidable within the tree protection zone or critical root zone then specific measures should be applied to minimize root damage. Tunneling is recommended as soon as roots 1 inch diameter and greater are encountered. Minimum tunnel depth should be 24 inches. Launch and recovery pits should be located outside of tree protection zones and critical root zones. If tunneling is impossible due to specific soil restrictions, the trenching should be done by hand within the tree protection zone or critical root zone. If this required trenching will sever more than 25% of the tree protection/critical root zone then the trench should be re-directed at the center of the tree with the final section dug under the base of the tree. Trenches should be backfilled with native soil or a prepared soil mixture when inside of a tree protection zone or critical root zone. Gravel, slurry, stone, and concrete are not appropriate fill material within a tree protection zone.
4. Changes to the approved construction plans or methods for trenching and tunneling must be submitted to and receive approval by the City’s Representative before proceeding.

## P. Procedures For Boring And Jacking

1. Casing pipe larger than 36 inches shall be bored or tunneled. Casing pipe smaller than 36 inches may be jacked or bored.
2. Boring:
  - a. Extend casing through entire distance bored.
  - b. Check grade and alignment after each casing section is installed.
  - c. Coordinate operations to provide continuous support to surrounding earth materials.
  - d. If the annular space between the casing pipe and the earthen bore exceeds 4 inches, the contractor shall fill the space with dry blown sand. Dry sand shall be blown in from both sides of the casing pipe.
3. Jacking:
  - a. Progressively push carrier pipe through completed casing. A minimum clearance of at least 2 inches between the inner wall of the casing pipe and the maximum outside diameter of the cased pipe and joints shall be provided.
  - b. Strap 2 wooden saddle blocks or plastic fins to each pipe length to provide support at regular intervals.
  - b. Center carrier pipe in casing at all times.
  - c. Fill annular space between casing and carrier pipe with dry blown in sand.
  - d. Seal each end of the casing after the sand has been deposited.
  - e. A minimum of 1 foot of grout shall be placed in the void between the inner wall of the casing pipe and the cased pipe at the ends of the casing pipe after placement of sand.
4. Field Tolerances for Boring and Jacking Casing Pipe
  - a. Boring
    - i. Maximum departure from established grade = 6 inches / 100 feet.
    - ii. Maximum departure from established line = 2 inches / 100 feet.
    - iii. Maximum departure from established line and grade = 6 inches / 100 feet.
  - b. Tunneling
    - i. Maximum departure from established grade = 2 inches / 100 feet.
    - ii. Maximum departure from established line = 2 inches / 100 feet.
    - iii. Maximum departure from established line and grade = 3 inches / 100 feet.

### 3.02 Laying of Pipe

Contractor shall provide all plant, equipment, labor, and material necessary for the safe and convenient prosecution of the work. Pipe manufacturer's installation instructions shall be followed and supplemented by these specifications.

- A. The sewer pipe shall be carefully lowered into trench piece by piece by means of a derrick, ropes, or other suitable tools or equipment in such a manner as to prevent damage to the protective coatings and linings. The use of chains is not allowed. Under no circumstances shall sewer main materials be dumped into the trench. Any damage to pipe coatings shall be repaired with the same materials used for the original coating before laying the pipe.
- B. Before lowering and while suspended, the pipe and fittings shall be inspected for defects and to detect any cracks. Any defective, damaged, or unsound material shall be rejected.



- C. All foreign matter or dirt shall be removed from the inside of the pipe before it is lowered into its position in the trench, and it shall be kept clean by approved means during and after laying. All openings along the line of the sewer shall be securely closed as directed and, in the suspension of work at any time, suitable watertight stoppers shall be placed to prevent earth, water or other substances from entering the main.
- D. Sewer piping shall be laid to the lines and grades indicated in the Contract Documents. Methods of maintaining alignment and grade, such as use of laser beam equipment or surveying instruments, shall be used.
- E. Fine grading of the trench bedding beneath the pipe shall proceed ahead of the pipe laying. Unauthorized over-excavation shall be backfilled with bedding material at the Contractor's expense. All bedding material added shall be moistened and compacted to 95% of maximum density (Standard Proctor).
- F. Bell holes shall be dug for the pipe bells or couplings and the materials placed along the preceding pipe laid. The pipe shall be supported for the bottom 60 degrees and throughout its length (except for the minimum distance necessary at the bell holes). Bell holes shall be adequate to make the joint, but no larger than necessary, so that maximum support on the prepared bedding beneath the pipe will be provided. The remainder of the pipe shall be surrounded to at least its midpoint by granular bedding material shovel-placed and hand-held machine tamped in maximum six-inch (6") (150mm) layers to completely fill all spaces under and adjacent to the pipe.
- G. No pipe shall be laid in water, on frozen ground, or when the trench conditions are unsuitable for such work.
- H. Pipe laying should proceed upgrade with the spigot ends pointed in the direction of the flow. The Contractor shall make all connections of pipe to the manholes that have previously been constructed.
- I. When connecting to existing sewers, the Contractor shall take every precaution necessary to prevent dirt or debris from entering the existing lines. The Contractor shall use an approved water-tight plug to securely plug the new sewer at the connection to the existing sewer immediately after the connection has been made. The plug shall be braced as necessary and tied to the manhole by a rope or chain. This plug shall remain until the new sewer mains have been accepted by the City or until otherwise directed by the City.

### **3.03 Installation of Manholes**

- A. Excavation shall be to a depth and size to provide for construction of the manhole. Concrete bases shall be poured on undisturbed ground. Precast concrete bases shall be carefully lowered onto one of the following:
  - 1. Six-inches (6") (150mm) minimum layer of well compacted granular material accurately laid to a smooth level surface using a straight edge and hand level.
  - 2. Three inches (3") (75mm) of concrete poured on undisturbed soil.

- B. Walls shall be of precast concrete as shown in the standard drawings and shall be constructed to form a complete watertight structure.
- C. The Contractor shall provide a minimum of two inches (2") (50mm) and a maximum of twelve inches (12") (300mm) in two-inch (2") (50mm) layers of precast reinforced concrete adjusting rings between the cast iron frame and the manhole top section. Each ring shall be set on a full bed of mortar and shall be made watertight. Wood will not be allowed as spacers. Adjusting rings shall conform to the size and shape of the casting frame. Frames and covers shall be set to the designated elevation in a full mortar bed.
  - 1. The minimum two-inch (2") (50mm) concrete ring for grade is not needed if grade can be met with a six-inch (6") (150mm) flange on top of the cone section of the manhole.
  - 2. If the number of adjusting rings exceeds the maximum twelve inches (12") (300mm), the manhole shall be reexcavated and a manhole barrel section installed.
- D. Manholes shall be set as shown on the detail drawings. All lifting holes must be grouted in after placement.
- E. Riser rings, if approved by the engineer, shall be a minimum of two inches (2") (50mm) or greater in height. No aluminum risers shall be used. In gravel or unpaved roads, the manhole ring shall be kept one to two inches (1"-2") (25mm-50mm) below the road surface.
- F. In asphalt paving areas, where patching material is required around the manhole covers, asphaltic material shall be required in the top two inches (2") (50mm) of the street.
- G. The invert of all manholes shall be smoothly shaped so as to allow a free, uninterrupted flow of sanitary sewage. The invert forming system shall be "A-Lok Tru Contour", or approved equal.
  - 1. Floor troughs shall be furnished for all sewers entering manholes. Inverts shall be U-shaped to the 1.0 diameter point before sloping at a 1 to 12 slope to the manhole walls.
  - 2. Unless approved by the Engineer, the sanitary sewer pipe should be laid continuously through the manholes and cut out when the manhole invert is finished. Manhole couplings or other acceptable water stops (i.e. PVC pipe gasket stretched over outside of pipe, Ram-Nek, etc.) must be used when connecting PVC pipe to manholes. After the installation of the pipelines into the manhole, the interior annular space around the outside of the pipe shall be sealed with grout.
- H. Fittings for drop manholes shall consist of a wye and a ninety-degree bend. (see Detail Drawings unless otherwise shown in the Contract Documents or approved by the Engineer). Clean out pipe on drop manholes will penetrate the inside of the manhole twelve inches (12") (300mm) to fourteen inches (14") (350mm) with the top half of the pipe cut out. The entire drop inlet piping arrangement shall be encased in mass concrete having a twenty-eight (28) day compressive strength of at least four thousand pounds per square inch (4,000psi) (27,600 kPa).

### **3.04 Installation of Air Release Valve Vault**

- A. The vault for the air release valve of a force main shall be installed in accordance with

### **3.05 Backfilling and Grading**

- A. All excavation in trenches shall be backfilled to the original ground surface or to such grades as specified or as shown on the drawings. The backfill shall begin as soon as practical after the pipe has been placed and shall thereafter be carried on as rapidly as the protection of the balance of the work shall permit.
  - 1. No pipe shall be covered before the Project Representative or the Engineer has observed and approved the pipe. If any piping or appurtenance is covered without the approval of the Engineer or Resident Project Representative, at the discretion of the Engineer, the Contractor shall be required to re-excavate to expose the covered materials. The cost of exposing those materials and then backfilling and recompacting will be at the Contractor's expense regardless of the condition of the pipe and/or the materials under question.
  - 2. The Contractor shall completely backfill all excavations before stopping work at the end of each day. Open excavations (fenced or unfenced) will not be allowed overnight, on weekends, or after work at any site after work has stopped for the day, unless approved by the City.
- B. Complete cleanup shall proceed directly behind the backfilling operation to accommodate the return to normal conditions. Should the Contractor, in the City's opinion, fail to pursue diligently the backfilling and cleanup, the amount of work on which complete cleanup has not been accomplished shall be limited to one thousand lineal feet (1,000') (300m) for the entire job. The Contractor shall have sufficient equipment on the job to assure timely backfill and cleanup at all times.
- C. Backfilling and compacting shall be done to meet minimum densities as required. Depositing of the backfill shall be done so the impact of falling material will not injure the pipe or structures. Grading over and around all parts of the work shall be done as directed by the Engineer.
  - 1. Where excavations occur in unpaved surfaces, such as alleys but not previously turfed areas, the area shall be restored by placing a minimum of two inches (2") (50mm) of stabilized gravel on the surface of the excavation. Stabilized gravel shall be equal to material meeting coarse aggregate for minimum three-fourths inch (3/4") (20mm) as specified in other Divisions and Sections related to Street Construction.
- D. Class C granular bedding shall be deposited in the trench simultaneously on both sides of the pipe for the full width of the trench to a height at least to the mid-point of the pipe. The bedding material shall be shovel placed and hand-held machine tamped in maximum six-inch (6") (150mm) layers to completely fill all spaces under and adjacent to the haunches of the pipe. Encasement material will then be placed around and over the pipe to a height of at least twelve inches (12") (300mm) above the top of the pipe, but need not be hand-placed. Granular encasement material, as specified, must be used for all pipe.
- E. Succeeding layers of backfill above the twelve-inch (12") (300mm) level may contain coarse materials not exceeding three-inches (3") (75mm) in the largest dimension, but shall be free from large pieces of rock, frozen material, concrete, roots, stumps, tin cans, rubbish, and other similar articles whose presence in the backfill would, in the opinion of the Engineer, cause settlement of the trench or damage to the pipe. If suitable trench excavation is not available, Contractor shall

import pit run material for trench backfill. Pit Run material shall meet the approval of the Engineer. Whenever select material, encountered in the upper two feet of the finished grade of paved or graveled streets or roadways, is removed by the trench excavation, the Contractor shall replace said material (or material of equal quality) as backfill. Where select material does not exist in place as described above, the Contractor shall provide and place sufficient select backfill to stabilize the finished grade as directed by the Engineer.

- F. Backfilling shall be done in lifts of uniform layers which will produce the required compaction. Each lift shall be completely compacted over the full width of the excavated area. Compacting shall continue until the specified relative compaction has been attained or until no more settlement occurs. Water jetting of backfill shall not be permitted.
- G. Groundwater barriers may be directed by the City Engineer to be placed at maximum three hundred feet (300') (90m) intervals. These shall be provided to interrupt the passage of water through the foundation, bedding, encasement, and select backfill material. The barriers shall be compacted to 95% of maximum density (Standard Proctor) the full depth of the granular material, the full trench width and a minimum of three-feet (3') (900mm) long.
- H. Special attention shall be given to the compaction operation performed around all manholes, valve boxes, curb boxes, other structures, and utilities by the use of pneumatic tampers, plate tampers, or plate vibrators to obtain the required compaction requirement.
  - 1. Structure backfilling shall cover manholes, valve boxes, curb boxes, and any other structure encountered during the course of the work. Fill around structures shall consist of trench backfill meeting the requirements of bedding and encasement material or select backfill material. Fill material shall be spread and compacted to provide continuous and uniform support around the structure.
  - 2. Do not place fill when the surface to be filled is snow covered or frozen. Do not place frozen fill.
  - 3. Fill around concrete structures shall commence only after concrete has attained 80% of the ultimate compressive strength specified. Remove all form materials, concrete spills, and trash from around the structures before placing fill. Where backfilling on both sides or around the perimeter of a structure is required, place the backfill and compact simultaneously at the same elevation on opposite sides or around the perimeter in lifts.
  - 4. Place fill material in eight-inch (8") maximum lifts and compact to at least 95% density for cohesive soils and 70% relative density for non-cohesive soils. The moisture content shall be plus or minus 2% of optimum.
- I. Sewer service trenches shall be compacted in the same manner as the sewer main trenches. In streets open to traffic, service trenches must not be left open overnight. In areas where curb and gutter exist, sufficient curbing shall be removed to allow this compaction over the entire disturbed area.
- J. All deficiencies in the quantity of material for backfilling the trenches or for filling depressions caused by settlement shall be supplied by the Contractor. Any excess material shall be hauled away and disposed of in a legal manner at no additional compensation.
- K. No waste material or debris shall be deposited on any public or private property without the written permission of the Engineer. Waste material and debris shall include, but not be limited to

trees, stumps, pieces of pipe, pieces of concrete, pieces of asphaltic concrete, tin cans, or other waste material from the construction operations. Disposal of this material shall be the responsibility of the Contractor.

- L. The in-place density of the compacted soil shall be determined by the Engineer using either ASTM standard test method D1556-82 (sandcone), AASHTO T 238-97, or ASTM standard test method D2722-81 (nuclear). The maximum density of the soil shall be determined by ASTM standard test method D698 (standard proctor). The in-place density must not be less than the following percentages of the maximum density in paved areas, areas to be paved, and graveled areas:
1. 95% compaction from twenty-four inches (24") (600mm) above top of pipe to the finished surface, except that in no case shall this 95% compaction zone be less than forty-eight inches (48") (1.2m) deep..
  2. The compaction required outside paved areas, outside areas to be paved or outside graveled areas shall be 90%.
  3. The compacted backfill shall have a moisture content of  $\pm 2\%$  of optimum moisture.
- M. The Engineer shall determine the frequency and number of tests to be conducted to measure the gradation, density, and moisture of the backfill. Minimum testing frequency is as follows:
1. Gradation Tests
    - a. Foundation Material. One initial gradation test for each type of material plus one additional test for each 1,000 cubic yards (1,000 yd<sup>3</sup>) (750 m<sup>3</sup>) or portion thereof placed of each material.
    - b. Bedding and Encasement Material. One initial gradation test for each type of material plus one additional test for each 10,000 cubic yards (10,000 yd<sup>3</sup>) (7,500 m<sup>3</sup>) or portion thereof placed of each material.
    - c. Select Backfill Material. One initial gradation test for each type of material plus one additional test for each 10,000 cubic yards (10,000 yd<sup>3</sup>) (7,500 m<sup>3</sup>) or portion thereof placed of each material.
    - d. All gradation tests shall be the responsibility of the Contractor using a certified approved soils testing laboratory acceptable to the Owner and Engineer. The Contractor shall be responsible for all costs associated with gradation testing.
  2. Density and Moisture Test
    - a. Pipe Encasement Material. One test for each one thousand cubic yards (1,000 yds<sup>3</sup>) (750 m<sup>3</sup>) or portion thereof placed of each material.
    - b. Foundation Material. One test for each one thousand cubic yards (1,000 yds<sup>3</sup>) (750 m<sup>3</sup>) or portion thereof placed of each material.
    - c. Bedding and Encasement Material. One test for each one thousand cubic yards (1,000 yds<sup>3</sup>) (750 m<sup>3</sup>) or portion thereof placed of each material.

- d. Select Backfill Material. One test for each one thousand cubic yards (1,000 yds<sup>3</sup>) (750 m<sup>3</sup>) or portion thereof placed of each material.
  - e. Job Excavated Select Backfill Material. Tests shall be taken as arranged by the Engineer.
  - f. Unless otherwise indicated in the Contract Documents, density and moisture tests shall be the responsibility of the Engineer. The Contractor shall cooperate with the Engineer or the soils testing agency in taking density and moisture tests.
- N. When the trench excavation for the sewer main and appurtenances is within the rights-of-way of state or county highways, the backfilling of the trench, compaction of materials, subgrade preparation and surfacing shall be done in strict accordance with the requirements and specifications of the authority having jurisdiction or as required by these specifications, whichever is more stringent.
- O. In all cases, the Contractor shall blade and compact the roadway after the trench has been backfilled, so that it shall be passable to traffic at all times. The Contractor shall maintain the roadway in a condition acceptable to the City at all times until final acceptance of the entire work by the City.
- P. The Contractor shall also blade and maintain all detours and bypasses. All maintenance work shall be done at no additional compensation. In addition to the blading and maintenance requirements specified, the Contractor shall provide at least one tank truck with pressurized spray bars for spraying water on the streets to control the dust. Dust control shall be required as necessary on all streets after compaction and grading and on all detours and bypasses.
- Q. The Contractor is responsible for the complete maintenance of his work at all times. If he fails to provide proper maintenance, and safety or nuisance conditions arise, it is expressly understood that City crews may be directed by the City to provide essential maintenance, and that such work will be done at the expense of the Contractor.
- R. The Contractor shall remedy at his own expense any defects that appear in the backfill following completion and during the warranty period.

### **3.06 Service Connections**

- A. It shall be the duty of the Contractor to keep an accurate record of service connections as to the location, elevation of the service at the property line, type of connection provided, and other pertinent data and to include this information on the record drawings. Locations shall be made in respect to the survey line stationing and house corners or lot corners. The Engineer, prior to any backfill, shall approve all service installations.
- B. The Contractor shall construct services for building connections and shall extend such services to the back of the utility easement. Service connections shall have a wye or tee installed at the main

line. The sewer lateral will be aligned at a 90 degree angle with the main line. Service connections shall not enter at an angle greater than 45 degrees from the horizontal. Contractor shall leak test all new service lines in conjunction with new sewer mains being leak tested.

- C. Sewer service riser pipes shall not be installed directly into the main line. The bottom section of the sewer service line (installed at an angle not greater than 45 degrees from the horizontal) shall be a minimum length of eighteen inches (18") (450 mm) between the main line and the riser pipe installed at a grade not greater than 1/2 – inch per foot. The trench bottom below the bottom sections and the riser of the sewer service line shall be compacted to support the sewer service riser pipe. Riser pipes shall be laid against the trench wall to help prevent drag down loading from soil settlement. An engineer will design all sewer service riser pipes where the depth of the main line is twelve feet (12') (3.6m) or greater.
- D. Sewer services shall be installed ten feet (10') (3m) from the lot centerline on the downhill side of the sewer main. Services may be installed at a greater distance from the centerline if required by the sewer elevation. Services shall be installed perpendicular to the sewer main between the main and the property line.
- E. Sewer service lines shall be kept as deep as required to serve the property and shall extend on a straight-line grade to the property line unless otherwise directed by the Engineer. Where possible, all sewer service connections shall end above the groundwater table.
  - 1. All sewer service connections shall be capped with stoppers which shall effectively prevent water from entering the sewer until the connection is placed in service. The cap shall be as recommended by the pipe manufacturer, sealed firmly in place, or by other methods accepted by the Engineer. The service connection end shall be clearly marked by a rebar extending from the pipe end to at least three feet (3') (1m) above the ground. The service line location shall also be marked in the concrete curbwalk by an arrow with the letter "S".
- F. In some areas, the sewer services may be laid at the minimum grade allowed by the plumbing code in effect due to a shallow sewer line or low abutting property. Services shall be at right angles to the main sewer unless otherwise directed by the Engineer.
- G. Where it is necessary to tap sewer services into existing mains, the City shall make the taps for the Contractor using saddle adapters. The Contractor shall be responsible for installing the service line from the installed tap to the property. The Contractor shall be responsible for obtaining a street cut permit, laying out and excavating the trench, protecting all mains and service pipes and backfilling the excavation in an approved manner. Contractor shall adhere to OSHA trenching and shoring rules and regulations.
- H. All abandoned or unused sewer service lines must be plugged at the property line and capped with a watertight stopper.

### **3.07 Leak Testing**

- A. Upon completion of all utility construction and before any sewer service line is connected into, leak testing will be required of all sanitary sewer pipe lines. The Contractor has the option of performing either an air test or a water exfiltration test. Testing shall be performed after complete compaction and backfill and completion manholes, but may be performed before the

final surfacing.

1. Leak testing, using low-pressure air shall be performed with suitable equipment specifically designed for air testing sewers.
  - a. The air test shall be made when the sewer is clean. Sections of sewer pipe to be tested may be wetted before the air test. The pipeline shall be plugged at each manhole with pneumatic balls. Low-pressure air shall be introduced into the plugged line until the internal pressure reaches four-pounds per square inch (4.0 psig) (28 kPa) greater than the average back pressure of any groundwater pressure that may submerge the pipe. At least two (2) minutes shall be allowed for the air temperature to stabilize before readings are taken and the time started.
  - b. The portion of the sewer line being tested shall pass if it does not lose air at a rate to cause the pressure to drop one-half pound per square inch (0.5 psig) (greater than the average back pressure of any groundwater that may submerge the pipe) in less time than listed below.

Pipe Diameter in. (mm)	Minimum Time (min:sec)	Specified Time for L (min:sec)							
		100' (30m)	150' (45m)	200' (60m)	250' (75m)	300' (90m)	350' (105m)	400' (120m)	450' (135m)
4 (100)	1:53	1:53	1:53	1:53	1:53	1:53	1:53	1:53	1:53
6 (150)	2:50	2:50	2:50	2:50	2:50	2:50	2:50	2:51	3:12
8 (200)	3:47	3:47	3:47	3:47	3:47	3:48	4:26	5:04	5:42
10 (250)	4:43	4:43	4:43	4:43	4:57	5:56	6:55	7:54	8:54
12 (300)	5:40	5:40	5:40	5:42	7:08	8:33	9:58	11:24	12:50
15 (375)	7:05	7:05	7:05	8:54	11:08	13:21	15:35	17:48	20:02
18 (450)	8:30	8:30	9:37	12:49	16:01	19:14	22:26	25:38	28:51
21 (525)	9:55	9:55	13:05	17:27	21:49	26:11	30:32	34:54	39:16
24 (600)	11:20	1:24	17:57	22:48	28:30	34:11	39:53	45:35	46:54
27 (675)	12:45	14:25	21:38	28:51	36:04	43:16	50:30	57:42	51:17
30 (750)	14:10	17:48	26:43	35:37	44:31	53:25	62:19	71:13	80:07
33 (825)	15:35	21:33	32:19	43:06	53:52	64:38	75:25	86:11	96:58
36 (900)	17:00	25:39	38:39	51:17	64:06	76:56	89:45	102:34	115:24

- c. If the pipeline section fails this test, the testing equipment may be used to determine the location of the pipe leak.
  - d. All service plugs shall be secured in place to prevent displacement during testing operations.
2. In lieu of the standard sanitary sewer air test, the Contractor may perform leakage testing on sewers using water and measuring the exfiltration.
  - a. The test section shall be bulkheaded at both ends and the pipe subjected to a hydrostatic pressure produced by a head of water at a depth of three feet (3') (1m) above the top of the sewer at the upper manhole under this test. In areas where ground water exists, this head of water shall be three feet (3') (1m) above the existing water table.



- b. For purposes of the test, the line between adjoining manholes will be considered a section and will be tested as such
  - i The head of water shall be obtained by means of an open ended stand-pipe projecting from a test plug on the upper manhole. Placing water in the upper manhole is not permissible as a means of obtaining the necessary pressure head of water.
  - ii This head of water shall be maintained for a period of one (1) hour during which it is presumed that full absorption of the pipe body has taken place, and thereafter for a further period of one (1) hour for the actual test of leakage. During this one (1) hour test period, the measured maximum allowable rate of exfiltration for any section of sewer, including service stubs, shall be listed below:

MAIN SEWER DIAMETER	MAXIMUM ALLOWABLE EXFILTRATION
inches(mm)	Gallons Per Hour Per 100 feet(l/hr/30m)
4 (100)	0.6 (2.2)
6 (150)	0.9 (3.4)
8 (200)	1.2 (4.5)
10 (250)	1.5 (5.5)
12 (300)	1.9 (7)
15 (375)	2.3 (9)
18 (450)	2.8 (10.5)
21 (525)	3.3 (12.5)
24 (600) & larger	38 (14)

- iii In case measurements indicate an exfiltration greater than the maximum allowable leakage, additional measurements shall be taken and continued until all leaks are located and the necessary repairs and corrective work have reduced the leakage in the section being tested below the maximum allowable by the specifications.
3. The Contractor shall furnish the plugs, standpipe, and other material and labor for placing the plugs and standpipe in the sewer.
  4. The introduction of any substance into the water used for testing with the intent of sealing such leaks as may be indicated will not be permitted.
  5. If results of either of these leakage tests are not satisfactory, repairs or pipe replacement will be required until the Engineer is satisfied that the leakage requirements are being met. All repair methods and materials used shall be approved by the Engineer.

B. Manholes will be tested for leakage separately from the pipe by one of the following methods:

1. Vacuum Testing

- a. All manholes shall be vacuum tested for leaks upon the completion of the backfill and compaction operation. The vacuum test method shall be in accordance with ASTM

C1244-05a, except as specified otherwise herein. The vacuum test shall be performed by the Contractor and witnessed by the Engineer or representative of the Engineering Department. Twenty-four hours (24hr) advance notice shall be provided before testing begins.

- b. The Contractor shall furnish all equipment and labor required, including necessary piping/hoses, pneumatic plugs, test vacuum equipment (vacuum pump and vacuum plate/head), vacuum gauge and second timer. The vacuum gauge shall have a maximum range of 0-30 inches of mercury (Hg) and the vacuum gauge figure intervals shall be in ½ inch increments.
- c. After cleaning the interior surface of the manhole, the Contractor shall place and inflate pneumatic plugs in all the connecting pipes with the exception of sewer services to isolate the manhole. Complete sewer services entering the manhole shall be part of manhole vacuum test.
- d. The vacuum plate/head shall be placed on the top of the manhole lid frame. The vacuum pump shall be connected to the outlet port with the valve open. When a vacuum of ten (10) inches of mercury has been attained, the outlet valve shall be closed and the test period is started. The minimum test period is determined from the following table:

DEPTH OF MANHOLE (ft)	DIAMETER OF MANHOLE (ft)	
	4	6
	TIME (sec)	
<14	60	60
16	60	67
18	60	73
20	60	81
22	60	89
24	60	97
26	64	105
28	69	113
30	74	121

- e. All pneumatic plugs shall be removed from the manhole after the test.
- f. Any manhole that fails the initial vacuum test must be repaired with a non-shrink grout material. The Contractor shall apply non-shrink grout on the interior of the manhole. Upon completion of the repairs, the manhole shall be retested as described in the above test procedures. The cost of the manhole repair and backfill is incidental to the cost of the project.
- g. Any manhole that fails the three vacuum tests must be removed and replaced with a new manhole. The new manhole shall be backfilled to grade and tested as described in the above test procedures. The cost of the new manhole and backfill is incidental to the cost of the project.
- h. The manhole shall have passed the vacuum test if the manhole vacuum does not drop below nine (9) inches of mercury during the minimum specified test period.

2. Manholes shall be filled with water to a depth of five feet (5') (1.5m) above the invert or five feet (5') (1.5m) above the groundwater table whichever is higher. If the groundwater level is more than five feet (5') (1.5m) above the invert, inflow to the manhole shall be measured. Allowable leakage into or out of or both shall be one gallon per hour (1g/h) (3.75l/h) per manhole measured over a minimum four (4) hours. At least 20% of all manholes shall be tested. Based on these tests, and visual inspection of all manholes, additional tests may be required for other manholes. Any manhole whose test is unsatisfactory shall be repaired and retested until satisfactory results are obtained.

### 3.08 PVC Deflection Test

A. All PVC pipe shall be subject to a deflection test by use of cage type approved mandrel.

1. In paved areas or areas to be paved, the Contractor has the option of:
  - a. Testing PVC sewer lines with a 4% deflection mandrel after completed backfill and compaction of trench but before paving, or
  - b. Testing PVC sewer lines with a 5% deflection mandrel after paving is complete.
2. In non-paved areas Contractor has the option of:
  - a. Testing PVC sewer lines with a 4% deflection mandrel after complete backfill and compaction of trench but before placing and spreading topsoil, or
  - b. Testing PVC sewer lines with a 5% deflection mandrel after placing and spreading topsoil (but before seeding).

B. All mandrels shall be precisely made to the diameters specified below (which include allowances for pipe manufacturer's outside diameter tolerance, excess wall thickness tolerance, and out-of-roundness tolerance).

<b>NOMINAL PIPE DIAMETER</b>	<b>MANDREL MINIMUM OD FOR 4% DEFLECTION</b>	<b>MANDREL MINIMUM OD FOR 5% DEFLECTION</b>
8''(200mm)	7.358'' (187mm)	7.282'' (185mm)
10'' (250mm)	9.180'' (233mm)	9.085'' (231mm)
12'' (300mm)	10.907'' (277mm)	10.793'' (274mm)
15'' (375mm)	13.342'' (339mm)	13.203'' (335mm)
18'' (450mm)	16.297'' (414mm)	16.127'' (410mm)
21'' (525mm)	19.204'' (488mm)	19.004'' (483mm)
24'' (600mm)	21.581'' (548mm)	21.356'' (542mm)
27'' (675mm)	24.314'' (618mm)	24.061'' (611mm)

\* OD – Outside Diameter

### **3.09 Separation of Water Mains and Sewers.**

- A. Minimum horizontal separation shall be ten feet (10') (3m) where the invert (bottom) of the water main is less than eighteen inches (18") (450mm) above the crown (top) of the sewer line. Minimum vertical separation shall be eighteen inches (18") (450mm) at crossings. Joints in sewers at crossings shall be located at least ten feet (10') (3m) from water mains. The upper line of a crossing shall be specially supported. Where vertical and/or horizontal clearances cannot be maintained, the sewer or water piping shall be placed in a separate conduit pipe.

### **3.10 Inspection and Acceptance**

- A. Prior to acceptance of each section of sanitary sewer line, the Contractor shall flush a ball the full diameter of the pipe through all pipelines up to eighteen inches (18") (450mm) in diameter. Larger pipelines shall be cleaned by other appropriate methods. All dirt and debris shall be prevented from entering the existing sewer system by suitable methods.

#### **B. Preliminary Acceptance**

1. Prior to preliminary acceptance of a sanitary sewer collection system, regardless of ownership, the following inspection tests shall be made and certified for each section of sewer line.
  - a. Gradation tests. Copies of the test results shall be enclosed as an attachment to the "Certificate of Completion".
  - b. Density and moisture tests. Copies of the test results shall be enclosed as an attachment to the "Certificate of Completion".
  - c. Air tests or exfiltration tests. Copies of the test results shall be enclosed as an attachment to the "Certificate of Completion".
  - d. Deflection test (PVC). Copies of the test results shall be enclosed as an attachment to the "Certificate of Completion".
  - e. Cleaning and flushing of the lines and manholes.
2. Each manhole shall be inspected for:
  - a. Proper construction. The invert of the manholes shall be smooth, clean, and free of obstructions.
  - b. Leakage
  - c. Cover accessible and at proper grade.
3. Items 1.c. and 1.d. above shall be performed only after complete backfill and compaction; items 1.e. and items 2.a., 2.b., and 2.c. shall be performed after an all-weather roadway is completed and complete easement restoration is accomplished.

4. The “Certificate of Completion” and “Record Drawings” shall be submitted to the City prior to preliminary acceptance.

C. Final acceptance

1. Final acceptance will not take place until preliminary acceptance is obtained and all paving and curbwalk is completed.
2. Before final acceptance of any sanitary sewer, the following inspections shall be made:
  - a. All lines clean and flushed.
  - b. Manholes up to proper grade in a proper condition.
3. All punch list items must be completed prior to final acceptance.
4. The warranty period shall not start until final acceptance is obtained and a complete set of “Record Drawings” is submitted to the City.

**3.11 Record Drawings**

- A. “Record Drawings” shall be submitted to the City prior to preliminary acceptance of the construction project. “Record Drawings” shall include, in addition to construction drawings and details, “as built” information where it differs from construction drawings and locate information including horizontal and vertical coordinates in the datum established by the City for the Geographical Information System.

**END OF SECTION**