Section 5 - Sanitary Sewer

Overview

This section includes specifications regarding all material, equipment, and labor required to install sewer lines, sewer service laterals, manholes, and appurtenances as specified, as shown on the Plans, and as directed by the Engineer.

The Contractor shall construct the sewer lines, sewer service laterals, manholes, and appurtenances as shown on the Plans and as specified in this section. Clearing, grubbing, trench excavation, shoring, backfill, restoration and other related items shall be as specified in Section 2: Trench Excavation and Backfilling. Pipe and accessories shall be new and unused materials as specified herein or as specifically approved by the Engineer.

Chapter 1 – Organization of Work

The Contractor shall so organize his work that backfilling and cleanup shall closely follow pipe laying operations and manhole construction.

In general, not more than one block of a street or roadway shall be closed for construction at any one time. Before proceeding with trenching operation in a succeeding block, the preceding section shall be backfilled, cleanup completed and the street opened to traffic.

For work outside the streets and roadways, not more than five hundred (500') feet of trench shall remain open at any one time.

Failure on the part of the Contractor to comply with the above provisions in a reasonable manner, as determined by the Engineer, shall be sufficient cause for the Engineer to order a temporary shut-down of further trenching and pipe laying operations until the provisions have been met.

The Owner reserves the right to accept and use portions of work when it is considered to be in the public's interest to do so; the Engineer shall have the authority to establish the order in which the lines shall be worked.

Chapter 2 – Location and Grade

The line and grade of the sewer, and the position of manholes and other structures shall be as shown on the plans or as directed by the Engineer. The price for trenching shall include trench excavation to the depth necessary to lay the sewer to the grade shown, but measurements for payment will be made only to the grade line indicated.

All lines and grades shall be laid out by the Contractor from the controlling lines and bench marks established by the Engineer, or from measurements shown. All line and grades shall be subject to checking by the Engineer, but that checking shall in no way relieve the Contractor from responsibility for their correctness. The Contractor shall provide such stakes, materials, labor and assistance as the Engineer may require in laying-out work, establishing bench marks and checking and measuring the work.

Chapter 3 – Unloading, Handling, and Storing of Materials

Equipment and facilities for unloading, hauling, and distributing and storing materials shall be furnished by the Contractor. Delays and/or charges for unloading materials shall be at the expense of the Contractor.

Pipe, fittings and other materials shall be carefully handled so as to prevent breakage and/or damage. Pipe may not be unloaded by rolling or dropping off of trucks or cars. Preferred unloading is in units using mechanical equipment, such as fork lifts, cherry pickers, or front-end loaders with forks. If fork lift equipment is not available units may be unloaded with use of spreader bar on top and nylon strips or cables (cushioned with rubber hose sleeve) looped under the unit.

Materials shall be distributed and placed where they will not interfere with traffic. No street or roadway may be closed without first obtaining permission of the proper authorities. The Contractor shall furnish and maintain proper warning signs and lights for the protection of traffic along highways, streets and roadways upon which material is distributed. No distributed materials shall be placed in drainage ditches.

3.00 All pipe, fittings and other materials which cannot be distributed along the route of the work shall be stored for subsequent use when needed. The Contractor shall make his own arrangements for the use of storage areas; except that, with permission, they may make reasonable use of the Owner's storage yards.

3.00.1 Concrete and ductile iron pipe must be stockpiled on level ground. Timbers must be placed under the pipe for a base and to prevent dirt and debris from washing into the pipe.

3.00.2 PVC pipe must be stockpiled on level ground. If pipe is unloaded individually by hand the same as factory load, with stop blocks nailed at either end. Stockpile must be built up the same manner as it was stocked for shipment. Individual lengths of pipe shall not be stacked in piles any higher than five feet (5').

If pipe is unloaded in units, the units must be place on level ground and shall not be stacked more than two (2) units high. Units must be protected while loaded on the truck or car. Supports shall be sufficient to carry the weight of all units loaded above.

If pipe is to be stored outside and exposed to sunlight for more than thirty days, the pipe must be protected by covering with a canvas or other opaque material. The cover shall be loose

enough to allow for air circulation around the pipe. The use of clear plastic sheets will not be permitted.

Chapter 4 – Pipe Materials

The following pipe materials are approved for use within the City of North Augusta. All pipe material shall be as shown on the Plans or as directed by the Engineer. The specification reference, and name of manufacturer shall be clearly marked on each length of pipe.

All work done and materials furnished shall be subject to inspection by the Engineer or his authorized representative. Improper work shall be reconstructed and materials which do not conform to the requirements of this section shall be removed from the work upon notice being received from the Engineer of the rejection of those materials. The Engineer shall have the right to mark rejected materials and/or the Contractor shall segregate said materials to distinguish them as such.

Section 4.0 – Quality and Inspection

Latitudes in workmanship and finish allowed by ASTM notwithstanding, all pipe shall have smooth exterior and interior surfaces; be first quality, be free from cracks, blisters, and other imperfections, and be true to theoretical shapes and forms throughout each length. Pipe shall be subject to inspection by the Engineer at the pipe plant, trench, and other points of delivery for the purpose of culling and rejecting pipe, independent to laboratory tests, which does not conform to the requirements of this Section. Pipe which does not conform will be so marked by the Engineer, and shall not be used in the work. On-the-job repairing of rejected pipe will not be permitted.

Section 4.1 – Experience of Manufacturers

The pipe manufacturer shall submit evidence, if requested by the Engineer, of having consistently produced pipe and joints of the quality specified herein, and which have exhibited satisfactory performance results in service over a period of not fewer than two years. The pipe manufacturer and the pipe manufacturing process shall be subject to approval by the Engineer.

Section 4.2 – Concrete Pipe

Concrete sewer pipe shall be bell and spigot and shall conform to ASTM C76 *Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe*, as amended to date.

4.20 Concrete reinforced pipe shall comply with ASTM C76, Table 3, 4 or 5 and be Class III, IV or V.

4.21 All pipe size eighteen inches (18”) and larger shall be reinforced. Pipe shall be of the class dictated by the depth of bury and bedding as shown in Table 2. Pipe shall be furnished in lengths of at least eight feet (8’).

4.22 Cement shall be Type II, or approved equal and coarse aggregate shall be crushed limestone.

4.23 Wire reinforcement used in the pipe shall conform to the standard specifications, with the following exceptions:

i. Elliptical steel reinforcement will not be permitted.

ii. Longitudinal wires for pipe made on packer head type machines shall be at least seven (7) gauge and in no case shall spacing thereof be in excess of four inches (4").

4.24 Steam curing of concrete pipe shall conform to the standard specifications, with the following exception:

i. When temperatures fall below an average of 40° F, curing shall be continuous for a 24-hour period, except for the interval when forms and/or rings are removed.

4.25 All pipe, when tested by the three-edge bearing method, in accordance with ASTM C497, *Standard Test Methods for Concrete Pipe*, shall have a minimum crushing strength of not less than the values provided in Table 1. Minimum crushing strength is defined as the load to produce a 0.01-inch crack for reinforced pipe.

Table 1 - Minimum Strengths for Reinforced Concrete Pipe

Pipe Size	Class III	Class IV	Class V
18 inches	2,025 plf	3,000 plf	4,500 plf
21 inches	2,360 plf	3,500 plf	5,250 plf
24 inches	2,700 plf	4,000 plf	6,000 plf
30 inches	3,375 plf	5,000 plf	7,500 plf

4.26 Absorption shall not exceed six percent (6%) when determined in accordance with ASTM C497.

4.27 All pipe shall have O-ring rubber gasket type joints conforming with the applicable provisions of ASTM C443, *Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets*. A rectangular groove shall be provided in the spigot end of the pipe to receive the circular rubber gasket and it shall be so formed that when the joint is complete the gasket will be deformed to the shape of the groove and confined on all four sides. Bell and spigot surfaces shall be accurately formed and smooth to provide a close sliding fit with a nominal clearance not to exceed one sixteenth inch (1/16") between the outside surface of the spigot and the inside surface of the bell.

4.28 Repaired and patched pipe will not be acceptable unless each individual pipe so repaired or patched shall have first been inspected and approved by the Engineer, for repair and patching at the pipe plant. Repairs to, and patching of gasket groves and shoulders will not be permitted if damage is of a nature which, in the opinion of the Engineer, would impair the water tightness of the completed joint.

4.29 Made-up gasketed joints shall be tested for shear loading at a total load of one hundred pounds per inch (100 lb/in) of diameter, including the weight of the pipe, water, and test apparatus. The load shall be uniformly applied to the spigot and over an arc of not less than one hundred and twenty degrees (120°) for a longitudinal distance of twelve inches (12”) immediately adjacent to the bell, with the pipe supported on blocks behind the bells during the test procedure. There shall be no visible leakage when tested with an internal water pressure of one hundred pounds per square inch (100 psi) for a period of ten minutes. At least one shear loading test shall be conducted for each size of pipe to be delivered to the jobsite.

Section 4.3 – Polyvinyl Chloride (PVC) Sewer Pipe

Polyvinyl Chloride (PVC) Sewer Pipe shall be bell and spigot in lengths not exceeding twenty feet (20’) laying lengths and shall have minimum wall thickness conforming to ASTM D3034, *Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings*, under the classification for SDR 35 pipe, as amended to date, or ASTM 789-85.

PVC sewer pipe fittings shall be bell and spigot or bell and plain end and shall conform to ASTM D3034, as amended to date.

4.30 PVC pipe shall be marked at intervals of five feet (5’) or less with the following information: Manufacturer's Name or trade Mark, Plant code, Date of manufacture, Nominal Pipe Size, PVC Cell Classification, the legend "Type PSM DR 35 PVC Sewer Pipe", and ASTM designation D3034.

Fittings shall be marked with the following information, Manufacturer's Name or Trade Mark, Nominal Size, Designation PVC and PSM and ASTM designation D3034.

All markings shall remain legible during normal handling, storage and installation.

4.31 The Contractor shall furnish the Engineer with a written statement from the manufacturer that all pipe and fittings furnished have been sampled, tested and inspected in accordance with ASTM D 3034, as amended to date. Each certification so furnished shall be signed by an authorized agent of manufacturer.

4.32 All pipe shall have elastomeric joints with an integral bell gasket coupler. Rubber gaskets shall comply with the physical requirements specified in the latest revision of ASTM F477, *Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe,* as amended to date. Joints shall meet the requirements specified in ASTM D3212, *Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals*, as amended to date.

Section 4.4 – Ductile Iron Pipe

Pipe shall be centrifugally cast and shall conform to ANSI Specifications A21.10, A21.50 and A21.51, as amended to date, with mechanical or push-on joints and laying lengths of at least eighteen feet (18') with Class 51 wall thickness for size three inch (3") and four inch (4") pipe and Class 50 wall thickness for pipe six inch (6") in size and above unless indicated otherwise herein and/or on the drawings.

4.40 Fittings shall be cast from gray or ductile iron and shall conform to ANSI Specifications A21.10 (AWWA C 110), as amended to date. All fittings shall have standard mechanical joints. Fittings for size three inch (3") through twelve inch (12") shall be Class 250 for Gray Iron and Class 350 for Ductile Iron. Fittings for size fourteen inch (14") through forty-eight inch (48") shall be Class 150 for Gray Iron and Class 250 for Ductile Iron. Either Gray Iron or Ductile Iron fittings will be permissible unless otherwise specified or shown on the Drawings.

4.41 Pipe and Fittings shall be cement-lined (standard thickness) inside and bituminous coated outside, in accordance with the applicable provisions of ANSI Specification A 21.4 (AWWA C 104) and, ANSI A 21.51 (AWWA C 151), as amended to date. The inside cement lining shall be treated with a bituminous seal coat.

4.42 Weights of pipe and fittings shall conform strictly to the requirements of ANSI Specifications. The class designations for the various classes of pipe and fittings shall be cast onto fittings in raised numerals, and cast or stamped on the outside of each joint of pipe. Weights shall be plainly and conspicuously painted in white on the outside of each joint of pipe and each fitting after the exterior coating has hardened.

4.43 The manufacturer of iron pipe and fittings shall furnish both the Engineer and the Owner with a certified letter stating that inspection and specified

tests have been made and that the results thereof comply with the applicable ANSI Specifications for each.

Chapter 5 – Trench Width

Section 5.0 – Concrete Pipe

Table 2 - Maximum Trench Widths and Depths for Concrete Pipe

Pipe Size	Maximum Trench Width	Class of Pipe	Class C Bedding		Class B Bedding		Class A Bedding	
			(1)	(2)	(1)	(2)	(1)	(2)
18"	3'-4"	III	8	8	11	9	24	15
		IV	15	12	24	15	*	22
		V	*	18	*	22	*	*
21"	3'-8"	III	8	8	11	9	24	16
		IV	15	12	24	16	*	22
		V	*	18	*	23	*	*
24"	4'-0"	III	9	9	13	11	24	16
		IV	16	12	24	16	*	22
		V	*	19	*	24	*	*
30"	4'-8"	III	10	10	14	12	25	17
		IV	17	14	25	17	*	24
		V	*	20	*	24	*	*

(1) Maximum Trench Depth for Maximum Trench Width
(2) Limit of Trench Depth if Maximum Trench Width is exceeded.
* Up to and including thirty feet (30') of depth.
Note: If trenches are excavated to widths in excess of the maximum trench width or if trench wall collapses, sewers shall be laid with the class of bedding required for the trench depth shown in column (2) above at the expense of the Contractor. See Chapter 6 for Pipe Bedding.

Section 5.1 – Polyvinyl Chloride (PVC) Pipe

5.10 The maximum clear trench width at the top of the pipe shall not exceed a width equal to the normal pipe diameter plus eighteen inches (18"). If this width is exceeded or the pipe is installed in a compacted embankment, pipe embedment shall be compacted to a point at least two and a half (2½) pipe diameters from the pipe on both sides of the pipe or to the trench walls, whichever is less.

5.11 For PVC pipe sizes six inch (6") to twenty one inch (21") the maximum height of cover shall be thirty feet (30') and pipe shall be bedded in Class I Bedding and compacted at ninety five percent (95%) of proctor density.

5.12 If the 95% proctor density compaction cannot be obtained with materials from trench excavation, the Contractor will be required to obtain them elsewhere.

Section 5.2 – Payment

The cost of special bedding and tamping shall be included in the prices bid for sewers at various depths, except that the Engineer may authorize payment for concrete bedding or the use of crushed stone bedding where poor soil conditions are encountered, each in accordance with unit prices bid. The cost of furnishing extra strength sewer pipe shall be included in the prices bid for sewers at various depths.

Chapter 6 – Pipe Bedding

All pipe shall be laid on foundations prepared in accordance with the following specifications.

Section 6.0 – Concrete Pipe

Concrete pipe shall be laid as specified using the following classes of bedding required by the trench width and trench depth for the various sizes of pipe to be installed.

6.00 Class A bedding shall be either a concrete cradle (Type 1) or a concrete arch (Type 2).

Where the Type 1 method is used, the trench shall be excavated not less than six inches (6") below the barrel of the pipe or a minimum of two inches (2") below the pipe bell (whichever is greater) and the pipe laid to line and grade on concrete blocking or equal. Class "B" concrete shall then be placed to the full width of the trench, but in no case less than four inches (4") from the pipe bell on either side of the trench, and to a height of at least one-fourth the outside diameter of the pipe. No backfill shall be placed in the trench for a period of at least twenty-four (24) hours after the concrete has been placed. The backfill shall then be completed with selected backfill, had placed and tamped, to the limits shown on Detail 5.07 – Pipe Embedment.

Where concrete arch (Type 2) method is used, the trench shall first be excavated not less than six inches (6") below the barrel of the pipe bell (whichever is greater). The trench shall then be brought to grade with compacted crushed stone, placed the full width of the trench, as excavated, up to one-half the outside diameter of the pipe. the backfill shall then be complete with Class "B" concrete placed for the full width of the trench, as excavated, and to a point at least four inches (4") above the barrel of the pipe or one-fourth the inside diameter of the pipe (whichever is greater).

6.01 Class B bedding shall be performed by first undercutting the trench not less than six inches (6") below the barrel of the pipe or a minimum of two inches (2") below the pipe bell (which is greater). The trench shall then be brought to grade with compacted crushed stone, the pipe laid to line and grade and backfilled with compacted crushed stone placed the full width of the trench, as excavated, up to one-half the outside diameter of the pipe. The backfill shall then be completed with selected backfill, hand placed and tamped, to the limits shown on Detail 5.07 – Pipe Embedment.

6.02 Class C bedding shall be performed by first undercutting the trench not less than six inches (6") below the barrel of the pipe or a minimum of two inches (2") below the pipe bell (whichever is greater). The trench shall then be brought to grade with compacted crushed stone, the pipe laid out to line and grade and backfill of compacted crushed stone placed and grade and backfill of compacted crushed stone placed the full width of the trench, as excavated, up to one-fourth the outside diameter of the pipe. The backfill shall then be completed with selected backfill, hand placed and tamped, to the limits shown on Detail 5.07 – Pipe Embedment.

6.03 Bell Holes shall be provided in all classes of bedding so as to relieve pipe bells of all load, but small enough to ensure that support is provided throughout the length of pipe barrel.

6.04 Crushed stone bedding material shall conform to the latest revision of ASTM C 33, *Standard Specification for Concrete Aggregates*, as amended to date, gradation of #57 (ASTM #57), varying in sizes ¼" through 1". Bedding material shall be placed in the trench and thoroughly compacted to grade by tamping. Compacted bedding materials shall be carried up the sides of the pipe to the heights shown for the various classes of bedding.

6.05 If trenches are excavated to widths in excess of those specified in Table 2 or if trench walls collapse, pipe shall be laid down with the class of bedding required for the trench depth shown in column (2) of the Table at the expense of the Contractor.

Section 6.1 – Polyvinyl Chloride (PVC) Pipe

PVC pipe shall be laid as specified using the following classes of bedding required for the various type soils and conditions encountered. Bedding for PVC pipe shall be in accordance with ASTM D2321, *Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications*, as amended to date, the manufacturers recommendations and these specifications.

6.10 Class IA or IB Materials shall be used for bedding and haunching in all conditions. Class II, Class III, Class IVA, Class IVB and Class V materials will not be permitted for bedding and haunching under any condition.

6.11 Trench shall be undercut to allow for a minimum of six inches (6") of bedding material. Bell holes shall be excavated in the bedding material to allow for unobstructed assembly of the joint but care shall be taken to assure that bell hole is no larger than necessary to accomplish proper joint assembly. After joint assembly, material shall be placed under and

around the entire length of pipe and compacted. Compaction up to one-half the outside diameter of the pipe and the full width of the ditch shall be of the same material used in the bedding. Backfilling shall then be carried to a point six inches (6") above the top of pipe, using hand tools for tamping. If the remaining backfill material contains large particles which could damage the pipe from impact during placement the initial backfill shall be increased to twelve inches (12") above the top of the pipe. Puddling will not be allowed as a method of compaction. The remaining backfill shall be as specified in Section 2: Trench Excavation and Backfilling. Pipe shall have at least thirty-six inches (36") of cover before wheel loading and at least forty-eight inches (48") of cover before using heavy duty tamping equipment.

6.12 Class IA, IB, II, III, IVA, IVB, and V materials are defined in Table 3. Their recommended uses are given in Table 4.

Table 3 - Classes of Embedment and Backfill Materials

Class	Type	Soil Group Symbol D 2487	Description	Percentage Passing Sieve Sizes			Atterberg Limits		Coefficients	
				1 1/2 in. (40 mm)	No. 4 (4.75 mm)	No. 200 (0.075 mm)	LL	PL	Cu	Cc
IA	Manufactured Aggregates: open-graded, clean.	None	Angular, crushed stone or rock, crushed gravel, broken coral, crushed slag, cinders or shells; large void content, contain little or no fines.	100%	</=10%	<5%	Non-Plastic			
IB	Manufactured, Processed Aggregates; dense-Graded, clean.	None	Angular, crushed stone (or other Class IA materials) and stone/sand mixtures with gradations selected to minimize migration of adja-cent soils; contain little or no fines.	100%	</=50%	<5%	Non-Plastic			
II	Coarse-Grained Soils, clean	GW	Well-graded gravels and gravel-sand mixtures; little or no fines.	100%	<50% of "Coarse Fraction"	<5%	Non-Plastic		>4	1 to 3
		GP	Poorly-graded gravels and gravel-sand mixtures; little or no fines.						<4	<1 or >3
		SW	Well-graded sands and gravelly sands; little or no fines.		>50% of "Coarse Fraction"				>6	1 to 3
		SP	Poorly-graded sands and gravelly sands; little or no fines.						<6	<1 or >3
	Coarse-Grained Soils, borderline clean to w/fines	e.g. GW-GC SP-SM	Sands and gravels which are borderline between clean and with fines.	100%	Varies	5% to 12%	Non-Plastic		Same as for GW, GP, SW and SP	
III	Coarse-Grained Soils With Fines	GM	Silty gravels, gravel-sand-silt mixtures.	100%	<50% of "Coarse Fraction"	12% to 50%		<4 or <"A" Line		
		GC	Clayey gravels, gravel-sand-clay mixtures.					<7 and >"A" Line		
		SM	Silty sands, sand-silt mixtures.		>50% of "Coarse Fraction"			>4 or <"A" Line		
		SC	Clayey sands, sand-clay mixtures.					>7 and >"A" Line		

Class	Type	Soil Group Symbol D 2487	Description	Percentage Passing Sieve Sizes			Atterberg Limits		Coefficients	
				1 1/2 in. (40 mm)	No. 4 (4.75 mm)	No. 200 (0.075 mm)	LL	PL	Cu	Cc
IVA	Fine-Grained Soils (inorganic)	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, silts with slight plasticity.	100%	100%	>50%	<50	<4 or <"A" Line		
		CL	Inorganic clays of low to medium plasticity, gravely clays, sandy clays, silty clays, lean clays.					>7 and >"A" Line		
IVB	Fine-Grained Soils (inorganic)	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.	100%	100%	>50%	>50	<"A" Line		
		CH	Inorganic clays of high plasticity, fat clays.					>"A" Line		
V	Organic Soils	OL	Organic silts and organic silty clays of low plasticity.	100%	100%	>50%	<50	<4 or <"A" Line		
		OH	Organic clays of medium to high plasticity, organic silts.				>50	<"A" Line		
	Highly Organic	PT	Peat and other high organic soils.							

Table 4 - Recommendations for installation and Use of Soils and Aggregates for Foundation, Embedment, and Backfill

Soil Class (See Table 3, above)					
	Class IA	**Class IB**	**Class II**	**Class III**	**Class IV-A**
General Recommendations and Restrictions	Do not use where conditions may cause migration of fines from adjacent soil and loss of pipe support. Suitable for use as a drainage blanket and underdrain in rock cuts where adjacent material is suitably graded.	Process materials as required to obtain gradation which will minimize migration of adjacent materials. Suitable for use as a drainage blanket and underdrain.	Where hydraulic gradient exists check gradation to minimize migration. "Clean" groups suitable for use as drainage blanket and underdrain.	Do not use where water conditions in trench may cause instability.	Obtain geotechnical evaluation of proposed material. May not be suitable under high earth fills, surface applied wheel loads, and under heavy vibratory compactors and tampers. Do not use where water conditions in trench may cause in-stability.
Foundation	Suitable as foundation and for replacing over-excavated and unstable trench bottom as restricted above. Install and compact in 6 in. maximum layers.	Suitable as foundation and for replacing over-excavated and unstable trench bottom. Install and compact in 6 in. max-maximum layers.	Suitable as foundation and for replacing over-excavated and unstable trench bottom as restricted above. Install and compact in 6 in. maximum layers.	Suitable as foundation and for replacing over-excavated trench bottom as restricted above. Do not use in thicknesses greater than 12 in. total. In-stall and compact in 6 in. maximum layers.	Suitable only in undisturbed condition and where trench is dry. Remove all loose material and provide firm, uniform trench bottom before bedding is placed.

Soil Class (See Table 3, above)					
	Class IA	**Class IB**	**Class II**	**Class III**	**Class IV-A**
Bedding	Suitable as restricted above. Install in 6 in. maximum layers. Level final grade by hand. Minimum depth 4 in. (6 in. in rock cuts).	Install and compact in 6 in. maximum layers. Level final grade by hand. Minimum depth 4 in. (6 in. in rock cuts).	Suitable as restricted above. Install and compact in 6 in. maximum layers. Level final grade by hand. Minimum depth 4 in. (6 in. in rock cuts).	Suitable only in dry trench conditions. In-stall and compact in 6 in. maximum layers. Level final grade by hand. Minimum depth 4 in. (6 in.in rock cuts).	Suitable only in dry trench conditions and when optimum placement and compaction control is maintained. Install and compact in 6 in. maximum layers. Level final grade by hand. Minimum depth 4 in. (6 in. in rock cuts).
Haunching	Suitable as restricted above. Install in 6 in. maximum layers. Work in around pipe by hand to provide uniform support.	Install and compact in 6 in. maximum layers. Work in around pipe By hand to provide uniform support.	Suitable as restricted above. Install and compact in 6 in. maximum layers. Work in around pipe by hand to provide uniform support.	Suitable as restricted above. Install and compact in 6 in. maximum layers. Work in around pipe by hand to provide uniform support.	Suitable only in dry trench conditions and when optimum placement and compaction control is maintained. Install and compact in 6 in. maximum layers. Work in around pipe by hand to provide uniform support.
Initial Backfill	Suitable as restricted above. Install to a minimum of 6 in. above pipe crown.	Install and compact to a minimum of 6 in. above pipe crown.	Suitable as restricted above. Install and compact to a minimum of 6 in. above pipe crown.	Suitable as restricted above. Install and compact to a minimum of 6 in. above pipe crown.	Suitable as restricted above. Install and compact to a minimum of 6 in. above
Embedment Compaction**	Place and work by hand to insure all excavated voids and haunch areas are filled. For high densities use vibratory compactors.	Minimum density 85%. *** Use hand tampers or vibratory compactors.	Minimum density 85%. *** Use hand tampers or vibratory compactors.	Minimum density 90% Std. Proctor. *** Use hand tampers or vibratory compactors. Maintain moisture content near optimum to minimize compactive effort.	Minimum density 95% Std. Proctor. *** Use hand tampers or impact tampers. Maintain moisture content near optimum to minimize compactive effort.
Final Backfill	Compact as required by the engineer.	Compact as required By the engineer.	Compact as required by the engineer.	Compact as required by the engineer.	Suitable as restricted above. Compact as required by the engineer.

***Class IV-B (MH-CH) and Class V (OL, OH, PT) materials are unsuitable as embedment. They may be used as final backfill as permitted by the Engineer.**

****When using mechanical compactors avoid contact with pipe. When compacting over pipe crown maintain a minimum of 6" cover when using mechanical compactors. When using larger compactors maintain minimum clearances as required by the Engineer.**

*****The minimum densities given in the table are intended as the compaction requirements for obtaining satisfactory embedment stiffness in most installation conditions.**

Section 6.2 – Ductile Iron Pipe

Ductile iron pipe for gravity sewer shall be laid as specified using the following type of bedding required for the depth of cover for the various sizes of pipe to be installed.

6.20 For pipe with a flat bottom trench on undisturbed earth, backfill shall be as specified in Section 2: Trench Excavation and Backfilling.

6.21 For pipe bedded in 4 inches (4”) of select materials, backfill shall be as specified in Section 2: Trench Excavation and Backfilling. Select materials may be excavated material if free from rocks, foreign material, and frozen earth.

6.22 Maximum depth of cover for ductile iron pipe of various classes and sizes to be installed are as shown in Table 5.

Table 5 - Maximum Depths of Cover Over Ductile Iron Pipe

			Maximum Depth of Cover (ft)	
Pipe Size (in.)	Thickness Class	Normal Thickness (in.)	Flat Bottom Trench (ft)	Selected Material (ft)
10	50	0.29	38	55
	51	0.32	49	66
	52	0.35	59	79
12	50	0.31	36	52
	51	0.34	43	60
	52	0.37	53	71
16	50	0.34	30	47
	51	0.37	34	51
	52	0.40	40	57
18	50	0.35	29	42
	51	0.38	32	49
	52	0.41	36	53
20	50	0.36	27	38
	51	0.39	30	44
	52	0.42	34	50
24	50	0.38	23	31
	51	0.41	27	36
	52	0.44	30	41
30	50	0.39	18	25
	51	0.43	21	29
	52	0.47	24	33

Chapter 7 – Laying Gravity Sewer Pipe

All sewer pipe shall be laid upgrade, spigots shall point downgrade. The pipe shall be laid in the trench so that, after the sewer is completed, the invert fixed or given by the Engineer. The interior of all pipes shall be carefully freed of all dirt and superfluous material of every description, as pipe laying proceeds. Defective joints discovered after laying shall be repaired and made tight. Defective pipe shall be removed and proper replacement made.

Section 7.0 – Concrete Pipe with Rubber Gasket Joints

The surfaces of the pipe joints as well as the rubber gaskets, shall be thoroughly cleaned and wiped free of dust, dirt, and other foreign material. After the surfaces have been thoroughly cleaned, the mating surfaces of the joints and gaskets shall be lubricated with proper type of lubricant supplied by and applied in accordance with the recommendations of the pipe manufacturer. The gasketed spigot end of the pipe shall then be centered on a grade into the bell of the preceding pipe, shoved home, and properly seated by applying a moderate force with a pry or lever device. Pipe joints shall have the ability to joint up with relative ease and shall resist backing out from the seated position so that when the joint is made, it will need no restraint to keep it tight. Immediately after joining the pipes, the last pipe shall be brought to final alignment and grade. After each joint is made, the gasket shall be checked for proper position in its groove. Care shall be taken to prevent pinching and cutting of the gasket during installation. If the gasket is out of position, or has been damaged in any way the pipe shall be removed and re-laid with a new gasket. Every pipe shall be filled around immediately after being properly placed to prevent the moving of joints.

Section 7.1 – Polyvinyl Chloride (PVC) Pipe with Elastomeric Joints

Proper implements, tool and equipment shall be used for placement of the pipe in the trench to prevent damage. Under no circumstances may the pipe be dropped into the trench. In subfreezing temperatures, caution shall be exercised in handling pipe to prevent impact damage. All pipe shall be carefully examined for cracks, blisters, nicks, gouges, severe scratches, voids inclusions, and other defects before laying. If any pipe is discovered to be defective after having being laid, it shall be removed and replaced with sound material at the expense of the Contractor.

7.10 The assembly of the gasketed joint shall be performed as recommended by the pipe manufacturer. The elastomeric gaskets may be supplied separately in cartons or pre-positioned in the bell joint or coupling at the factory. When gaskets are color-coded, the Contractor shall consult the pipe manufacturer or his literature for the significance. In all cases, the gasket, the bell or coupling interior, especially the groove area (except when the gasket is permanently installed) and the spigot area shall be cleaned with a rag, brush, paper towel to remove any dirt or foreign material before the assembling. The gasket pipe spigot bevel, gasket

groove, and sealing surfaces shall be inspected for damage of deformation. When gaskets are separate, only gaskets which are designed for and supplied with the pipe shall be used. They shall be inserted as recommended by the manufacturer.

7.11 Lubricant used shall be supplied by the pipe manufacturer and shall be applied as specified by the pipe manufacturer.

After lubrication, the pipe is ready to be joined. Good alignment of the pipe is essential for ease of assembly. Align the spigot to the bell and insert the spigot into the bell until it contacts the gasket uniformly. Do not swing or "stab" the joint, that is, do not suspend the pipe and swing it into the bell. The spigot end of the pipe is marked by the manufacturer to indicate the proper depth of insertion.

If undue resistance to insertion of the pipe end is encountered, or the reference mark does not position properly, the joint shall be assembled and the position of the gasket checked. If it is twisted or pushed out of its seat ("fish mouthed"), the Contractor shall inspect components, and repeat the assembly steps. Both pipe lengths concentric alignments. If the gasket was not out of position, the Contractor shall verify proper location of the reference mark. The reference mark shall be relocated if it is out of position.

7.12 Field cut pipe to be joined shall be square cut using a hacksaw, handsaw or power saw with a steel blade or abrasive disc. The pipe shall be marked around its entire circumference prior to cutting to assure a square cut. A factory-finished beveled end shall be used as a guide for proper bevel angle, and depth of bevel plus the distance to the insertion reference mark. The end may be beveled using a pipe taper. A portable sander or abrasive disc may be used to bevel the pipe end. Any sharp edged on the leading edge of the bevel must be rounded off with a pocket knife or a file.

7.13 The maximum deflection in the installed PVC pipeline shall not exceed 5% of the pipe original internal diameter. Deflection testing will be required using either a deflectometer or a "GO-NO-GO" mandrel. The Engineer shall randomly select portions of the project to be deflection tested. Such portions shall consist of not less than 5% of the total reaches. (Reach being lengths of pipe between two manholes in the project excluding house leads).

Where deflection is found to be excess of 5% of the original pipe diameter, the Contractor shall excavate to the point of excess deflection and carefully compact around the point where excess deflection was found. However, should after the initial testing, the deflected pipe fail to

return to the original size (inside diameter) the line shall be replaced.

In the event that deflection occurs beyond the 5% limit in any section of 5% or more of the reached tested, the entire system shall be tested.

Section 7.2 – Ductile Iron Pipe with Mechanical or Push-On Joints

Proper and suitable tools and equipment shall be used for the safe and convenient handling and laying of ductile iron pipe. Care shall be taken to prevent damage to the exterior coating and interior cement lining. All pipe shall be carefully examined for crack and other defects before laying. If any pipe or fitting is discovered to be defective after having being laid, it shall be removed and replaced with sound material at the expense of the Contractor. Whenever pipe is required to be cut, the cutting shall be done by skilled workmen using an abrasive wheel cutter. Use of a cold chisel or oxyacetylene torch will not be permitted.

7.20 Mechanical joints shall be made only by experienced mechanics. Sockets and spigots shall be washed with soapy water before slipping the gland and gasket over the spigot end of the pipe.

The spigot shall be inserted into the socket full depth, then backed off one quarter inch (1/4”) to provide clearance for expansion. The gasket shall be brushed with soapy water and shall be pushed into position making sure that it is evenly seated in the socket. The gland shall then be moved into position for compressing the gasket. All bolts and nuts shall be made "finger-tight."

For joints made in trenches, the bolts shall be tightened to a uniform tightness, using a torque wrench for tightening. Bolts shall be tightened alternately one hundred and eighty degrees (180°) apart.

7.21 Push on joints shall be assembled as follows.

The groove and bell socket shall be thoroughly cleaned and lubricated before the gasket is inserted. Before inserting the gasket, it shall be thoroughly lubricated and manufacturer’s instructions shall be followed for proper facing and seating of a gasket. After the gasket is in place and just prior to joint assembly, a generous coating of lubricant shall be applied to the exposed gasket surface. The lubricant used shall be a lubricant supplied by the pipe manufacturer.

The plain end shall be inspected and any sharp edges which might damage the gasket shall be removed by mean of a file or a power grinder. Pipe that is cut in the field must be ground and beveled before assembly. Prior to inserting the plain end of the pipe into the bell socket lubricant shall be applied to the beveled nose of the pipe.

Small pipe may be pushed home with a long bar but large pipe may require additional power such as a jack, lever, or back hoe. A timber header shall be used between the bell and bar or other power to avoid damage to the pipe.

During assembly of the pipe the joint must be kept straight while pushing. Pipe may be deflected if desired but only after the assembly is complete.

7.22 Mechanical or Push-on Joint pipe may be used on piers in gravity sewer lines. Pipes shall be laid with one quarter inch (1/4”) clearance in each joint to provide for expansion. Jointing of pipe shall be as described above. On mechanical joint pipe the bolts shall be tightened alternately one hundred and eighty degrees (180°) apart, but be left "finger-tight" until the sewage is diverted into the sewers; then the bolts shall be further tightened a sufficient amount which will prevent slippage which may occur because of temperature stress.

Section 7.3 – Closing Pipe

When the work of pipe-laying is suspended for the night, and at other times, the end of the sewer shall be closed with a tight cover. The Contractor shall be responsible for keeping the sewer free from obstruction.

Chapter 8 – Precast Concrete Manholes

Precast concrete manholes shall consist of precast reinforced concrete riser sections, concentric top section and a base section conforming to Detail 5.01 – Standard Manhole. Precast manhole sections shall be manufactured in accordance with ASTM C478, *Standard Specification for Circular Precast Reinforced Concrete Manhole Sections*, as amended to date, and these specifications. Concrete shall have a minimum compressive strength of four thousand pounds per square inch (4,000 psi) when tested in accordance with ASTM C39, *Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens*, as amended to date. Steel reinforcement shall be as specified in ASTM C478, as amended to date. Wall and bottom section shall have a minimum thickness of five inches (5"). Absorption shall not exceed nine percent (9%) when determined in accordance with ASTM C497, as amended to date.

8.00 Base sections for precast concrete manholes shall have a bottom poured monolithically with the walls. Base sections shall be furnished with inside diameters of four, five, or six feet as required. Base sections shall be furnished with a minimum height of twenty-four inches (24”) for pipes having a diameter of eight, ten, or twelve inches and a minimum height of thirty-six inches (36”) for pipes having a diameter of fifteen or eighteen inches. Minimum height for 5- or 6-feet diameter base sections shall be forty-eight inches (48”) regardless of pipe size. Base sections with five or six foot inside diameter shall be reduced to four foot inside diameter by means of an adapter ring or transition top.

The openings in the base section for the accommodation of the pipe shall be cast to closely conform to job conditions and shall provide a minimum clearance of three inches (3") between the inside bottom of the base and outside bottom of the pipe barrel.

8.01 Riser sections shall be furnished in a minimum of six inch (6”) increments and shall be four feet (4') in diameter with, either tongue and groove joint to be sealed with approved butyl rubber or bitumastic material, similar to "Ram Nek" as manufactured by K. T. Snyder Co., Inc. or O-ring gasket type joint conforming to ASTM C443, as amended to date. The gasket joint shall be thoroughly cleaned of all loose materials and brushed with an approved Epoxy to give a smooth surface free of any honeycomb.

8.02 In the event that the manhole has to be altered after delivery to job site the Contractor may, with permission of the Engineer, connect the pipe to the manhole with a collar of mortar and brick. The opening between the pipe and manhole shall have a minimum clearance of one inch (1”) and shall be filled from the inside of the manhole with a non-shrink grout.

8.03 Repaired and Patched sections will not be acceptable unless each individual section so repaired and patched shall have first been inspected and approved by the Engineer, for repair and patching at the manhole plant. Repairs to the patching of O-Ring grooves and shoulders will not be permitted.

8.04 Manhole brick for grade adjustment shall be whole hard burned common brick conforming to ASTM C32, *Standard Specification for Sewer and Manhole Brick (Made From Clay or Shale)*, Grade MS, as amended to date. A maximum of three courses shall be used.

Chapter 9 – Placing Precast Manholes

Precast concrete manholes shall be placed or constructed where shown and/or directed by the Engineer. Manholes shall be four, five, and six feet in diameter as determined from the schedule of pipe sizes and line deflections or as shown.

The top of manholes outside of roads, streets, and highways shall be built to grades twelve inches (12") above ground surface unless otherwise shown on the Drawings. Manholes in roads, etc. shall be built to grade designated by the Engineer. Vented manholes shall be constructed to elevations as shown on the Drawings.

Section 9.0 – Precast Concrete Manholes

Precast concrete manholes shall be bedded on not less than six inches (6") of compacted crushed stone at Contractor's expense. The crushed stone shall extend to not less than six inches (6") outside the walls of the manhole, and shall be compacted under entire length of pipe within manhole excavation.

9.00 Connections of pipe to manholes shall be made with a flexible joint system. The joint system shall be a neoprene or synthetic rubber boot or sleeve, either cast or core drilled into the wall of manhole. The boot or sleeve shall be clamped and seated to the pipe with a stainless-steel band. The boot or sleeve, system shall be "Lock Joint Flexible Manhole Sleeves" as manufactured by Interpace Corporation or "Kor-N-Seal" as manufactured by National Pollution Control System, Inc. or equal. connections of pipe to manhole shall have a minimum clearance of one inch (1") and shall be filled from the inside of the manhole with a non-shrink grout.

9.01 The top of the concentric top section shall have a minimum wall thickness of eight inches (8") to accommodate brick courses for height adjustment. A maximum of three (3) brick courses will be allowed for adjustment of manhole to required grade.

Section 9.1 – Drop Connections

Drop connections will be required, wherever there is a difference in elevation between the inlet and outlet inverts of two feet (2') or more or wherever called for on the Drawings. Drop pipe shall be the same size as the sewer which they serve. Openings in the walls of precast concrete manholes for drop connections shall not be made at joints. Drop connection fittings and riser pipe shall be encased in formed Class "C" concrete. Drop connections shall conform with Detail 5.03 – Drop Manhole or as shown on the Drawings. Drop connections shall be carefully backfilled to prevent dangerous side pressure.

Section 9.2 – Manhole Inverts

Manhole inverts shall be carefully constructed with cement grout, Class "B" concrete, or cement mortar brickwork; special care shall be taken to lay the channel and adjacent pipes to grade. Cement mortar shall be made of one (1) part cement and two (2) parts clean sharp sand. Channels shall be properly formed, rounded, and troweled smooth. The connections of the sewer with the wall and channel of the manhole shall be tight and smooth.

Section 9.3 – Manhole Steps

Manhole steps shall conform to Detail 5.01 – Standard Manhole. Steps for precast concrete manholes shall be installed along a vertical centerline, on approximately fourteen to sixteen inches (14" to 16") centers.

Section 9.4 – Future Sewer Connections

Where shown, a twelve inch (12") long pipe stub for future sewers, of such size as any be designated, shall be laid to proper grade and alignment and plugged with a factory plug with same type joint as used on the sewer pipe.

Section 9.5 – Manhole Frames and Covers

Manhole frames and covers shall be as shown on Detail 5.04 – Manhole Frame & Cover and as called for in the proposal and shall include setting to finished grade as required, and grouting in place.

Section 9.6 – Manhole Inflow Seal

A manhole inflow seal made of High-Density Polyethylene Copolymers shall be installed on all sanitary sewer manholes.

Section 9.7 – Frames and Chimney Seal

An internal frame and manhole chimney seal shall be installed on all manholes installed in areas that have potential for water infiltration through the frame and chimney section. The seal shall be removable and flexible see FlexRib by NPT, Inc or approved equal.

Chapter 10 – Connections to Existing Sewers

At location where new sewers are shown to be connected to existing sewers at a new manhole, the Contractor shall first expose the existing sewer and install a supporting timber beam with suitable straps around the pipe so as to bridge the excavation for the new manhole. The manhole shall then be constructed complete with invert and frame and cover. Under special conditions the Contractor may temporarily block and/or divert sewer flows to facilitate the construction operations. Actual physical connection of the sewer will be made at a later date, as directed. See Detail 5.12 – Doghouse Manhole for schematic drawing of installation.

Chapter 11 – Iron Castings

Castings shall be of gray-iron conforming to ASTM A48, *Standard Specification for Gray Iron Castings*, as amended to date. Manhole and step castings shall be as shown on Detail 5.01 – Standard Manhole unless otherwise specified. Castings shall be tough, close-grained and smooth, free from blow holes, blisters, shrinkage stains, cracks, cold shots and like defects. No plugging of defective castings will be permitted. Castings shall be made accurately to dimensions shown on the Drawings or ordered and shall be planned or ground where necessary, whether marked or not, to secure perfectly flat bearing surfaces. Allowance shall be made in the patterns so that the specified thickness or metal will not be reduced. No casting will be accepted, the weight of which is less than the theoretical weight, based on required dimensions, by more than five percent (5%).

Chapter 12 – Highway Crossings

The Contractor shall install pipe lines across highways in accordance with the applicable regulations of the State Highway Department and as shown on the Drawings. Permits for highway crossings will be obtained by the Owner. A copy of the permit shall be submitted to the City prior to construction.

Section 12.0 – Steel Pipe Casing

Steel pipe casing shall be manufactured from Steel conforming to ASTM A252 *Standard Specification for Welded and Seamless Steel Pipe* Grade 2, as amended to date, with a minimum yield strength of 35,000 psi before cold forming. Pipe may be straight seam or spiral weld. A protective coating will not be required. The diameter and wall thickness of steel pipe casing shall be as shown on the Drawings.

Section 12.1 – Installation of Steel Pipe Casing by Boring Method

Installation of steel pipe casing shall be by the dry boring method at locations shown on the Drawings. Installations of steel pipe casing shall be in accordance with the applicable regulations of the State Highway Department; the Detail Drawings and these Specifications. All excavation for pit and bore shall be unclassified.

12.10 The boring pit shall be solid sheeted, braced and shored as necessary to provide a safe operation. The Contractor shall take all precautions, and shall comply with all requirements as may be necessary to protect private or public property.

12.11 The Contractor shall set the boring rig so that, after the casing is completed and the sewer carrier pipe installed, the invert surface of the sewer shall conform accurately to the grades and alignment fixed or given by the Engineer.

12.12 The hole shall be bored and cased through the soil by a cutting head on a continuous auger mounted inside the casing pipe. The boring of the howl and installation of the casing pipe; shall be simultaneous. Lengths of casing pipe shall be fully welded to the prodding section in accordance with AWS recommended procedures.

12.13 After installation of the casing pipe is complete, the sewer carrier pipe shall be installed through the casing pipe as shown on the Detail Drawings.

Section 12.2 – Concrete Piers

Concrete piers for ductile iron pipe shall be constructed of Class "A" concrete, and shall be constructed as shown on Details 5.08.1-5.08.5 – Aerial Crossings. If rock is encountered, piers supporting pipe lines across streams shall be anchored into the rock, so as not to resist overturning during periods of flood stages in the stream. Holes not smaller than two and one-half inches (2½") in diameter by two feet (2') deep shall be drilled into the rock after excavation for the footing is complete; No. 6 reinforcing bars shall be embedded in grout made with high-early strength cement poured into the holes. In wet holes, grout shall be deposited with a tremie. Straight bars shall be used, and shall be bent over for anchorage after the concrete has attained its full strength. Where unusually poor soil conditions are encountered, the Engineer may direct that spread footings of concrete be constructed, or that pin piles be driven for support for piers.

Chapter 13 – Testing and Cleaning

Before acceptance of any sewer or systems of sewers, lines shall be cleaned and tested in accordance with these Specifications. Where any obstruction is met, the Contractor will be required to clean the sewers by means of rods, swabs, or other instruments. Lines and manholes shall be clean before final inspection. Pipe lines shall be straight and show a uniform grade between manholes. The Contractor shall be required to correct any variations therefrom which may be disclosed during the inspection.

Section 13.0 – Leakage Tests

All sewer lines, including in house service lines, shall be tested for leakage, in the presence of the Engineer or his representative, before being placed into service. Tests shall be conducted by one or a combination of the three methods listed herein.

13.00 Infiltration Test

Where natural ground water levels stand a minimum of two feet (2') above the top of the pipe, the amount of leakage may be determined form measurements made at the lower end of the sewer section under test. Sewers above the test section shall be closed before testing by the installation of suitable watertight bulkheads. The length of the test section shall be determined by the Engineer. The average of six readings at five-minute intervals will be used to determine the rate of infiltration for any one test section.

Table 6 - Allowable Infiltration

Size of Sewer	Gallons Per 24 Hours Per Foot of Sewer
8"	0.30
10"	0.38
12"	0.45
15"	0.57
18"	0.68
21"	0.80
24"	0.91
30"	1.14

13.01 Exfiltration Test

Where natural ground water levels do not stand two feet (2') above the top of the pipe, an exfiltration test shall be conducted on each section of sewer. The test shall be performed up to an average maximum hydrostatic head of ten feet (10'). The test shall be conducted in the following manner.

The ends of the pipe in the test section shall be closed with suitable watertight bulkheads. Inserted into each bulkhead at the top of the sewer pipe shall be a two-inch (2”) pipe nipple with an elbow. At the upper end of the test section a riser pipe shall be installed. The test section of the pipe shall be filled through the pipe connection in the lower

bulkhead which shall be fitted with a tight valve, until all air is exhausted and until water overflows the riser pipe at the upper end. Water may be introduced into the pipe twenty-four (24) hours prior to the test period to allow complete saturation. House service line, if installed, shall also be fitted with suitable bulkheads having provisions for the release of air while the test section is being filled with water.

During the test period, which shall extend over a period of thirty (30) minutes, water shall be introduced into the riser pipe from measured containers at such intervals as are necessary to maintain the water at the top of the riser pipe. The total volume of water added during the thirty (30) minute test period shall not exceed that shown for infiltration in Table 6.

13.02 Low-Pressure Air Test

Where sewer grades are such that preclude performance of the exfiltration test or at the Contractor's option, a low-pressure air test shall be conducted on each section of sewer after completion and before acceptance.

Prior to air testing, the section of sewer between manholes shall be thoroughly cleaned and wetted. Immediately after cleaning or while the pipe is water soaked, the sewer shall be tested with low-pressure air. At the Contractor's option sewers may be tested in lengths between manholes or in short sections (twenty-five feet (25') or less) using Air-Lock balls pulled through the line from manhole to manhole. Air shall be slowly supplied to the plugged sewer sections until internal air pressure reaches approximately four pounds per square inch (4.0 psi). After this pressure reached and the pressure allowed to stabilize approximately 2 to 5 minutes), the pressure may be reduced to 3.5 psi before starting the tests. If a drop of 1.0 psi or greater occurs during the test time the line is presumed to have failed the test, and the Contractor will be required to locate the failure, make necessary repairs and re-test the line. Minimum test time for various pipe sizes, in accordance with ASTM C828, *Standard Practice Test Method for Low-Pressure Air Test of Vitrified Clay Pipe* Lines, as amended to date, is shown in Table 7.

Table 7 - Minimum Test Times for Low-Pressure Air Test

Nominal Pipe Size (Inches)	T(time) Min/100 Feet
8	1.2
10	1.5
12	1.8
15	2.1
18	2.4
24	3.6
30	4.8

Required test equipment includes Air-Lock balls, braces, air hose, air source, timer, rotometer as applicable, cut-off valves, pressure reducing valve, 0-15 pressure gauge, 0-5 pressure gauge with gradations in 0.1 psi and accuracy of + 2%.

The Contractor shall keep records of all tests made. Copy of such records will be given to the Engineer or the Owner. Such records shall show date, line number and stations, operator and such other pertinent information as required by the Engineer.

The Contractor is cautioned to observe proper safety precautions in performance of the air testing. It is imperative that plugs be properly secured and that care be exercised in their removal. Every precaution shall be taken to avoid the possibility of over pressurizing the sewer line.

13.03 Repairs

All visible leaks shall be repaired regardless of whether infiltration, exfiltration or air test is within allowable limits. No sewer will be accepted until leakage tests demonstrate compliance with one of the above leakage test methods.

Section 13.1 – Manhole Vacuum Test

All new wastewater manholes shall be vacuum tested according to ASTM C1244-93 *Standard Test Methods for Concrete Sewer Manholes by the Negative Pressure (Vacuum) Test* after backfilling operations. The general procedure shall be as outlined in this section.

13.10 Manholes shall be prepared by plugging all lift holes and pipes entering the manhole. Care should be taken to securely brace all pipes and plugs to prevent being pulled into the manhole during the test.

13.11 The test head shall be placed on top of the manhole according to manufacture specifications and 10 inches of mercury be drawn down on the manhole.

13.12 The valve on the vacuum line shall be closed and valve pump shut off.

13.13 The inspector shall record the time that that it takes for the vacuum to drop to nine inches (9“) of mercury. The manhole will pass if the time required to drop from ten inches (10”) to nine inches (9”) of mercury exceeds the time shown in Table 8, adapted from ASTM C1244, *Standard Test Methods for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test*. If the drop occurs faster than the time below the manhole shall be repaired using approved methods and retested until a passing time is obtained.

Table 8 - Minimum Test times for Manhole Vacuum Test

Depth of Manhole (Feet)	Diameter of Manhole (Feet)			
	4	5	6	Time (Seconds)
0-8	20	26	33	
10	25	33	41	
12	30	39	49	
14	35	46	57	
16	40	52	67	
18	45	59	73	
20	50	65	81	
22	55	72	89	
24	59	78	97	
26	64	85	105	
28	69	91	121	
30	74	98	121	

Section 13.2 – Cleaning Up

Before the work is considered complete, all material not used, and rubbish of every character must be removed from the project. All streets, sidewalks, curbs, fences and other private or public facilities and structures disturbed must be in essentially as good condition as existed before the work was done. Any subsequent settlement of backfill or payment over trenches shall be replaced by the Contractor and the surfaces brought to grade.

Section 13.3 – Acceptance of Work

Sewer lines and appurtenances will not be considered ready for acceptance until all provisions of the Specifications have been complied with, until all tests have been satisfactorily completed, and until inspection of the lines has been made by the Engineer, and permission granted therefor.