

SECTION 9

SANITARY SEWERS

9.01 GENERAL.

A. Scope. This section covers the construction of all sanitary sewers, manholes, reinforced concrete sewer structures, and other related appurtenances.

B. General Construction Requirements. Pipelines shall be constructed using the type of pipe material specified in the Project Documents and meeting the requirements of these Standard Specifications. Pipes may be designated by their use.

Pipe shall be inspected before it is laid, and any defective or damaged lengths shall not be accepted. Pipe shall be laid in the finished trench to a true and uniform grade as shown in the Project Documents. Bedding shall conform to the requirements of Subsection 2.08. All pipes shall be laid with ends abutting and true to line and grade. Pipes shall be fitted and matched so that when laid together they will form a smooth and uniform invert.

When bell and spigot pipe is used, bell and spigot ends shall be carefully cleaned before pipes are lowered into the trenches. Construction of gravity sewers shall begin at the lower end with bell ends facing upstream, and with bell holes excavated as required.

The downstream end of new sewer extensions shall be plugged in a positive manner satisfactory to the Engineer until construction, cleaning, and testing are completed and the new construction is accepted by the Owner.

The Contractor shall take all precautions to ensure adequate trench ventilation and protection for workers installing the pipe.

C. Construction Loads. Construction loads on sewers and culverts may exceed the final design loads. The Contractor shall protect sewers and culverts from excessive loading due to the Contractor's construction activities and shall repair or replace any sewers or culverts so damaged.

9.02 CRITICAL AREAS FOR WORK.

A. "Critical Areas" are defined as the areas 500' landward for the City of Topeka, 1,000' landward for Shawnee County and 300' water side of the Kansas River and Soldier Creek Levees within the City of Topeka and Shawnee County. Construction activities within these areas must adhere to all applicable Army Corps of Engineers requirements for Federally protected levees and design and construction plans must be submitted to the Engineer for review by the Army Corps of Engineers. Army Corps of Engineers approval and permits are required for construction activities within this area.

B. All sanitary sewer within "Critical Areas" shall be made with Ductile Iron (DIP) or Polyvinyl Chloride (PVC) pipe. "Critical Areas" are defined as the area upon which curb and gutter or pavement is to be placed. The critical area for streets shall extend one foot on each side beyond the back of curb, edge of pavement, or edge of shoulder, whichever is greater. This requirement does not apply to areas outside the corporate limits of the City of Topeka.

9.03 SANITARY SEWERS

A. Materials. Sanitary sewer pipelines shall be one of the following types as indicated in the Project Documents:

- Ductile Iron Pipe (DIP),
- Polyvinyl Chloride Pipe (PVCP), or
- Fiber Glass Reinforced Polymer Pipe (FRP)

(1) Ductile Iron Pipe Materials. DIP may be “Push-on” or “Mechanical Joint” and shall conform to ANSI/AWWA C151/A21.51.

- i. General. Unless otherwise indicated in the Project Documents, required by trench load, or required by internal working pressure, all 4 inch DIP shall be Class 51 and all 6 inch and larger DIP shall be Class 50. Thickness design of DIP shall be in accordance with ANSI/AWWA C150/A21.50.
- ii. Mechanical Joint and Flanged Fittings. The requirements of ANSI/AWWA C110/A21.10 shall apply to all mechanical joint and flanges fittings.

Pipe and fittings for sanitary sewer service shall be lined with either Protecto 401 ceramic epoxy or polyethylene. The Protecto 401 or polyethylene lining on all pipe barrels and fittings shall be tested for pinholes with a nondestructive 2,500 volt test. Any defects found shall be repaired prior to shipment. The lining thickness shall be checked using a magnetic film thickness gauge. The thickness testing shall be done using the method outlined in SSPC-PA-2 Film Thickness Rating. The Contractor shall submit to the Engineer a manufacturer’s certificate or catalog cut showing that the pipe supplied complies with the specifications.

(1) Protecto 401 Ceramic Epoxy. The lining material shall be amine cured novalac epoxy containing at least 20% by volume of ceramic quartz pigment. Lining shall have a nominal dry film thickness of 40 mils. In no case shall the lining thickness be less than 30 mils.

(2) Polyethylene. The lining material shall be virgin polyethylene complying with ANSI/ASTM D 1248, shall be heat-bonded to the interior of the pipe or fitting, and shall have a nominal thickness of 40 mils. In no case shall the lining thickness be less than 30 mils.

iv. Mechanical Joint Pipe. All bolts, glands, and gaskets for mechanical joint pipe and fittings shall conform to ANSI/AWWA C111/A21.11.

v. Flanged Joints. Flanged joints shall conform to ANSI/AWWA C115/A21.15. Flanges shall be ductile iron, flat faced, and of solid construction. The use of hollow-back flanges will not be permitted. Flanged gaskets shall be neoprene, 1/8 inch thick, full-face type. Flange bolts shall conform to ASTM A307 with chamfered or rounded ends and shall project 1/4 to 1/2 inch beyond

the outer face of the nut. Nuts shall be hexagonal ANSI/ASME B18.2.2 heavy semi-finished pattern, conforming to ASTM A307.

vi. Encasing. Unless otherwise specified or indicated in the Project Documents, all buried ductile iron pipe and fittings shall be encased in seamless, 8 mil polyethylene tubes conforming to ANSI/AWWA C105/A21.5.

(2) Polyvinyl Chloride (PVC) Pipe Materials.

i. Pipes and Fittings. PVCP shall be made of PVC plastic having a cell classification of 12454-B or 12454-C as defined in ASTM D1784. PVCP and fittings shall meet the requirements tabulated in Table 6.04 A (3) i.

Table 6.04 A (3) i. – PVC Pipe and Fitting Material Requirements

Nominal Pipe Size	Specified Requirements of Pipes and Fittings
4" through 6"	ASTM D2665 (schedule 40 wall thickness)
8" through 15"	ASTM D3034 SDR 26
18" through 36"	ASTM F679 - PS 46

ii. Joints, Gaskets and Solvent Cement. PVCP push-on joints shall conform to ASTM D3212. PVCP gaskets shall conform to ASTM F477. Solvent cements for joining PVC pipe and socket-type fittings shall conform to ASTM D2564.

(3) Fiberglass Reinforced Polymer Pipe Materials.

i. Pipe. All fiber glass reinforced polymer pipe (FRP) shall meet the requirements of ASTM D3262 and AWWA C-950. Pipe shall have a minimum stiffness of 45.

ii. Joints. Pipe joints shall conform to the requirements of ASTM D4161. Gaskets shall conform to the requirements of ASTM F477.

iii. Couplings. Couplings shall conform to the requirements of ASTM D3567.

(4) Riser Pipes. Riser pipes shall be constructed of approved sewer pipe and fittings as shown in the Project Documents or as approved by the Engineer.

B. Construction Requirements. The full method of construction shall be observed and approved by the Engineer at the start of operations.

a. Protection of Water Supplies. Sewer lines constructed of DIP with polyethylene or Protecto 401 lining, PVCP or FRP may be constructed within 10 feet of a private water supply well provided a length of pipe is centered on the well. All other sewer lines must be at least 50 feet from a private water supply well.

Where a gravity sanitary sewer line is laid parallel with a water line, the horizontal distance between them shall be 10 feet, measured from edge of pipe to edge of pipe. The

sewer and the water line shall be laid in separate trenches with undisturbed earth between them.

Where sanitary sewer lines cross water lines, the sewer line shall be either DIP with a polyethylene or Protecto 401 lining, PVC-P or FRP. One 20-foot length of pipe shall be centered on the crossing, or, if a 20 foot length of pipe is not available, the sewer may be encased in concrete for 10 feet either side of the water line. Encasement shall be as shown on the Sanitary Sewer Standard Detail Sheet. Where the water line is at least 2 feet above the sewer, the requirements of this paragraph shall not apply.

- b. Trench Excavation. The Contractor shall excavate the bottom of the trench to the line, grade and elevation shown in the Project Documents beginning at the outlet end and proceeding toward the upper end. The excavation and the width of the trench shall be as specified in Subsection 2.02. If the sanitary sewer is being installed in a location where pavement is not otherwise planned for removal or replacement, pavement removal shall be as specified in Subsection 4.06.

The Contractor shall follow all OSHA safety regulations for all excavations and use shoring and bracing as required by Section 2.03. Shoring and bracing is subsidiary. Ground water shall be controlled as specified in Subsection 2.04. Trench stabilization shall be as specified in Subsection 2.05.

- c. Bedding. Bedding material shall be placed as specified in Subsection 2.08. Bedding material is subsidiary.

- d. Laying. The Contractor shall lay the pipe as specified in Subsection 9.01 and as per the manufacturer’s recommendations.

- i. Laying Ductile Iron Pipe. DIP shall be installed in accordance with the Project Documents. The Contractor has the option to use mechanical, push-on, or flanged joints, except that flanged joints are not permitted in any underground location.

(1) Mechanical Joints. The Contractor shall clean the inside of the bell and 8 inches of the spigot end of pipe and coat the ends with a soap solution (½ cup granulated soap per gallon of water) or other approved lubricant. The Contractor shall place the gland and rubber gasket on the spigot and seat the spigot in the bell. The Contractor shall press the gasket and gland into place, set bolts and initially tighten nuts by hand until further tightening by hand cannot be accomplished. Nuts shall be tightened on opposite sides of joint alternately. Final tightening of nuts shall be completed with torque limiting wrench set in accordance with the following table:

<u>Bolt Size (Inches)</u>	<u>Range of Torque (ft./lb.)</u>
5/8	40 - 60
¾	60 - 90
1	70 - 90
1¼	90 -120

(2) Push-on Joints. Construction of push on joints shall be in accordance with the recommendations of the manufacturer. Gaskets shall be placed on the pipe before the pipe is lowered into the trench.

(3) Flanged Joints. Flanged gaskets shall be placed and flanged pipes shall be joined in such a manner as to not damage either the flange facing or the gasket. Flanged pipe joints shall be cleaned, assembled and tightened with a torque wrench to the ranges specified for mechanical joints in Subsection 6.05 B (4).

(4) Encasement. Unless otherwise specified or indicated in the Project Documents, all buried DIP and fittings shall be encased in seamless, 8 mil polyethylene tubes. Ends of polyethylene tubing shall be overlapped at least 12 inches and shall be thoroughly sealed with polyethylene adhesive tape. All cuts, tears, punctures, or other damage to the polyethylene shall be repaired by the Contractor using approved polyethylene adhesive tape or with a short length of polyethylene sheet or tube cut open, wrapped around the pipe to cover the damaged area, and secured in place.

ii. Laying PVC (Polyvinyl Chloride) Pipe. PVCP shall be installed in accordance with ASTM D2321 and in accordance with the Project Documents. Installations of solvent weld joint pipe and fittings shall be made in accordance with ASTM F402.

iii. Laying Fiberglass Reinforced Polymer Pipe. FRP with resilient material joints shall be installed in accordance with the manufacturer's recommendations and in accordance with the Project Documents. All joints shall be wiped clean as the work progresses. Exposed ends of FRP shall be protected from damage and shall be plugged or covered to prevent entry of obstructing matter. Joints in FRP shall not be covered until inspected and approved by the Engineer.

iv. Service (Wye) Connections. The Contractor shall install wye fittings (SDR 26 fully gasketed) for service connections at the locations shown in the Project Documents and approved by the Engineer. Wyes shall be located a minimum distance of 5' from the outside face of manholes. Wyes for all types of pipe shall be installed as recommended by the manufacturer and approved by the Engineer. Concrete cradles will not be required under wyes when PVCP is used.

v. Riser Pipes. The Contractor shall install riser pipes at the locations shown in the Project Documents and as identified by the Engineer. Each riser pipe shall be plugged with an approved plugging device.

vi. House Service Lines. The Contractor shall construct house services lines as detailed in the Project Documents. Connections between new and old work shall be made by means of suitable adapters and/or in a manner satisfactory to the Engineer. Service line connections directly into manholes shall be prohibited, unless approved in advance by the Engineer.

vii. Abandonment of House Service Lines or Wye Connections. House service lines or wye connections to be abandoned shall be plugged at the property

line with an approved plugging device. Following installation of the plugging device, the plugged end of the service line shall be encased in concrete. The concrete encasement shall extend outward from the plugging device 4 to 6 inches in all directions. Abandoning house service lines or wye connections as specified above is subsidiary to other items of the Contract.

viii. Stubs and Plugs. Pipes designated in the Project Documents to be plugged for future connections shall be plugged to prevent infiltration, resist deterioration, and permit future reopening without substantial damage to the existing construction. All plugs shall be approved by the Engineer before backfilling.

Special fittings, discs, and other devices may be installed with the approval of the Engineer in accordance with the manufacturer's recommendations. Plugging of stubs and other pipes as specified above is subsidiary to other items of the Contract.

(5) Backfill and Compaction. Backfill and compaction shall be completed as specified in Subsections 2.09 and 2.10.

(6) Pavement Replacement. Unless otherwise indicated in the Project Documents, the Contractor shall replace pavement as specified in Subsection 4.06.

C. Cleaning, Testing and Acceptance of Sanitary Sewers.

(1) Cleaning. The Contractor is responsible for the cleaning of sanitary sewers and manholes. After installation of sewers is complete, including all backfill and compaction, the sewer shall be flushed clear of all foreign material. Flushing shall be completed in manner complying with the SWPPP and shall not contribute to soil erosion or water pollution.

All debris shall be removed from manholes immediately following the structure's construction. All lift holes shall be plugged with non-shrink grout prior to testing. Vacuum or hydrostatic testing of manholes is recommended prior to backfilling to assist in locating leaks. However, the final test and acceptance of manholes shall be based only on tests completed after the manholes are backfilled.

(2) Testing. Testing of manholes shall be subsidiary to the manhole and testing of gravity sewers shall be subsidiary to the sewer. Manhole and sanitary sewer testing shall be witnessed by the Engineer. The Contractor shall provide all labor, materials, tools, equipment, and incidentals required to complete testing of sanitary sewers and sanitary sewer manholes. After cleaning, the Contractor shall test sanitary sewers and manholes as follows:

i. Manhole Testing. All manholes shall be either vacuum or hydrostatically tested in the presence of the Engineer and in accordance with these procedures. Existing manholes or new manholes constructed over existing lines do not require testing. **If the seal on a new manhole is broken by an adjustment or other procedure, than a new vacuum test is required.** Manholes greater than 72" diameter may be tested hydrostatically at the request or approval of the Engineer.

(1) Vacuum Test. Plug all manhole entrances and exits, other than the manhole top access, by using suitably sized and rated pneumatic or mechanical pipeline plugs. Follow the manufacturer's recommendations and warnings for proper and safe installation of such plugs, taking care to securely brace the plugs and the pipe. Attach the vacuum test device to the manhole top and draw a vacuum to 10 inches of Mercury. With the valve at the vacuum line connection closed and the vacuum pump off, measure the time required for the vacuum to drop to 9 inches of Mercury. The manhole passes the test if the time is greater than 60 seconds for a 48-inch diameter manhole, 75 seconds for a 60 inch diameter manhole, and 90 seconds for a 72 inch diameter manhole. If the manhole fails the test, the Contractor shall locate the leak and make proper repairs to the interior of the manhole with non-shrink grout. The manhole shall be retested and repaired or replaced until acceptable test results are obtained.

(2) Hydrostatic Test. Manholes may be tested using internal or external hydrostatic pressure. External hydrostatic testing shall only be used where the groundwater level is at least 4 feet above the invert of the manhole. In all other cases, the internal hydrostatic test procedures must be followed. Sewers connected to the manhole shall be adequately plugged.

For the internal hydrostatic test, the manhole shall be filled with water to the top of the ring or to a maximum depth of 25 feet above the invert. Water gain or loss shall not exceed 1.14 gallons per day per vertical foot of manhole for either external or internal hydrostatic testing. Infiltration and exfiltration shall be determined after 24 hours of hydrostatic testing by determining the gain or loss of water in the manhole. Contractor shall be responsible for retrieving any plugs or material accidentally washed down a sewer.

ii. Deflection Testing. All flexible and semi-rigid pipes used for sanitary sewer lines shall be tested for deflection. The Mandrel Deflection Test is conducted by pulling the test device through a completed sewer run, from manhole to manhole. If the Mandrel gets caught in the pipeline and cannot be pulled through the line (manhole to manhole) in one straight pass, the line fails. Pipe through which the mandrel does not pass will be considered unacceptable, and shall be re-laid, and also re-tested.

Deflection shall not exceed 5% of the **average inside** diameter of the pipe for pipes up to and including 12 inch. For pipes over 12 inches in diameter, the allowable deflection shall not exceed 4% **of the nominal inside diameter**. The mandrel test shall not be performed within 30 days of pipe installation.

The mandrel shall be made of steel or other hard metallic, non-corrodible, nonpliable material and have non-adjustable legs. The mandrel shall: (1) be a rigid nonadjustable, odd number of legs (9 legs minimum), mandrel having an effective length not less than its **inside** diameter; and (2) be fabricated of steel or other hard metallic, non-corrodible, nonpliable material, fitted with pulling rings

at each end, stamped or engraved on some segment other than a runner indicating the pipe material specification nominal size and be furnished in a suitable carrying case labeled with the same data as stamped or engraved on the mandrel.

The mandrel shall be pulled through the pipe by hand. The Engineer may require the mandrel to be certified by an independent testing laboratory to insure that it meets dimensional requirements.

Nominal Pipe Size (inches)	Minimum Mandrel Diameter (inches)
6"	5.7"
8"	7.3"
10"	9.2"
12"	10.9"
12" +	Nominal Inside Diameter x 96%

iii. Gravity Sewer Line Testing. In addition to the visual inspection, the Contractor shall furnish all labor, tools and equipment necessary to perform low pressure air tests on all pipe installed under the contract, including laterals and service stubs. The methods and equipment used to make the test shall be approved by the Engineer before any testing is started. The Contractor shall, at their own expense, correct any excess leakage and repair any damage to the pipe or its appurtenances indicated by, or resulting from, the test. For the purpose of testing, a section of the sewer shall be considered as the length of sewer between successive manholes. Any section that fails the test shall be repaired and retested by the Contractor until the leakage is within the allowable limit.

(1) Low Pressure Air Test. This test method provides procedures for testing sewer lines using low-pressure air to prove the integrity of the installed material and the construction procedures. Tests shall conform to the requirements of this section, ASTM F 1417 and C 828. The section of pipe between successive manholes shall be sealed with suitable plugs.

This low-pressure air test may be dangerous to personnel if, through lack of understanding or carelessness, a line is over-pressurized, or plugs are installed or restrained improperly. No one shall be allowed in the manholes during the actual testing. All plugs shall be braced during the testing. Do not over-pressurize the line. Do not exceed 9.0 psig.

One of the plugs shall have an orifice through which to pass air into the section of pipe being tested. The air supply source (air compressor) shall have a 9 psig pressure relief valve. The air supply line shall have a positive on-off valve and suitable means for readily disconnecting it at

the control panel. A second orifice in the plug shall be used for constantly reading the internal pressure of the pipe. This orifice shall be continuously connected to a pressure gauge having a range of from 0 to 10 psi. The gauge shall have minimum divisions of 0.10 psi and shall have an accuracy of ± 0.04 psi.

The line under test shall be slowly pressurized to approximately 4 psi. Regulate the air supply so that the pressure is maintained between 3.5 and 4.0 psig for at least 2 minutes. The air temperature should stabilize in equilibrium with the temperature of the pipe walls. Disconnect the air supply and decrease the pressure to exactly 3.5 psi before starting the test. Determine the time required for the pressure to drop from 3.5 psi to 2.5 psi, and compare this interval to the required minimum holding time provided by the City of Topeka or Shawnee County to determine if the rate of air loss is within the allowable.

TABLE 1
Minimum Specified Time Required for a 1.0 psig pressure drop
for size and length of pipe indicated for $Q = 0.0015$

1 Pipe Dia (in.)	2 Minimum Time (min:sec)	3 Length for Minimum Time (ft)	4 Time for Longer Length (sec)	Specification Time for Length (L) Shown (min:sec)								
				100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft	450 ft	
4	3:46	597	.380 L	3:46	3:46	3:46	3:46	3:46	3:46	3:46	3:46	3:46
6	5:40	398	.854 L	5:40	5:40	5:40	5:40	5:40	5:40	5:40	5:42	6:24
8	7:34	298	1.520 L	7:34	7:34	7:34	7:34	7:36	8:52	10:08	11:24	
10	9:26	239	2.374 L	9:26	9:26	9:26	9:53	11:52	13:51	15:49	17:48	
12	11:20	199	3.418 L	11:20	11:20	11:24	14:15	17:05	19:56	22:47	25:38	
15	14:10	159	5.342 L	14:10	14:10	17:48	22:15	26:42	31:09	35:36	40:04	
18	17:00	133	7.692 L	17:00	19:13	25:38	32:03	38:27	44:52	51:16	57:41	
21	19:50	114	10.470 L	19:50	26:10	34:54	43:37	52:21	61:00	69:48	78:31	
24	22:40	99	13.674 L	22:47	34:11	45:34	56:58	68:22	79:46	91:10	102:33	
27	25:30	88	17.306 L	28:51	43:16	57:41	72:07	86:32	100:57	115:22	129:48	
30	28:20	80	21.366 L	35:37	53:25	71:13	89:02	106:50	124:38	142:26	160:15	
33	31:10	72	25.852 L	43:05	64:38	86:10	107:43	129:16	150:43	172:21	193:53	
36	34:00	66	30.768 L	51:17	76:55	102:34	128:12	153:50	179:29	205:07	230:46	

For pipes 36" diameter and larger, the Time for pressure drop can be calculated from the formula: $t_{(min)} = \text{Area} \times \text{Length} \times 0.072554023$

If the pressure drops 1.0 psig before the appropriate time has elapsed, the air loss rate shall be considered excessive and the pipe section has failed the test. For testing of long sections or sections of larger diameter pipes, or both, a timed-pressure drop of 0.5 psig shall be used in lieu of a 1.0 psig drop. It is not necessary to hold the test for the entire period of time when it is evident that the rate of air loss is zero or less than the allowable if authorized by the Engineer. Upon completion of the test, open the bleeder valve and allow all air to escape. Plugs should not be removed until air pressure in the test section has been reduced to atmospheric pressure.

TABLE 2
Minimum Specified Time Required for a 0.5 psig pressure drop
for size and length of pipe indicated for Q =0.0015

1 Pipe Dia (in.)	2 Minimum Time (min:sec)	3 Length for Minimum Time (ft)	4 Time for Longer Length (sec)	Specification Time for Length (L) Shown (min:sec)							
				100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft	450 ft
4	1:53	597	.190 L	1:53	1:53	1:53	1:53	1:53	1:53	1:53	1:53
6	2:50	398	.427 L	2:50	2:50	2:50	2:50	2:50	2:50	2:51	3:12
8	3:47	298	.760 L	3:47	3:47	3:47	3:47	3:48	4:26	5:04	5:42
10	4:43	239	1.187 L	4:43	4:43	4:43	4:57	5:56	6:55	7:54	8:54
12	5:40	199	1.709 L	5:40	5:20	5:42	7:08	8:33	9:58	11:24	12:50
15	7:05	159	2.671 L	7:05	7:05	8:54	11:08	13:21	15:35	17:48	20:02
18	8:30	133	3.846 L	8:30	9:37	12:49	16:01	19:14	22:26	25:38	28:51
21	9:55	114	5.235 L	9:55	13:05	17:27	21:49	26:11	30:32	34:54	39:16
24	11:20	99	6.837 L	11:24	17:57	22:48	28:30	34:11	39:53	45:35	51:17
27	12:45	88	8.653 L	14:25	21:38	28:51	36:04	43:16	50:30	57:42	64:54
30	14:10	80	10.683 L	17:48	26:43	35:37	44:31	53:25	62:19	71:13	80:07
33	15:35	72	12.926 L	21:33	32:19	43:56	53:52	64:38	75:24	86:10	96:57
36	17:00	66	15.384 L	25:39	38:28	51:17	64:06	76:55	89:44	102:34	115:23

For pipes 36" diameter and larger, the Time for pressure drop can be calculated from the formula: $t_{(min)} = \text{Area} \times \text{Length} \times 0.036277011$

iv. **Television Inspection.** After the sewer line has passed the air test, the City/County shall inspect the line with television equipment. The Contractor at no additional cost to the City/County shall repair all defects found by this inspection.

v. **Force Main Testing.** After the force main has been installed, anchored or blocked as specified, the pipe shall be filled with water and subjected to pressure and leakage tests.

All piping shall be tested by water pressure at not less than twice the maximum operating pressure or at 100 psig, whichever is greater, for a sufficient period to examine the pipeline for leakage, cracks, defects or other faults. Any leaks shall be repaired and tests repeated until all defects have been repaired.

After approval of repairs, the pressure shall be set at twice the maximum operating pressure or at 100 psig, whichever is greater, and maintained for a period of 3 hours with the total loss of water being measured. The amount of water allowed to be lost during this time shall comply with AWWA C600 for DIP and AWWA Manual M23 for PVC-P.

The test pressure shall be applied by a hand operated force pump, or other suitable device, with the pump taking suction from a reservoir of small enough volume so that the amount of water loss can be measured volumetrically.

The Contractor shall furnish all water necessary for filling the lines and for making the tests.

Any leaks which appear during the one-year warranty period shall be repaired at the expense of the Contractor.

vi. Tolerances The intent of the City Standard Specifications is that all sanitary sewer pipe be installed to the grade shown on the plan drawings. If ponding is identified, it is the contractor’s responsibility to prove that the ponding is within the tolerances outlined in the table below.

Pipe Size	Allowable Pooling Depth (in.)
8”-12”	¼”
18”-30”	½”
36”-48”	¾”
>48”	1”

D. Bid Items, Measurement and Payment.

(1) Bid Items:

- (*) **SANITARY SEWER** Unit: Lineal Foot (nearest 1 L.F.)
- (*) **SANITARY SEWER (DIP)** Unit: Lineal Foot (nearest 1 L.F.)
- (*) **SANITARY SEWER (PVCP)** Unit: Lineal Foot (nearest 1 L.F.)
- (*) **SANITARY SEWER (FRP)** Unit: Lineal Foot (nearest 1 L.F.)
- SERVICE (WYE) CONNECTION, (*)** Unit: Each
- (*) **RISER PIPE (TYPE)** Unit: Lineal Foot (nearest 1 L.F.)
- (*) **HOUSE SERVICE LINE (TYPE)** Unit: Lineal Foot (nearest 1 L.F.)

(*) - Diameter of pipe
 (TYPE) – DIP, PVCP or FRP

(2) Measurement. “(*) Sanitary Sewer”, “(*) Sanitary Sewer (DIP)”, “(*) Sanitary Sewer (PVCP)” and “(*): Sanitary Sewer (FRP)” for the various sizes of sanitary sewer pipes shall be measured as the horizontal distance from centerline of manhole to centerline of manhole measured to the nearest foot.

“Service (Wye) Connection, (*)” shall be measured per Each service (wye) of the various sizes installed.

“(*)” Riser Pipe (Type)” shall be measured as the length along the centerline of the riser, measured to the nearest foot for the various sizes and types of riser pipe installed.

“(*)” House Service Line” shall be measured as the horizontal distance, to the nearest foot, from the centerline of the main sewer to the end of the house service line for the various sizes and types of service line pipe installed.

(3) Payment. The completed and accepted lengths of Sanitary Sewers, measured as specified above, shall be paid for at the Contract unit price per foot for each of the various

sizes and types of Sanitary Sewers, which payment shall be full compensation for all excavation, shoring, bedding, pipe, joints, fittings, laying, materials, backfilling, cleaning and testing as specified; and for all materials, equipment, tools, labor, and incidentals necessary to complete the work.

The completed and accepted “Service (Wye) Connection, (*) inch”, measured as provided above, shall be paid for made at the Contract unit price per Each for each of the various sizes of Service Wyes, which payment shall be full compensation for all equipment, tools, labor, and incidentals necessary to complete the work as specified.

The completed and accepted “(*) inch Riser Pipe (Type)”, measured as provided above, shall be paid for made at the Contract unit price per foot for each of the various sizes and types of Riser Pipes, which payment shall be full compensation for all equipment, tools, labor, and incidentals necessary to complete the work as specified.

The completed and accepted “(*) inch House Service Line (Type)”, measured as provided above, shall be paid for made at the Contract unit price per foot for each of the various sizes and types of House Service Lines, which payment shall be full compensation for all materials, equipment, tools, labor, and incidentals necessary to complete the work as specified. If Rock Excavation as defined in Subsection 3.06 is required to install "House Service Line", that rock excavation shall be measured and paid for as defined in Subsection 3.06.

9.04 Encasements, Cradles, and Arches. The Contractor shall construct concrete encasements, cradles and arches at the locations, to the dimensions, and to the requirements shown in the Project Documents or as determined by the Engineer. Concrete shall be Commercial Grade meeting the requirements set forth in Subsection 5.01.

A. Bid Items, Measurement and Payment.

(1) Bid Items.

CONCRETE ENCASEMENT FOR (*)" PIPE Unit: Lineal Foot (nearest 1 L.F.)

CONCRETE CRADLE FOR (*)" PIPE Unit: Lineal Foot (nearest 1 L.F.)

CONCRETE ARCH FOR (*)" PIPE Unit: Lineal Foot (nearest 1 L.F.)

(2) Measurement. Concrete Encasements, Cradles, and Arches for the various sizes of storm or sanitary sewer pipes shall be measured as the length, to the nearest foot, of the cradle, arch or encasement along the centerline of the pipe.

(3) Payment. Completed and accepted Concrete Encasements, Cradles, and Arches for the various sizes of storm or sanitary sewer pipes shall be paid for at their respective Contract unit prices, which payment shall be full compensation for all materials, equipment, tools, labor, and incidentals necessary to complete the work as specified.

9.05 MANHOLES

A. Materials

(1) Precast Reinforced Concrete Manholes, Risers and Tops. Materials for circular vertical precast reinforced concrete manholes, risers and tops shall conform to the applicable requirements of ASTM C478. The minimum shell thickness shall be as follows.

<u>Depth</u>	<u>Minimum Shell Thickness</u>
0 to 16 feet	One twelfth internal shell diameter
16 feet or greater	One twelfth internal shell diameter plus one inch

(2) Precast Reinforced Concrete Structures, Risers and Tops. Materials for precast reinforced concrete structures, risers and tops and circular precast reinforced concrete manholes, shall conform to the requirements of ASTM C913.

(3) Concrete. Cast-in- place or pre-cast manholes and the cast-in-place or pre-cast concrete bases of pre-cast manholes shall be constructed of Structure Class Concrete as specified in Subsections 5.01 and 5.04. At locations specified in the plans, an anti-bacterial admixture Con-Shield or an approved equal shall be used in the concrete for casting manholes designated in the project plans. The anti-bacterial admixture shall also be used in the construction of the manhole invert. The Anti-Bacterial admixture shall include a color tint as visual proof of the admixtures' presence.

(4) Reinforcing Steel. Shall meet the requirements of the Project Documents specified in Subsection 5.03.

(5) Structural Steel. Carbon structural steel shapes, plates, and bars used in manholes and inlets shall conform to the requirements of ASTM A36.

(6) Joint Sealants for Precast Manholes and Inlets. Preformed mastic used shall conform to the requirements of AASHTO M 198 and must be pre-approved by the Engineer.

(7) Non-shrink Grout. Grout shall be Five Star by U.S. Grout Corporation or an approved equal. Grout shall not be a gas liberating type but shall be non-metallic and non-corrosive.

(8) Resilient Connectors. A flexible pipe to manhole connector shall be used whenever a sanitary sewer pipe penetrates into a concrete manhole or structure and shall be of the two types specified in Paragraphs a and b below:

i. Type Cast Into Manhole Wall At The Manufacturing Facility. The connector shall be the A•LOK X-CEL as manufactured by A•LOK PRODUCTS, INC., Tullytown, PA or approved equal. The connector shall be molded from materials with physical/chemical properties that meet or exceed the physical/chemical resistant properties and performance requirements outlined in ASTM C923.

The Z•LOK pipe to manhole connector as manufactured by A•LOK PRODUCTS, INC., Tullytown, PA or an equal product may be used with approval of the Engineer.

ii. Pipe To Manhole Connector For Penetrations Into Existing Concrete Manholes And Structures. The connector shall be the G3 Boot System featuring component packaging as manufactured by A•LOK PRODUCTS, INC., Tullytown, PA or approved equal.

The connector shall be made from materials that conforms to the physical and chemical requirements outlined in Section 4, “Materials and Manufacture” of ASTM C923 “Standard Specifications for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals”, and the overall design will meet or exceed Section 7, “Test Methods and Requirements” of ASTM C923.

(9) Iron Castings.

i. Governing Standard. Except as modified or supplemented herein, all castings furnished shall conform to the requirements of ASTM A48, Class 35B or higher.

ii. Acceptable Products. Castings shall be the product of Clay & Bailey, Deeter, Neenah, or an approved equal.

iii. Submittals.

(1) Cast Test Bars. Cast test bars shall be delivered to the site with the castings. Laboratory verification of chemistry, Brinell Hardness, or tensile strength will be required at the Engineer's request and shall be delivered within two weeks of request at no additional cost.

(2) Certificate of Insurance. The casting manufacturer shall purchase and maintain product liability insurance in the amount of \$3,000,000.00. Prior to delivery of castings, the Contractor shall deliver to the Engineer the manufacturer's properly completed certificate of insurance.

iv. Marking. All castings shall have the manufacturer's name and Julian heat date legibly cast thereon. Indistinct markings shall be grounds for rejection of individual castings. All castings of foreign origin must comply with current U.S. Customs marking regulations.

(1) Sanitary Sewers. The designation “CITY OF TOPEKA SANITARY SEWER” shall be cast in 2-1/2 inch high block letters flush with the traffic surface on all manhole covers intended for wastewater use. Letters shall be arranged around the circumference of the cover. A surface pick slot and concealed pick slots shall be manufactured into the lid.

v. Dimensions and Weight. All castings shall conform to the dimensions and weights indicated in the Project Documents. Dimensions shall not deviate more than 1/16 inch per foot. Surfaces of lids or covers shall not vary more than 1/16 inch above or below surfaces of accompanying frames or rings when properly seated. The weight of individual castings shall not vary by more than 4 percent from that specified.

vi. Minimum Tensile Strength. The tensile strength of each casting provided under this specification shall be at least 30,000 psi.

vii. Workmanship. All castings shall be manufactured true to pattern. Compatibility and fit of component parts shall be subject to inspection and acceptance or rejection. Castings shall be free of defects, to include but not necessarily limited to, blow holes, sand inclusions, cracks, distortion, and/or deviations from specified or indicated dimensions. All castings shall be furnished in bare metal.

viii. Compliance with U.S. Customs Regulations. All castings imported into the United States shall conform to the applicable provisions of United States Customs regulations.

ix. Interchangeability. Manhole frames and covers shall be manufactured so as to be fully interchangeable. All of the covers provided shall be suitable for installation on any of the frames provided and shall not rock or tip under an applied load.

x. Drops for Manholes. Generally, drops shall be placed inside the manhole for new manholes. However, the Engineer shall have the authority to approve an drop outside on a case-by-case basis. All drops shall provide for access to CCTV inspection from manhole to manhole. Fasteners for inside drops shall be 3/8" stainless steel fasteners. Straps shall be 1-1/2" wide, 11 gauge (.1196") stainless steel. Pinch bolt and nuts shall be 3/8" diameter, Type 18-8 stainless steel. The inside drop system by Reliner/Duran Inc. has been approved for use in drop manholes. Other systems may be used as approved by the Engineer. The Contractor shall submit catalog cuts to the Engineer to obtain approval of systems used as inside drops in manholes or inlets.

B. Construction Requirements

(1) Excavation and Subgrade Preparation. The Contractor shall provide excavation and subgrade for manholes as specified for structures in Section 2. The Contractor shall obtain the Engineers approval of the excavation and subgrade prior to constructing manholes.

(2) Precast Reinforced Concrete Manholes.

i. General. Pre-cast manholes shall be constructed in accordance with the Project Documents. The Contractor shall handle the pre-cast sections with care to avoid damage to joint ends of each section. Damaged sections may be subject

to rejection at the discretion of the Engineer. All manhole construction shall be watertight. The invert and walls shall be cleaned of excess grout and laitance.

ii. Concentric and Eccentric Manholes. Precast Reinforced Concrete Manholes shall be constructed in sections. Precast reducer cone sections for 4'-0" diameter manholes shall be of the concentric type. Manholes of 5'-0" and larger diameter may have cones or concrete flattop lids of the eccentric type. Where eccentric types are used in pavements, the top section shall be rotated so that the lid is not in a wheel path or curb line.

iii. Joints. All joints shall be set and sealed with an approved preformed mastic sealant. Two rings of preformed mastic sealant must be used for the joint between the manhole concrete and the cast iron ring.

iv. Base & Invert. Cast-in-place or pre-cast concrete bases shall be constructed as detailed in the Project Documents. Invert channels shall be smooth and shall conform to adjacent sewer sections as detailed in the Project documents.

v. Lifting Holes. Lifting holes shall be filled and sealed with non-shrink grout or concrete.

(3) Cast-in-Place Concrete Manholes and Special Structures. Forms, mixing and placing of concrete, placing of reinforcing, finishing and curing shall conform to the requirements for Structure Class Concrete as specified in Section 5. Invert channels shall be smooth and shall conform to adjacent sewer sections as detailed in the Project documents.

(4) Sewer Pipe Connections. All sanitary sewer pipe connections to manholes shall be flexible, unless approved by the Engineer. All connections shall be made carefully to prevent leakage and breakage of the pipe.

i) Rigid connections shall be made using concrete or grout to fill the annular space around the pipe in manhole walls. A clamp-on resilient connector shall be installed on the pipe prior to being grouted into wall. Pipes shall be encased with concrete as shown on the Standard Detail Drawing. Concrete used in concrete collars shall cure for a minimum of 48 hours unless otherwise directed by the Engineer.

ii) Flexible connections shall allow for limited differential settlement to occur between the pipe and manhole. The uniform compaction of the bedding material under the pipe and up to the springline of the pipe is essential to the control of this differential settlement. Cast-in-place resilient connectors shall be used with all flexible connections. To ensure a flexible watertight connection, no mortar shall be placed around the connector on the outside of the structure or around the top half of the connector on the inside when completing the invert work.

(5) Inside Drops for manholes shall be constructed as detailed on the Standard Manhole

Details Drawing. Stainless steel straps shall be secured to the structure wall with 3/8” stainless steel fasteners at 4 ft. intervals (minimum of 2).

- (6) Backfill and Compaction. The Contractor shall backfill and compact backfill for manholes as specified for structures in Section 2.09 and 2.10. The Contractor shall obtain the Engineers approval prior to backfilling around manholes.
- (7) Cast Iron. Castings shall be installed at the locations and to the requirements shown in the Project Documents. Castings shall be true to line and grade and match the structures to which they are attached. Castings shall be installed in the structures in accordance with the manufacturer’s instructions and requirements.

Manhole Castings shall be sealed with two rings of preformed mastic sealant. In situations where the exterior walls of the manhole will be exposed to weather, the manhole casting shall be bolted to the precast cone section or flat slab top using 5/8 inch diameter galvanized bolts and threaded inserts in the concrete.

- (8) Leveling and Adjusting Manhole Rings, Frames and Covers. When either new manholes or existing manholes are in areas to be paved or re-graded, manhole frames shall be set such that it will be flush with, and at the same slope of as, the new pavement. For new manholes, all leveling or adjustment to pavement slopes shall be accomplished with a concrete leveling course at the top of the top slab on Type II manholes and at the top of the cone on Type I manholes. Where the ring of an existing manhole is being adjusted, the concrete leveling course may be constructed immediately below the frame. Bitumastic shall not be used for leveling or adjusting the slope of manhole rings.

Manholes and valve castings located in a traffic lane shall be adjusted to meet the grade and slope of the adjacent pavement within a tolerance limit of 1/8± inch. The tolerance shall be measured as the vertical distance between a 10-foot straight edge, centered over the manhole or valve casting in both the longitudinal and transverse directions, and the top of the manhole or valve casting.

- (9) Manhole Testing. Requirements for the testing of sanitary sewer manholes are specified in Subsection 9.03 C.

C. Bid Items, Measurement, and Payment.

- (1) Bid Items:

(*) FT. DIA. STANDARD MANHOLE, TYPE (**)	(0’-6’)	Unit: Each
(*) FT. DIA. ADDITIONAL DEPTH FOR STD. MANHOLE, TYPE (**)		Unit: Vertical Foot (nearest 0.1 V.F.)
INSIDE DROP FOR MANHOLE		Unit: Each
SPECIAL STRUCTURE		Unit: Each
ADJUST EXISTING (MANHOLE OR VALVE) COVER		Unit: Each

(*) -- Diameter of the Manhole in feet

(**) -- Type I, Type II, or other Type as designated in the Project Documents

(2) Measurement.

- i. Manholes. Manholes shall be measured per Each of the various sizes and types of inlets and manholes installed.
- ii. Additional Depth. If a manhole has a depth dimension greater than 6.0 feet, it shall be measured per Each as stated above and the portion of the structure's "Additional Depth" or depth in excess of 6.0 feet measured to the nearest 0.1 Vertical Foot.

"Depth" for the various types of structures is defined as follows:

- Manholes – Top of cover frame to invert of lowest pipe

- iii. Special Structures and Inside Drops for Manholes. "Special Structure" and "Inside Drop for Manhole" shall be measured per Each of the items installed.
- iv. Adjust Existing (Manhole or Valve) Cover. Each existing manhole or valve frame and cover that is adjusted to grade and/or slope shall be measured per Each adjusted.

- (3) Payment. Completed and accepted manholes, inside drops, special structures, and the regrading of existing manhole covers, measured as provided for above, shall be paid for at the Contract unit price per Each for the various sizes and types of items listed, which payment shall be full compensation for all excavation, backfill, shoring, sheeting, dewatering, concrete, masonry, castings, reinforcement, steps, mortar, grout, castings, connectors, and cleaning as specified; and for all materials, equipment, tools, labor, and incidentals necessary to complete the work.

The completed and accepted "Additional Depth" for manholes, measured as provided above, shall be paid for made at the Contract unit price per vertical foot of depth greater than 6.0 feet for each of the various sizes and types manholes, which payment shall be full compensation for all excavation, shoring, installation, forming, reinforcing, castings, connectors, backfilling and cleaning as specified; and all materials equipment, tools, labor, and incidentals necessary to complete the work.

9.06 CONNECTION TO EXISTING STRUCTURES

- A. Materials. Materials for the connection of pipes to existing structures shall meet the requirements specified in Subsection 9.03 B.
- B. Construction Requirements. Connection to Existing Structures shall be done in such a manner as to prevent damage to existing structures. An opening for installation of pipe shall be cut to a diameter approximately 4 inches larger than the outside diameter of the pipe to be installed. New invert channels shall be constructed as needed to conform to the standard details.

- (1) Rigid Connections. A clamp-on resilient connector shall be installed on pipe prior to being grouted into wall. Annular space around the pipe shall be filled solid with grout.
- (2) Flexible Connections. A flexible pipe to manhole connector shall be used for sanitary pipe penetrations into existing concrete manholes and structures. The seal between the connector and the manhole wall shall be made by placing the connector and expansion ring into the center third of the concrete opening. The band is then expanded and locked by utilization of torque wrench or porta-power unit to transmit the force required to seal the rubber connector against the concrete.

The connector shall be of size specifically designed for the pipe material being used and shall be installed in accordance with recommendations of the manufacturer.

C. Bid Item, Measurement and Payment.

- (1) Bid Item:

CONNECTION TO EXISTING STRUCTURE

Unit: Each

- (2) Measurement. Will be for each connection to an existing structure.
- (3) Payment. Completed and accepted "Connect to Existing Structure" shall be paid for at the Contract unit price per Each connection of a sewer pipe to an existing structure, which price shall include all excavation, cutting, connecting, rebuilding of invert, grouting, backfilling, and compacting as specified; and all materials equipment, tools, labor, and incidentals necessary to complete the work.

9.07 IN-SITU REHABILITATION OF EXISTING SANITARY SEWER PIPE

A. GENERAL

The Contractor shall furnish all material, tools, equipment and labor necessary to rehabilitate the existing pipeline at the locations shown in the Drawings, as detailed and in conformance with the Specifications.

- a) The Cured in Place Pipe (CIPP) shall be continuous and jointless from manhole to manhole or access point to access point and shall be free of all defects that will affect the long-term life and operation of the pipe.
- b) The CIPP shall fit sufficiently tight within the existing pipe so as to not leak at the manholes, at the service connections or through the wall of the installed pipe. If leakage occurs at the manholes or the service connections the Contractor shall seal these areas to stop all leakage using a material compatible with the CIPP as directed by the Engineer. If leakage occurs through the wall of the pipe the liner shall be repaired or removed as recommended by the CIPP manufacturer. Final approval of the liner installation will be based on a leak tight pipe.
- c) The CIPP shall be designed for a life of 50 years or greater.
- d) Where specified in the contract documents, the installed CIPP shall be a structurally designed pipe within a pipe, meet or exceed all contract specified physical properties, fitting tightly within the existing pipe all within the tolerances specified. The installed CIPP shall withstand all

applicable surcharge loads (soil overburden, live loads, etc.) and external hydrostatic (groundwater) pressure, if present, for each specific installation location.

- e) The installed CIPP shall have a long term (50 year) corrosion resistance to the typical chemicals found in domestic sewage.
- f) All existing and confirmed active service connections and any other service laterals to be reinstated as directed by the Owner shall be re-opened robotically or by hand in the case of man-entry size piping, to their original shape and to 95% of their original capacity. All over-cut service connections will be properly repaired to meet the requirements of these specifications.
- g) All materials furnished shall be marked with detailed product information, stored in a manner specified by the manufacturer, and tested.

B. APPLICABLE STANDARDS

- a) Specifications of the following listed standards will be referred to hereinafter by standards abbreviation and specification number which shall include the latest revision thereof.
 - 1. ASTM - American Society for Testing and Materials.
 - 2. ACI - American Concrete Institute
 - 3. NACE - National Association of Corrosion Engineers
 - 4. SSPC - Society of Protective Coatings

C. SUBMITTALS

A. Pipeline Rehabilitation

- 1. Technical data sheet on each product used, including applicable ASTM test results indicating the product conforms to and is suitable for its intended use per these specifications.
- 2. Manufacturer's product data, including physical properties, results of applicable ASTM tests for the material supplied, and requirements for installation, curing and field quality control.
- 3. Manufacturer Qualifications: Submit a list of a minimum of 10 successful similarly sized pipeline rehabilitation projects completed during the past 3 years.
- 4. Installation Contractor Qualifications:
 - a. Manufacturer certification that installer has been trained and approved by manufacturer in the preparation, handling and installation of specified products, if applicable.
 - b. List of recently completed successful similarly sized pipeline rehabilitation projects, including project name and location, names of owner and engineer, and description of products used, and installation procedures.
 - c. Proof of any necessary federal, state or local permits or licenses necessary for the project.
 - d. For a Product to be considered Commercially Proven, a minimum of 1,000,000 linear feet or 4,000 manhole-to-manhole line sections of successful wastewater collection system installations in the U.S. must be documented to the satisfaction of the Owner to assure commercial viability.
 - e. For an Installer to be considered as Commercially Proven, the Installer must satisfy all insurance, financial, and bonding requirements of the Owner, and must have had at least 3 (three) years active experience in the commercial installation. In addition, the Installer must have successfully installed at least 1,000,000 feet of the same product bid in wastewater collection systems and a minimum of 500,000 feet of the product bid in 8-inch or larger sizes in wastewater collection systems. Acceptable documentation

- of these minimum installations must be submitted to the Owner.
- f. Field Supervisor/Foreman: Minimum five (5) years as a foreman/superintendent for a cured-in-place lining crew (installing actual product included with this bid/project), and a minimum of 300,000 linear feet of cured-in-place lining, diameters up to, and including, thirty-six (36) inch diameter. A minimum of five (5) years as a foreman/superintendent for a cured-in-place lining crew, a minimum of 50,000 linear feet of cured-in-place lining of twenty-four (24) inch or greater diameter, installed under his/her supervision. Such experience shall include the actual product, by trade name, Installer proposes to install.
 - g. The rehabilitation manufacturing process shall operate under a quality management system which is third-party certified to ISO 9000 or other recognized organization standards. Proof of certification shall be required for approval.
 - h. The Contractor performing the rehabilitation work shall be fully qualified, experienced and equipped to complete this work expeditiously and in a manner that fulfills all requirements of this Contract.
 - i. The Contractor shall have not less than five (5) years' experience in the last five years within the United States in complete CIPP rehabilitation of sanitary sewer systems using the methods indicated in these specifications.
 - j. For a product and installer to be Commercially Proven, the installer must own and operate a legally permitted permanent facility to impregnate the CIPP tubes. To ensure the Owner all installed products will meet the minimum product quality control standards set forth by the manufacturer, all CIPP liners shall be impregnated by the approved product's licensed installer that is performing the work. No pre-impregnated CIPP products will be accepted from a third-party vendor. Provide a copy of your permits for this facility with the bid.
 - k. Within seven (7) days after the Bid Letting, the Contractor shall submit to the Owner, for review and approval prior to award of the Contract, resumes of the personnel to be performing the work, including those personnel to be performing the installation of the CIPP liner, to determine if the Contractor is responsible for meeting the requirements of the work. The Owner has the right to reject the use of personnel that, in the opinion of the Owner, do not have adequate or relevant experience installing CIPP Liner systems in sewer mains of similar diameters as those being rehabilitated as part of the project. Failure to provide the required experience may be grounds for rejection of the bid at the discretion of the Owner.
- 5. Manufacturer's design analysis.
 - 6. Additional submittal requirements related to the grouting operation as specified herein.
 - 7. Design details for any additional ancillary systems and equipment to be used in site and surface preparation and testing.

D. WARRANTY

- a) The materials used for the project shall be certified by the manufacturer for the specified purpose. The manufacturer shall warrant the liner to be free from defects in raw materials for three (3) years from the date of installation and acceptance by the Owner. The Contractor shall warrant the liner installation for a period of three (3) years. During the Contractor warranty period any defect, which may materially affect the integrity, strength, function and/or operation of the pipe, shall be repaired at the Contractor's expense in accordance with manufacturer's recommended procedures.
- b) After a pipe section has been lined and for a period of time up to three (3) years following completion of the project, the Owner may inspect all or portions of the lined system. The specific locations will be selected at random by the Owner and will include all sizes of CIPP from this project. If it is found that any of the CIPP has developed abnormalities

since the time of "Post Construction Television Inspection," the abnormalities shall be repaired and/or replaced according to the manufacturer's recommended procedures. If, after inspection of a portion of the lined system under the contract, problems are found, the Owner may televise all the CIPP installed on the contract. All verified defects shall be repaired and/or replaced by the Contractor and shall be performed in accordance with the manufacturer's recommended procedures and per the original specifications, all at no additional cost to the Owner.

E. CONSTRUCTION REQUIREMENTS

I.) BYPASS PUMPING

- a) Where flow control is required to perform a specified repair or replacement operation, plugging or blocking shall be used wherever possible.
- b) If plugging or blocking is not feasible or at the Contractor's discretion, Contractor shall provide the necessary pumps and temporary piping and associated accessories as required for pumping of wastewater around areas of construction so as to not impede the collection and treatment of the wastewater. Backup pumping capability will be required.
- c) The design, installation, and operation of the temporary pumping system shall be the Contractor's responsibility. The temporary pumping system shall comply with the requirements of all codes and regulatory agencies having jurisdiction. Contractor shall be responsible for any spillage of raw sewage that results in civil or criminal charges from any local, state, or federal agency and will bear all costs for these charges and any restoration required.
- d) It is essential to the operation of the existing sewerage system that there be no interruption in the flow of sewage throughout the duration of the Project. Contractor shall provide, maintain, and operate all temporary facilities such as plugs, pumping equipment (both primary and backup units as required), conduits, all necessary power or fuel source, and all other labor and equipment necessary to handle the sewage by-pass flow.
- e) Contractor shall maintain sewage flow around the work area in a manner that will not cause surcharging of sewers, damage to sewers, and that will protect public and private property from damage and flooding.
- f) Contractor shall protect water resources, wetlands, and other natural resources.
- g) Contractor shall insure that the flow diversion pumping system is properly operated and maintained and shall provide responsible personnel to oversee the diversion pumping system at all times.
- h) Work shall be so scheduled and timed as to cause the least possible interference with the operation of the existing sewer collection and treatment system.
- i) Sewage and water contaminated with sewage shall be conveyed to sanitary sewers.

II.) CURED IN-PLACE PIPE

A. The cured-in-place liner system shall incorporate a resin-impregnated non-woven felt tube installed by inversion and expanded and cured by circulation of heated water or through the use of steam and air pressure (Insituform or SAK or pre-approved equal).

B. Resin-impregnated tube

1. Tube. The sewn tube shall consist of one or more layers of absorbent non-woven felt fabric and meet the requirements of ASTM F 1216 or ASTM F 1743, Section 5. The tube shall be constructed to withstand installation pressures, have sufficient strength to bridge missing pipe, and stretch to fit irregular pipe sections.

2. The wet out tube shall have a uniform thickness that when compressed at installation pressures will meet or exceed the design thickness.
3. The tube shall be sewn to a size that when installed will tightly fit the internal circumference and length of the original pipe. Allowance should be made for circumferential stretching during inversion. Overlapping layers of felt in longitudinal seams that cause lumps in the final product shall not be utilized.
4. The outside layer of the tube (before wet out) shall be coated with an impermeable flexible membrane that will contain the resin and facilitate monitoring of resin saturation during the resin impregnation (wet out) procedure.
5. The tube shall be homogeneous across the entire wall thickness containing no intermediate or encapsulated elastomeric layers. No material shall be included in the tube that may cause delamination in the cured CIPP. No dry or unsaturated layers shall be evident.
6. The wall color of the interior pipe surface of CIPP after installation shall be a light reflective color so that a clear detailed examination with closed circuit television equipment may be made.
7. Seams in the tube shall be stronger than the non-seamed felt.
8. The resin system shall be a corrosion resistant polyester, vinyl ester, or epoxy and catalyst system that when properly cured within the tube composite meets the requirements of ASTM F 1216 and ASTM F 1743, the physical properties herein, and those which are to be utilized in the design of the CIPP for this project.
9. The resin shall be a different color from the tube to allow for visual identification of areas of the tube that have or have not been wet out. The color of the resin shall be changed by the addition of dye or pigmentation.
10. The CIPP shall be designed as per ASTM F 1216, Appendix X.1. The CIPP design shall assume no bonding to the original pipe wall. The design safety factor shall be 2.0. The CIPP shall meet the chemical resistance requirements of ASTM F 1216, Appendix X2.
11. For the design of the CIPP system, the following assumptions shall be made. The host pipe should be considered fully deteriorated, and the CIPP liner shall be designed as a fully structural pipe-within-a-pipe. The live load on the pipe should include traffic loading. The ground water table shall be assumed to be at the ground surface.
12. If the bituminous coating on the inside of the existing pipe will inhibit the cure of the CIPP, a preliner shall be used. The preliner shall act as a barrier between the bituminous coating on the pipe wall and the new CIPP. The preliner shall cover the full circumference of the pipe and extend its full length. It shall remain in place during the installation of the CIPP without tearing and shall be able to withstand the curing temperature without melting. Information on the preliner shall be submitted to the Engineer prior to installing the lining.
13. Resin-impregnated tube system shall be as manufactured by Insituform Technologies, Memphis, TN; Inliner Technologies, Paoli, IN; National Liner, Houston, TX; Spiniello Companies, Morristown, NJ; Pipenology, LLC, O'Fallon, MO or pre-approved equal.
14. The cured pipe material shall conform to the structural properties, as listed below.

CIPP Minimum Physical Properties

Property	Test Method	Cured Composite	
		min. per ASTM F 1216	(400,000) psi Resin
Modulus of Elasticity	ASTM D 790 (Short Term)	250,000 psi	400,000 psi
Flexural Stress	ASTM D 790	4,500 psi	4,500 psi

a. The required structural CIPP wall thickness shall be based, as a minimum, on the above physical properties in accordance with the Design Equations in Appendix X.1 of ASTM F 1216 and the following minimum design parameters:

b.

Minimum Design Parameters

Design Safety Factor	2
Flexural Modulus to be Used in Design Ovality (to be verified by preinstallation video tapes)	50%
Groundwater Depth (above invert)	(varies, assume at ground surface elev.) ft.
Soil Depth (above crown, see plans for depth information)	(varies) ft.
Soil Modulus	700 psi
Soil Density	120 pcf
Live Load	H20 Highway
Design Condition	Fully Deteriorated

c. The Contractor shall provide calculations for the thickness of the CIPP liner which show compliance with the minimum design parameters outlined above. The Engineer shall be the sole judge as to the percent ovality. Percent ovalities in excess of 10% will require a point repair prior to installing CIPP. Where it is determined that a thickened tube/bag is required, the Contractor shall provide a thicker tube at no additional cost to the Owner or Engineer.

d. The soil depth varies for each section of pipe and can be estimated from the profile data provided in the plans. CIPP design shall be based on the actual soil depth.

e. Any layers of the tube that are not saturated with resin prior to insertion into the existing pipe shall not be included in the structural CIPP wall thickness computation.

III.) CURED IN-PLACE PIPE END SEALS

- A. The cured-in-place pipe end seals shall be a hydrophilic seal compatible with the installed cured-in-place liner system. End seal shall be a seamless sleeve type seal. End seal shall be held in place during lining by a mechanical fastener.
- B. Cured-in-place pipe end seals shall be Insignia™ End Seal Sleeve as manufactured by LMK Technologies, Ottawa, IL; Perma Main™ End Seals, as manufactured by Perma-Liner Industries LLC, Clearwater, FL, or approved equal.

IV.) GENERAL PIPE INSTALLATION

- A. The repair installation shall be continuous and tight fitting.
- B. Prior to installation of any type of pipe, the existing pipe must be cleaned with high pressure water blasting to remove any obstructions that might prevent installation of the new pipe. Cleaning shall constitute removal of all debris, solids, roots, deposits, and other matter which would preclude the installation of the new pipe into the sewer line. It may be necessary to pull a mandrel or cleaning pig through the pipe to remove the corrosion growth and loose liner material.
- C. Prior to installation of the cured in place pipe, the Contractor shall inspect the sewer

segments receiving the pipe using high-definition closed circuit television inspection (780p minimum). Any portion of the sewer determined to be unprepared to receive the cured in place pipe or the slipliner pipe shall be cleaned again to remove the obstruction. The sewer shall then be inspected again to verify the obstruction has been removed. Additional cleaning and inspection shall be at no additional expense to the Owner.

1. Contractor shall submit high-definition closed circuit television inspection video (780p minimum) once installation of the CIPP liner is complete. All CCTV videos submitted should be coded using PACP Version 7.

2. During the process of pre-lining CCTV inspection, the contractor shall identify active service locations through the use of CCTV and dye testing. Each active service shall be attributed to an address in the post CCTV logs. Every effort shall be exhausted to identify not only if a service is active, but to which structure it is connected. If a service cannot be identified the engineer shall be notified and further action will be determined. Only active service connections will be reinstalled after CIPP lining. Any service lines that intrude into the mainline more than 0.5" shall be cut as close to the inside of the pipe as possible but not less than 0.5", at no additional cost.

D. Prior to the installation of the cured in place pipe, the Contractor shall review the CCTV footage and note any intruding inlets. Any inlets that the Contractor believes will be detrimental to the installed cured in place pipe and all inlets intruding further than 0.5" shall be trimmed prior to installation. Inlets to be trimmed shall be trimmed to flush with the edge of the existing interceptor. Trimming method shall utilize a robotic cutter specially designed for pipeline applications. Any other trimming methods must be approved by the engineer.

E. Contractor shall take all necessary measures to control the flow of wastewater during construction. Surcharging of the sewer facilities upstream of the sections of line being rehabilitated will not be allowed under any circumstances. Contractor shall provide temporary bypass pumping, if necessary.

F. Pipe shall be protected during handling against impact shocks and free fall and the pipe interior shall be free of extraneous material.

G. Pipe Handling: Pipe lining material shall be handled in a manner to ensure installation of the material in an undamaged and structurally sound condition. Handling equipment and procedures shall be in accordance with the approved manufacturer's recommendation for proper handling of its products. Improper handling of pipe that results in damage to pipe will be grounds for rejection of the pipe for installation. The Engineer will be the final judge as to the acceptability of any material on the project. Cutting of pipe is discouraged. The Contractor is urged to plan his job to minimize the necessity for cutting. Prior to installation each pipe shall be inspected for defects and cracks. All defective, unsound or damaged pipe shall be rejected. The interior of all pipes shall be thoroughly cleaned and kept clean thereafter. All joint surfaces shall be kept absolutely clean during the jointing process.

H. Contractor shall take all necessary measures to control the flow of wastewater during construction. Surcharging of the sewer facilities upstream of the sections of line being rehabilitated will not be allowed under any circumstances. Contractor shall provide temporary bypass pumping, if necessary.

V.) PIPE INSTALLATION

A. CURED-IN-PLACE PIPE INSTALLATION:

Installation shall be in accordance with ASTM F 1216, Section 7, or ASTM F 1743, Section 6 with the following modifications:

1. Resin Impregnation - The quantity of resin used for tube impregnation shall be sufficient to fill the volume of air voids in the tube with additional allowances for polymerization shrinkage and the loss of resin through cracks and irregularities in the original pipe wall. A vacuum impregnation process shall be used. To ensure thorough resin saturation throughout the length of the felt tube, the point of vacuum shall be no further than 25 feet from the point of initial resin introduction. After a vacuum in the tube is established, a vacuum point shall be no further than 75 feet from the leading edge of the resin. The leading edge of the resin slug shall be as near to perpendicular as possible. A roller system shall be used to uniformly distribute the resin throughout the tube. If the installer uses an alternate method of resin impregnation, the method must produce the same results. Any alternate resin impregnation method must be proven and approved by the engineer.
2. The beginning and end of the CIPP shall be sealed to the existing host pipe. The end seal shall be a hydrophilic seamless seal compatible with the installed cured-in-place liner system and shall provide a watertight seal.
3. Tube Insertion -The wet-out tube shall be positioned in the pipeline using either inversion or a pull-in method. If pulled into place, a power winch should be utilized, and care must be exercised so as not to damage the tube as a result of pull-in friction. The tube should be pulled-in or inverted through an existing manhole or approved access point and fully extend to the next designated manhole or termination point.
4. Temperature gauges shall be placed inside the tube at the invert level of each end to monitor the temperatures during the cure cycle.
5. Curing shall be accomplished by utilizing hot water under hydrostatic pressure or air and steam in accordance with the manufacturer's recommended cure schedule.
6. Inspection - CIPP samples shall be prepared, and physical properties tested in accordance with ASTM F 1216 or ASTM F 1743, Section 8, using either method proposed. The flexural properties must meet or exceed the values listed in Table 1 of the applicable ASTM. Wall thickness of samples shall be determined as described in paragraph 8.1.6 of ASTM F 1743. The minimum wall thickness at any point shall not be less than 87½% of the design thickness. Visual inspection of the CIPP shall be in accordance with ASTM F 1743, Section 8.6.

B. FINISH

- a. The installed CIPP shall be continuous over the entire length of a sewer line section and be free from visual defects such as foreign inclusions, dry spots, pinholes, major wrinkles and de-lamination. The lining shall be impervious and free of any leakage from the pipe to the surrounding ground or from the ground to inside the lined pipe.
- b. Any defect, which will or could affect the structural integrity or strength of the linings, shall be repaired at the Contractor's expense, in accordance with the procedures submitted.
- c. The beginning and end of the CIPP shall be sealed to the existing host pipe. The sealing material shall be compatible with the pipe end and shall provide a watertight seal.
- d. If the wall of the CIPP leaks, it shall be repaired or removed and replaced with a watertight pipe as recommended by the manufacture of the CIPP system.

C. REINSTATEMENT OF BRANCH CONNECTIONS

- a. The Contractor shall be responsible for confirming the locations of all branch

service connections prior to installing the CIPP.

- b. It is the intent of these specifications that branch connections to buildings be re-opened without excavation, utilizing a remotely controlled cutting device, monitored by a CCTV. The Contractor shall certify a minimum of two complete functional cutters plus key spare components are on the job site before each installation or are in the immediate area of the jobsite and can be quickly obtained. Unless otherwise directed by the Owner or his authorized representative, all active laterals will be reinstated. No additional payment will be made for excavations for the purpose of reopening connections and the Contractor will be responsible for all costs and liability associated with such excavation and restoration work.

D. TESTING AND ACCEPTANCE

- A. The liner shall be evaluated by the Engineer based on a review of television recordings and certified test data for the installed pipe samples and shall be deemed acceptable if the following criteria are met:
 1. No observable groundwater infiltration.
 2. All service connections are open and clear. All service and manhole connections are made watertight using the approved system.
 3. No observable evidence of splits, cracks, breaks, kinks, wrinkles larger than 1 inch that are not caused by the existing condition of the sewer, delaminations, or crazing in the liner.
- B. If any defective liner is discovered after it has been installed it shall be repaired to achieve the specified acceptance criteria or, if that is not achievable, removed and replaced with either a sound liner or a new pipe at no additional cost to the Owner and without a time extension to the Contract.

E. CERTIFICATION TESTING

- i. The Contractor shall provide specimens from one location per 1000 feet of CIPP lining installed to allow an independent laboratory to conduct the tests specified below. For each inversion, two CIPP samples shall be provided, using at least one of the following two methods. At least one of the samples shall be clamped mold sample as described in paragraph "2." below. The second sample may be taken per either paragraph "1." or paragraph "2." below.
 1. The sample shall be cut from a section of cured CIPP at an intermediate manhole or at the termination point that has been inverted through a like diameter pipe which has been held in place by a suitable heat sink, such as sandbags.
 2. The sample shall be fabricated from material taken from the tube and the resin/catalyst system used and cured in a clamped mold placed in the downtube.
 3. The samples for each of these cases shall be large enough to provide a minimum of three specimens and a recommended five specimens. Each specimen shall be clearly marked to indicate the installed location of the liner, the date of installation, the pipe diameter, and the resin used.
- ii. For each specimen, the thickness shall be determined, and the following test shall be performed.
 1. Short-Term Flexural (Bending) Properties - The initial tangent flexural modulus of elasticity and flexural yield strength in accordance with ASTM D790.
- iii. The test results shall be sent directly to the Engineer by the Contractor's

laboratory. The results shall report the actual test results for each of the properties being tested. The laboratory shall certify the reports as to the results and test method utilized.

- iv. Each individual reported value shall meet or exceed the value of that property as specified herein or as used in the design calculations, whichever is higher. Should the test results not meet the minimum strength requirements; the Owner will have the option of rejecting the CIPP sections found to be defective. If rejected, the CIPP shall be repaired or, if that is not feasible, removed and replaced at no additional cost to the Owner.
- v. All the expenses for the certified testing of the CIPP lining furnished under this contract shall be paid for by the Contractor.

VI.) Bid Item, Measurement and Payment.

- (1) Bid Item:

CURED-IN-PLACE PIPE (CIPP)

Unit: Lin. Ft.

- (2) Measurement. Will be by the linear foot.

- (3) Payment. Compensation shall be at the actual length of cured-in-place pipe installed. The length shall be measured from center of manhole to center of manhole. The unit price per linear foot installed shall include all materials, labor, equipment and supplies necessary for the complete CIPP liner installation.

9.08 SANITARY MANHOLE REHABILITATION

A.) GENERAL

- A. The Contractor shall furnish all material, tools, equipment and labor necessary to rehabilitate the existing manholes, at the locations shown on the Drawings, as detailed, and in conformance with the Specifications.

B.) APPLICABLE STANDARDS

- B. Specifications of the following listed standards will be referred to hereinafter by standards abbreviation and specification number, which shall include the latest revision thereof.
- 1. ASTM - American Society for Testing and Materials.
 - 2. NACE - National Association of Corrosion Engineers, NACE International
 - 3. ACI - American Concrete Institute.
 - 4. NACE - National Association of Corrosion Engineers.
 - 5. SSPC - Society of Protective Coatings.
 - 6. ICRI - International Concrete Repair Institute
 - 7. OSHA - Occupational Safety and Health Administration
 - 8. RCRA - Resource Conservation and Recovery Act
 - 9. EPA - United States Environmental Protection Agency
 - 10. EVT - Environmental Technology Verification
 - 11. NASSCO - National Association of Sewer Service Companies
 - 12. NSF - National Sanitation Foundation
 - 13. CIGMAT - Center for Innovative Grouting Materials and Technology
 - 14. AASHTO - American Association of State Highway and Transportation Officials

C.) QUALITY ASSURANCE

- C. Items submitted for approval in accordance with requirements shown on the Drawings and details shall be of the manufacturer indicated, or an approved equal, in compliance with materials, operations, physical assembly and performance as specified herein.
- D. In addition to the correction period set forth in General Conditions, the manufacturer's standard warranties shall be provided.
- E. Applicator shall be certified by the manufacturer of the manhole rehabilitation system.
- F. Products from other manufacturers will be considered for substitution prior to the receipt of Bids. Requests for substitution by the Contractor after the Bids have been received will not be considered. The Engineer must receive complete requests for substitution from the Contractor not later than 10 days prior to the Bid Opening. Only bona fide bidding Contractors are eligible to request substitutions. Requests directly from equipment suppliers or their representatives will not be reviewed. The Engineer and Owner will review the requests and will issue an addendum listing the approved alternates, if allowed, approximately 7 days before the receipt of Bids.
- G. Services of Manufacturer's Representative: A representative of the rehabilitation product manufacturer must be present at the first four complete lining system installations. The representative shall inspect the manholes to be lined for conformance with surface preparation requirements, environmental conditions at the time of placement, and for any other condition that may adversely affect the intended performance of the product.

D.) SUBMITTALS

- H. Sanitary Manhole Rehabilitation.
 - 1. Technical data sheet on each product used, including applicable ASTM test results indicating the product conforms to and is suitable for its intended use per these specifications.
 - 2. Material Safety Data Sheets (MSDS) for each product used.
 - 3. Manufacturer's product data including, physical properties, warranty information, and requirements for surface preparation, repair, application, curing; and field quality control.
 - 4. Project specific guidelines and recommendations.
 - 5. Proof of any required federal, state or local permits or licenses necessary for the project.
 - 6. Detailed Minimum Liner Thickness Calculations ensuring that rehabilitation system is a fully structural system along with proposed plan for ensuring that the installed liner meets the minimum thickness requirements.
 - a. The Minimum Liner Thickness Calculations shall be completed and stamped by a licensed professional engineer.
 - 7. Manufacturer Qualifications: The Contractor shall provide documentation that the rehabilitation material to be used has been successfully installed in 2,000 manholes in the United States and has been in service for a minimum of five (5) years.
 - 8. Contractor and Applicator Qualifications:
 - a. Proof of applicator certification by the manhole rehabilitation system manufacturer.
 - b. The manhole rehabilitation contractor shall provide evidence and references for successfully installing a minimum of 500 manholes using their proposed rehabilitation method in the United States.
 - c. The manhole rehabilitation contractor shall provide evidence and references for a minimum of one (1) year of experience installing specified rehabilitation products.
 - d. Manufacturer certification that Applicator has been trained and approved by manufacturer in the handling, mixing and application of the specified products.
 - e. Certification that the equipment to be used for applying the products has been manufactured or approved by the protective coating manufacturer and Applicator

- personnel have been trained and certified for proper use of the equipment.
- f. List of recent successfully completed similarly sized manhole rehabilitation projects, including project name and location, names, addresses and telephone numbers of owner and engineer, and description of products used, substrates, and application procedures.
- g. Proof of any necessary federal, state or local permits or licenses necessary for the project.
- h. Detailed information about the procedures the Contractor intends to use in rehabilitating the manholes including step-by-step description of the proposed rehabilitation operation; thickness of the materials to be utilized; the materials cure time; surface preparation requirements; and any other factors affecting installation.
- i. Design details for any additional ancillary systems and equipment to be used in site and surface preparation and testing.

E.) WARRANTY

- I. The materials used for the project shall be certified by the manufacturer for the specified purpose. The manufacturer shall warrant the materials to be free from defects in raw materials for ten (10) years after installation and from the date of acceptance by the Owner. The Contractor shall warrant the installation of the renewal component for a period of ten (10) years. During the ten (10) year warranty period if the rehabilitation system, fails, delaminates, peels or shows any defect, which may materially affect the integrity, strength, function and/or operation of the manhole structure, it shall be repaired at the Contractor's expense in accordance with procedures recommended by the manufacturer.
- J. Repair/Replacement.
 - 1. After a manhole has been rehabilitated and for a period of time up to ten (10) years following completion and final acceptance of the project, the Owner may inspect all or portions of the rehabilitated manholes. The specific locations will be selected at random by the Owner and will include all types of structures from this project.
 - 2. If it is found that any of the rehabilitation system components have developed defects since the time of "Quality Assurance and Testing," the defects shall be repaired and/or the component shall be replaced as recommended by the manufacturer. If, after inspection of a portion of the rehabilitated manholes under the contract, problems are found, the Customer may inspect all manholes where rehabilitation systems have been applied/installed under this contract.
- K. All verified defects shall be repaired and/or replaced by the Contractor and shall be performed in accordance with the manufacturer's recommendations and per the original specifications, all at no additional cost to the Customer.

F.) MANHOLE REHABILITATION

- A. It is the intent of this section to provide for the waterproofing, sealing, structural reinforcement and corrosion protection of manholes and similar underground structures by the safe, quick and economical application of an ultra-high build 100% solids structural epoxy liner.
- B. This specification establishes the minimum standard for material and method of application for the structural reinforcement, sealing and corrosion protection of leaking and deteriorated manholes by lining with a 100% solids, high build structural grade epoxy. The structural epoxy liner shall be installed at a minimum thickness of 100 mils DFT (0.1").
- C. The Contractor shall submit Detailed Minimum Liner Thickness Calculations to the Owner/Consulting Engineer for review. Thickness calculations shall substantiate sufficient liner thickness to achieve desired structural rehabilitation. The minimum thickness of the

Geopolymer lining material shall be 100 mils DFT (0.1").

1. The Detailed Minimum Liner Thickness Calculations Shall be stamped by a licensed professional engineer.
 2. Separate calculations will be required for the different type of structures included in the project. This includes but is not limited to: round manholes of varying diameter, rectangular diversion structures, rectangular flow control structures, etc.
- D. The structural epoxy lining system will be used on surfaces in order to protect against corrosion and seal from I&I.
- E. Manholes found to be structurally deficient shall be replaced with new precast reinforced concrete manholes.

G.) STRUCTURAL EPOXY

- F. Structural epoxy lining system must be a structural epoxy exhibiting the following features:
1. The structural epoxy must have undergone testing and verification by the US Environmental Protection Agency's, Environmental Technology Verification Program for Infrastructure Rehabilitation Technologies (EPA ETV).
 - a. The structural epoxy must be 100% solid, no VOCs.
 - b. The structural epoxy must be a high flexural strength, fiber-filled system; a fiber-reinforced-polymer (FRP) formulates technology.
 - c. The structural epoxy must be self-priming, requiring no primer.
 - d. The structural epoxy must adhere to concrete with adhesion testing results in PSI that outperformed the cohesion of concrete on both dry concrete and wet brick (CIGMAT CT-2/3).
 - e. The structural epoxy must be moisture tolerant up to 100% and fully cure underwater.
 - f. The structural epoxy must withstand freeze-thaw and wet-dry cycles without causing adverse changes to the cure and performance properties.
 - g. The structural epoxy must be able to be applied by trowel (hand-applied) in order to mobilize and apply in limited access areas.
 - h. The structural epoxy must hang with vertical and overhead thickness capability of 1/16 inch to 3/8 inch in one pass without sag.
 - i. The structural epoxy must have an indefinite recoat window without preparation for simple repair requirements.
 - j. The structural epoxy shall be resistant to all forms of chemical or bacteriological attack found in municipal sanitary sewer systems, including severe hydrogen sulfide (up to 800ppm).
 - k. The coating system must be a dense structural epoxy (epoxide) coating system (16,000psi or greater) exhibiting elongation (ASTM D2370) of 5% (minimum) to 10% (maximum) to ensure properties which withstand minor movement, vibration, and access induced mechanical impact.

G. Approved material shall exhibit the following physical properties:

1. FRP-type, hybridpolymer
 - a. (epoxy/epoxide)
 - b. Solids by Volume ASTM D2697 100%
 - c. Solvent (VOC) ASTM D3960 none
 - d. Adhesion Strength (concrete, dry) CIGMAT CT-2/3 substrate failure
 - e. Adhesion Strength (brick, wet) CIGMAT CT-2/3 substrate failure
 - f. Adhesion Strength (steel) ASTM D4541 1,500+ psi
 - g. Water Absorption ASTM D1653 < 0.1 g/sq.m.
 - h. Acid Exposure (pH 1, H2SO4) CIGMAT CT-1 passed
 - i. Tensile Strength ASTM D638 5,500+ psi

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|----|--------------------------------|----------------|
| j. | Flexural Modulus ASTM D790 | 500,000+ psi |
| k. | Flexural Strength ASTM D790 | 4,000+ psi |
| l. | Compressive Strength ASTM D695 | 16,000+ psi |
| m. | Elongation ASTM D2370 | 4-6% |
| n. | Complete Cure | 18 hours (77F) |

H. Structural epoxy lining system shall be Epoxytec CPP #RC3 and/or CPPSprayable #C311S by Epoxytech or approved equal.

H.) WALL RESURFACER

I. Specially formulated materials may be centrifugally cast in thickness from 1/2 inch to 2 inches with a robotic applicator, which does not require manhole entry or may be applied by spraying and troweling. Mortar shall be high strength, quick setting and corrosion resistant. All fins and protrusions shall be leveled and provide a smooth continuous liner that restores the concrete to a continuous plane. This material shall be PERMACAST from Action Products Marketing Corp., QM-1s Restore from Quadex, Sauereisen Substrate Resurfacer No. F-121, Strong-Seal Profile Plus Mix or approved equal. Mortar liner shall be followed by an application of a compatible corrosion resistant coating.

I.) MANHOLE CHIMNEY SEALS

J. General

1. Manhole frame sealing includes the sealing of the frame joint area and the chimney above the cone of the manhole with an applied internal flexible seal.
2. The contractor shall have a manufacturer's recommended expansion tool, removal tool if necessary and all other equipment/tools required to install the specified frame seals.
3. Frame sealing will be executed after the lining section is complete and coating is fully cured.

K. Materials

1. Polymer manhole chimney seals are designed to prevent leakage of water into the manhole through the frame joint area and the area above the manhole cone including all extensions to the chimney area. This typically occurs as the manhole ages, and in time undergoes vibration, impact, and movement. Therefore, polymer seals with the correct properties are often sought as a preventive measure to bridge this concern should the frame start moving beyond its original design capabilities.
2. Primer
 - a. Primer is encouraged on section of metal to increase the surface bond prior to applying the elastomer.
 - b. The material must be epoxy based, designed to set quickly within 15 minutes, and formulated for polyurethane bonding.
 - c. Specified material is Epoxytec 45 Primecoat (#PR45) by Epoxytec, or approved equal.
3. Polymer elastomer
 - a. The polymer elastomer chimney seal material shall be corrosion resistant and applied to the inside wall of the entire chimney area as specified in the contract documents.
 - b. The material must be a 2-component, hand-applied high build polyurethane.
 - c. Approved material shall exhibit the following physical properties:

1) Shore Hardness ASTM C92	45 A
(a) Freeze / Thaw ASTM C666	300 cycles - no damage
(b) Bond Durability ASTM C920-87	No failure after 25%

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|-----|---------------------|--------------|-------------|
| | extension | | |
| (c) | Tear Resistance | ASTM D624-86 | 44 lbs./in. |
| (d) | Ultimate Elongation | ASTM D412 | 800% |
- 2) Specified material is Epoxytec Uroseal 45V (#J45V) by Epoxytec or approved equal.

J.) ANNULAR SPACE AND ACTIVE LEAK CONTROL

L. Pressure injected plugging material, or hydraulic cement shall be used to repair annular spaces and actively leaking cracks.

M. Pressure Injected Plugging Material

1. Annular spaces around the gravity sewer lines and actively leaking cracks, joints, holes, or other defects shall be repaired by means of pressure injected hydrophobic polyurethane grout designed for use in a wet environment. The material must be capable of withstanding movement caused by thermal cycle changes and/or settling of the structure.
2. The grout shall expand in the presence of water to effectively seal any voids within the wall and shall produce a stable soil mass outside the wall.
3. Polyurethane grout shall meet or exceed the following material and performance criteria:
 - a. Material shall be 100% solids.
 - b. Material shall have a minimum confined and free rise density of 15 and 3 lbs/ft³, respectively, ASTM D-1622.
 - c. Minimum tensile strength: 15.6 psi (perpendicular), ASTM D-1623.
 - d. Minimum shear strength: 14.5 psi, ASTM C-2733
4. Polyurethane grout shall be "SealGuard II" as manufactured by SealGuard Inc.; "Hydroactive Polyurethane Grout No. F-370" as manufactured by Sauereisen; "Hydro Grout" as manufactured by Parson Environmental Products, Inc. or approved equal.

N. Hydraulic Cement

1. Annular spaces around the gravity sewer lines and actively leaking cracks, joints, holes, or other defects shall be repaired by means of hand placed hydraulic cement.
2. The hydraulic cement shall react with water to produce a fast setting, non-shrink, water resistant cement to effectively seal any voids within the wall and stop the infiltration of water from outside the wall.
3. Hydraulic cement shall meet or exceed the following material and performance criteria:
 - a. Compressive strength (ASTM C-109):

750 psi @ 15 minutes
3,700 A 1 day
5,500 @ 28 days
 - b. Set time (ASTM C-266): 60-90 seconds
4. Hydraulic cement shall be "Super Faststop" as manufactured by CONSPEC Marketing & Manufacturing Co.; "SikaSet Plug" as manufactured by Sika Corporation; "Parson Quick Plug" as manufactured by Parson Environmental Products, Inc. or approved equal.

K.) MANHOLE FRAME AND COVER

O. Manhole frame and covers shall be provided as specified herein. Frame and cover castings shall be the product of Clay & Bailey, Deeter, Neenah, or equal and shall conform to the requirements of these specifications.

L.) BONDING AGENTS

P. Epoxy adhesives shall conform to ASTM C881, Types I and V, moisture insensitive, 100% solids and shall be the following products for the applications specified.

1. For bonding freshly mixed, plastic concrete to hardened concrete, Sikadur Hi-Mod Epoxy Adhesive, as manufactured by Sika chemical Corporation; Concreative 1001-LPL, as manufactured by Master Builders; or equal.

2. For bonding to hardened concrete or masonry to steel, Colma-Dur Gel, Sikadur Hi-Mod Gel, or equal.

M.) CONSTRUCTION

- A. All work shall be in strict accordance with the specifications and recommendations including application of all products as required and in accordance with manufacturer's directions.
- B. Contractor shall conform to all local, state and federal regulations including those set forth by OSHA, RCRA and the EPA and any other applicable authorities.
- C. Products are to be kept dry, in a climate-controlled environment, protected from weather and stored under cover. Products are to be stored and handled according to their safety data sheets. When freezing temperatures are expected in the area, the Contractor shall take measures to keep applied materials warm (as per manufacturer's guidelines) and provide the required heat in the structure before repair work is started.
- D. Any invert(s), channels, drains, or other openings shall be covered during construction operations to prevent loose materials from collection.
- E. Bypassing and/or blocking of flow shall be done only with prior approval of the Owner. Contractor shall be responsible for transporting or pumping water to maintain operation of any flow, treatment, collection or distribution system while repairs or lining to structures are made.
- F. It shall be the contractor's responsibility to provide traffic control required by the particular location and/or jurisdiction.
- G. Use approved equipment designed, recommended and/or manufactured by the material supplier specifically for the application of all materials.
- H. Applicator shall initiate and enforce quality control procedures consistent with applicable ICRI, NACE, and/or SSPC standards and the repair/coating manufacturer's recommendations.
- I. Examination
 1. Examine surface to receive rehabilitation prior to applying any materials. Notify Owners in writing if surfaces are not acceptable for rehabilitation and/or lining.
 2. All structures to be repaired and coated shall be readily accessible to the Applicator.
 3. Any active flows shall be dammed, plugged or bypassed as required to ensure that the liquid flow is maintained below the surfaces to be coated and that concrete to be coated has not reached moisture levels surpassing 90%. Flows should be totally plugged and/or diverted when coating any invert. All extraneous flows into the structures at or above the area coated shall be plugged and/or diverted until the structural epoxy coating has set hard to the touch.
 4. Temperature of the surface to be coated must be maintained between 65F and 110F during application. Prior to and during application, care should be taken to avoid exposure of direct sunlight or other intense heat source to the structure being coated. Specified surfaces should be shielded to avoid exposure of direct sunlight or other intense heat sources. Where varying surface temperatures do exist, coating installation should be scheduled when the temperature is falling versus rising.
 5. New Portland cement concrete structures shall have endured a minimum of 28 days since installation, prior to commencing epoxy structural coating installation.
 6. Prior to commencing surface preparation, Contractor shall inspect all surfaces specified to receive the coating and notify Owner, of any noticeable disparity in the site, structure or surfaces which may interfere with the work, use of materials or procedures as specified herein.

N.) SURFACE PREPARATION

- A. Surface preparation must be achieved immediately prior to utilizing any repair material and/or

coatings; re-inspection and/or subsequent surface preparation may need to be repeated should conditions change after initial preparation.

- B. All receiving surfaces shall be thoroughly cleaned and made free of all foreign materials including dirt, grit, roots, grease, sludge and all debris or material that may be attached to the substrate.
- C. Surface preparation shall be performed on all specified surfaces to be lined or rehabilitated. Unless otherwise noted, all newly installed concrete structures should first undergo curing of minimum 28 days prior to surface preparation and rehab/lining execution.
- D. All existing liner shall be removed to a sound concrete surface prior to rehabilitation unless otherwise approved by engineer. All existing concrete and mortar that is not sound or has been damaged by corrosion shall be removed to a sound concrete surface or replaced.
 - 1. Maintain strict adherence to applicable NACE and SSPC recommendations regarding proper surface preparation. Surface preparation must achieve a clean and sound substrate in accordance with SSPC-SP13/NACE No. 6 "Surface Preparation of Concrete."
 - 2. Remove existing coal tar lining prior to application of new protective coatings.
 - 3. An ICRI profile of CSP 3 or higher shall be achieved.
 - 4. Manhole walls shall be cleaned with high pressure water cleaning equipment capable of a minimum of 5,000 psi at 25 or more gpm or the as recommended by the rehabilitation product manufacturer, whichever is greater. Other methods such as abrasive blasting, shotblasting, grinding, scarifying or acid etching may also be required.
 - 5. No surface water or active leaks are to be present. Prepared concrete surfaces shall be tested for residual moisture after cleaning and drying, and prior to the application of the coating. Drying may be required with forced air and/or dry heat to achieve moisture levels below 80% prior to coating.
 - 6. When grease and oil are present within the structure, an approved detergent or degreaser may be used integrally with the high pressure cleaning water if conditions dictate.
 - 7. Protrusions such as from burrs, sharp edges, fins, and concrete spatter shall be removed during surface preparation.
 - 8. The manhole surface shall be tested to ensure that the pH is within the manufacturer's acceptable limits. Surface preparation shall yield a PH of 7 or higher. If the pH of the surface is not within acceptable limits, the Contractor shall neutralize the surface prior to proceeding with the rehabilitation. Surface preparation shall be in accordance with the manufacturer's recommendations.
 - 9. End result shall be a uniform, sound, clean neutralized surface that is not excessively damaged.
- E. Covers or fine screens shall be placed over manhole invert prior to cleaning to prevent extraneous material from entering sewer lines.
- F. All prepared surfaces shall be inspected prior to application of repair materials.
- G. Manhole wall repair shall include the plugging and/ or patching of all visible leaks, cracks, holes, voids, manhole steps, and deteriorated surfaces in the manholes. Concrete surface defects shall be filled flush and true with the specified grouting, plugging, or patching compound in accordance with ICRI Technical Guideline No. 03730 "Guide for Select Application Methods for the Repair of Concrete Surfaces".
 - 1. Existing manhole steps shall be removed regardless of condition. The Contractor shall cut the steps so that they are flush with the prepared manhole wall surface or remove the steps completely and fill the void with non-shrink grout.
 - 2. Any infiltration shall be stopped by using a material which is compatible with the specified repair method and is suitable for top coating with the specified protective coating.
 - 3. The invert and bench areas shall be repaired as further indicated or as directed by the Engineer. All leaks in the flow channel shall be patched or grouted. The prepared surface shall be smooth and provide smooth flow through the channel. The repaired bench shall be

- sloped to allow for all areas to drain to the invert.
4. All materials used in the plugging and patching process shall be allowed to fully cure according to the manufacturer's material specifications before continuing with the manhole rehabilitation.

O.) ACTIVE LEAK CONTROL PROCEDURE

A. Execution

1. When leaks are not readily identifiable upon cleaning operation, use blowers to dry interior for positive identification of leaks and weeping areas.
2. Hydraulic cement
 - a. The work consists of hand applying a dry quick-setting cementitious mix designed to instantly stop running water or seepage in all types of concrete and concrete structures. The certified applicator shall apply material in accordance with manufacturers' recommendations.
 - b. The area to be repaired must be clean and free of all debris.
 - c. Proper applications should not require any special mixing of product or special curing requirements after application.
3. Chemical grout
 - a. Application of materials shall be by injection method only.
 - b. Mixing and handling of all the chemical grout materials shall be in strict accordance with manufacturer's recommendations.
 - c. All excess chemical grout must be removed from the surface via mechanical grinding means and top patched with Hydraulic cement.

P.) CONCRETE REPAIR METHODS

- A. All loose, cracked and corroded materials shall be removed from the area, exposing a sound substrate.
- B. The materials shall be formed, trowel-applied, or shotcrete sprayed utilizing proper equipment on to specified surfaces. Follow instructions as published by the material manufacturer. If spraying, consult manufacturer for proper instruction and material version.
- C. Concrete patching and rebuilding
 1. Execution
 - a. Once cured, and before applying any lining system materials, refer to material specifications for post-cure preparation and readiness instructions. Follow mixing, application and handling instructions as written per materials product technical data sheets and SDS.
 - b. Apply materials and allow proper curing times prior to coating/lining.
- D. Resurfacing
 1. Execution
 - a. Follow mixing, application and handling instructions as written per materials product technical data sheets and SDS.
 - b. The mortar kits come pre-proportioned, for hand applications- use full kits as supplied, do not add any extra water.
 - c. For spray applications, water may be added, but limited, as specified by the Manufacturer.
 - d. When mixed, a paste-like material will develop which may be troweled, sprayed, cast, pumped or gravity-flowed applied.
 - e. This mortar will harden quickly without any need for special curing. Therefore, execute finishing work by trowel immediately after applying or disbursing onto the substrate.

- f. Either commence spraying or hand applying.
 - g. The epoxy-modified-mortar shall be applied at a 1/4 inch minimum, and 1/2 inch maximum (1/4" – 1/2") for existing infrastructure. And between 1/16 inch and 1/8 inch (1/16" – 1/8") for newly installed structures.
 - h. Finish with trowel.
 - i. Allow at least two (2) hours (77F) to cure, minimum, before applying the specified structural epoxy coating, but do not exceed thirty-six (36) hours. The window and condition to apply the structural epoxy coating remains open for 36 hours. Should this window expire, consult with manufacturer for written and approved guidance and instruction.
- E. Exposed reinforcing bars
- 1. Execution
 - a. Prepare and clean via SSPC-SP 2 or 3 exposed reinforcing bars then clean with solvent (SSPC SP-1).
 - b. Treat with an epoxy-based, rapid-setting, rust inhibiting primer.
 - c. Allow primer to cure.
 - d. Patch with concrete patching materials as specified in "Concrete patching and rebuilding" section. Follow product and manufacturer execution specifications accordingly.

Q.) MANHOLE ADJUSTMENT

- A. Adjust manhole frame and cover where indicated on the plans. Manhole grade adjustments include a new frame and cover.
- B. Contractor shall use the least number of grade rings possible to adjust the manhole frame and cover, maximizing the use of 6", 8", and 12" grade rings.
- C. All costs for salvaging, removing, and replacing the manhole frames and covers shall be included in the appropriate unit price bid item.

R.) BYPASS PUMPING

- A. Maintain sanitary sewer service during the installation process, as required for acceptable completion of the work and / or to avoid damages due to sewer spills or overflows.
- B. Install and operate bypass pumping equipment to maintain sewage flow around the host infrastructure being rehabilitated, and to prevent backup or overflow in compliance with Owner requirements.
- C. Install all bypass and isolation material and equipment so as to not affect flow in upstream or downstream structures. The pump and bypass lines shall be of adequate capacity and size to handle the anticipated flow. Bypassing of sanitary sewer into the storm water system will not be permitted. For all bypass pumping, pump noise shall be kept to a minimum.

S.) APPLICATION OF REHABILITATION MATERIALS

- A. Application procedures shall conform to the recommendations of the manufacturer of the selected coating system, including material handling, mixing, application, environmental controls during application, safety and equipment.
- B. Spray equipment shall be specifically designed to accurately ratio and apply the specified materials and shall be regularly maintained and in proper working order. Air assisted spray application equipment may be acceptable only if the air source is filtered to completely remove all oil and extraneous water. Spray equipment shall be certified to spray the coating by the manufacturer.

- C. Prior to and during application, care should be taken to avoid exposure to air movement and direct sunlight or other intense heat source to the structure being coated. Where varying surface temperatures do exist, care should be taken to apply the coating when the temperature is falling rather than when it is rising.
- D. After the initial coat has cured, all protrusions, points, etc., shall be sanded down and removed by mechanical means to provide a smooth surface for the final coat to ensure the minimum thickness over the entire surface.
- E. Finished materials shall not be exposed to sunlight or air movement for longer than 15 minutes before covering or closing access.
- F. If coatings do not bond properly to the manhole surfaces, such coating shall be removed and replaced at no expense to the Owner.
- G. Follow manufacturer's instructions whenever more than 12 hours have elapsed between layer applications.
- H. Other than for application of cementitious products, surfaces shall be completely dry.
- I. All inverts shall be coated unless a mainline CIPP liner extends entirely across the manhole.
- J. The type or thickness of rehabilitation material required will not be known until the manholes have been cleaned and the amount of deterioration can be determined. Bid quantities are based upon preliminary investigation.

T.) INSTALLATION OF CHIMNEY SEAL

A. Execution

- 1. On the metal surfaces, prepare surface to a SSPC-SP3 "Power Tool Cleaning" standard so that the preparation removes all loose mill scale, loose rust, loose paint, and other loose detrimental foreign matter by power wire brushing, power sanding, power grinding, power tool chipping, and power tool descaling.
 - a. After preparation, clean with SSPC-SP1 "Solvent Cleaning" method to remove dust and debris.
 - b. Allow solvent or cleaner to dry out.
 - c. Apply one coat of epoxy primer.
 - 1) Primer shall be applied as directed on manufacturer published data sheets at 2-3 mils WTF.
 - 2) Allow primer to cure until it is tack-free. This time depends on conditions; blowing forced air will assist the cure time.
- 2. To prepare other substrates, refer to concrete preparation sections of this specification as described for cementitious/brick/or mortar substrates. Should you have to prepare installed liner, solvent rub and wire brush to create scored abrasion prior to top coating with polymer elastomer.
- 3. Once the primer is tack-free, apply polymer elastomer as directed on manufacturer published data sheets at 125 mils (1/8") DFT for peak to valley.

U.) CURING

- A. Cure materials in accordance with manufacturer's instructions. Cure time before subjecting manholes to flows shall be as recommended by the manufacturer.
- B. Opening to traffic shall be as recommended by the manufacturer, but not less than 24 hours after final application of rehabilitative or protection material.

V.) INSPECTION AND TESTING

- A. Surface preparation inspection must take place prior to proceeding to material applications, this applies to both repair and lining applications.
 - 1. Applicator must record, and submit to coating manufacturer's representative or designated

inspector:

- a. PH level
 - b. Moisture content
 - c. Abrasive media type and/or preparation methods
 - d. ICRI conditions
- B. Contractor shall furnish all labor, tools, and equipment necessary to perform rehabilitated manhole testing as specified herein. The methods and equipment used to make the test shall be mutually determined by the Engineer and Contractor before any testing is started
- C. During application of coatings, a wet film thickness gage meeting ASTM D 4414 Standard Practice for Measurement of Wet Film Thickness of Organic Coatings by Notched Gages, shall be used regularly to insure a monolithic coating and uniform thickness during application.
- D. After the protective coating has set hard to the touch it shall be inspected with high-voltage holiday detection equipment. Surface shall first be dried; an induced holiday shall then be made on to the coated concrete surface and shall serve to determine the minimum/maximum voltage to be used to test the coating for holidays at that particular area. The spark tester shall be initially set at 100 volts per 1 mil (25 microns) of film thickness applied but may be adjusted as necessary to detect the induced holiday (refer to NACE RPO188-99). All detected holidays shall be marked and repaired by abrading the coating surface with grit disk paper or other hand tooling method. The entire surface to which repair material is to be applied shall be roughened. Abrading only the high points on the surface profile is not acceptable. After abrading and cleaning, additional protective coating material can be hand applied to the repair area. All touch-up/repair procedures shall follow the protective coating manufacturer's recommendations.
- E. Measurement of bond strength of the coatings to the substrate shall be measured in accordance with ASTM D 4541. Any areas detected to have inadequate bond strength shall be removed and replaced at no cost to the Owner. Further bond tests may be performed in that area to determine the extent of potentially deficient bonded area and repairs shall be made by the Contractor in strict accordance with manufacturer's recommendations. A minimum of one bond strength test shall be performed for each manhole. Selection of the point of measurement in the manhole shall be determined by the Engineer or the Owner's Representative.
- F. Manhole Testing. Manholes lined in their entirety shall be vacuum tested. All pipes entering manhole shall be plugged, taking care to securely brace the plugs to prevent being drawn into manhole. Attach the vacuum test device to the manhole top and draw a vacuum of 10 inches of mercury. With the valve at the vacuum line closed and the vacuum pump off, measure the time required for the vacuum to drop to 9 inches of mercury. Following are minimum allowable test times for manhole acceptance at the specified vacuum drop:

<u>Depth (Feet)</u>	<u>Time (Seconds)</u>
4	16
8	33
12	49
16	67
20	81
24	97

If the manhole fails the initial test, repairs and adjustments necessary due to extenuating circumstances (ie. Pipe joint, liner, plug sealing) shall be made. Retesting shall proceed until a satisfactory test is obtained.

- G. A final visual inspection shall be made by the Inspector and manufacturer's representative. Any deficiencies in the finished coating shall be marked and repaired.

W.) BID ITEMS, MEASUREMENT AND PAYMENT

(1) Bid Item.

(*) FT. DIA. SANITARY MANHOLE REHABILITATION Unit: Each

(*) -- Diameter of the Manhole in feet

(2) Measurement. Sanitary Manhole Rehabilitation for the various sizes of sanitary sewer manholes shall be measured per each.

(3) Payment. Completed and accepted “Sanitary Manhole Rehabilitation” for the various sizes of sanitary sewer pipes shall be paid for at their respective Contract unit prices, which payment shall be full compensation for all materials, equipment, tools, labor, and incidentals necessary to complete the work as specified

9.09 CCTV INSPECTION

A. General. The following notes and specifications outline the minimum standards for materials and methods for performing CCTV inspections of sanitary sewer pipes.

B. Construction Requirements. Following backfill and compaction of a storm water pipe, each pipe will be inspected (structure to structure). The following is required.

a. The contractor shall flush all pipes with clean water prior CCTV to inspection. The CCTV inspection shall be performed with either standing water in the pipe or under a steady flow of water.

b. A CCTV inspection will be performed using a robotic camera with high-resolution video and pan/tilt capabilities to record observations of the pipe interior (structure to structure). Inspection will include both upstream and downstream structures; pipes will be inspected for condition and workmanship. Observations of the pipe will include joints, wyes, sags, etc. Observations of the structures will include pipe connection(s), inverts, benches, and drops. Inspection data will be generated digitally with software that is NASSCO 7 certified. Inspection data will be exported in a standard PACP exchange file and include a **.mdb** file. Once the Contractor has submitted inspections for review, the Owner will have 5 business days to review and respond. The Contractor shall wait for a notice to proceed before constructing any improvements above new wastewater pipes. Contractor to provide an electronic file of each inspection. Each file and inspection will be labeled accordingly, “Station to Station”, e.g. Sta. 1+05 to Sta. 3+78. If existing Facility Ids are available, they may be referenced in lieu of stationing. Files will be delivered via UBS Flash Drive or a file share link.

C. Bid Item, Measurement and Payment.

a. Bid Item:

CCTV INSPECTION OF SANITARY SEWER PIPES Unit: Linear Foot

b. Measurement. If “CCTV Inspection of Sanitary Sewer Pipes” is included as a bid item in the contract, it will be by the linear foot for all pipes specified in the Contract Documents.

c. Payment. Payment shall be for all inspection work completed and accepted for payment by the Owner. This price shall include all materials, equipment, tools, labor, and incidentals necessary to complete the work.

END OF SECTION