

SECTION 9

SANITARY SEWER
&
MANHOLE REHAB-CIPP

SECTION 9

SANITARY SEWER AND MANHOLE REHABILITATION

9.1 General

This section pertains to the maintenance and rehabilitation of sanitary sewers and manholes. The common form of sanitary sewer rehabilitation is the process of cured-in-place pipe, or CIPP. Manhole rehabilitation includes a variety of methods with appropriate uses described in this section.

9.2 General Sewer Requirements

A. Description

1. The intent is to have a resin impregnated flexible felt tube installed and cured in place in the designated mainline sewers. The tube shall be inverted into the mainline sewer utilizing a vertical inversion standpipe and hydrostatic head or mechanically installed. Curing of the mainline sewer shall be accomplished by circulating hot water to cure the resin into a hard-impermeable conduit. When cured, the tube shall extend over the length of the existing line in a continuous tight-fitting watertight pipe within a pipe. The rehabilitation of the sewer main shall be performed without the need for excavation or demolition of existing structures and be able to re-establish lateral services without excavation. The pipe lining method shall have sufficient structural strength to support all dead loads, live loads, and ground water loads imposed with the assumption that the existing pipe cannot share any loading or contribute to structural integrity of the liner. The liner shall provide the least possible thickness or decrease in pipe diameter to meet the strength and other design requirements of this specification.
2. The Contractor shall be responsible for a site visit before the submittal of the bid package to determine the existing field conditions. Contractor shall be responsible to verify the pipe diameter before or during CIPP lining segments.
3. Steam-cured lining is acceptable where applicable in the field, in accordance with ASTM standards, and as determined by Contractor and his/her respective Engineer's recommendations.
4. Installed liners that fail shall be removed and reinstalled by Contractor at no additional cost to City.
5. This section references ASTM D5813 (Standard Specification for Cured-in-Place Thermosetting Resin Sewer Pipe), ASTM F1216 (Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube, ASTM F1743 (Standard Practice for Rehabilitation of Existing Pipelines and Conduits by Pulled-In-Place Installation of Cured-In-Place Thermosetting Resin Pipe),

and ASTM D790 (Test Methods for Flexural Properties of Un-reinforced and Reinforced Plastics and Electrical Insulating Materials).

B. General Requirements

1. Submit manufacturer's product data, including physical and chemical properties, installation instructions, application limitations, and field quality control.
2. Manufacturer's certificate of compliance certifying compliance with the applicable specifications and standards.

Certification on manufacturer's letterhead stating applicator is factory trained and approved by manufacturer in application of the specified products.

3. Certified copies of all test reports on the properties of the selected resin, including structural tests and chemical resistance test performed on each installation run.
4. Liner wall thickness and design criteria and criteria, seal by a professional engineer, for each location.
5. Proposed location to "wet out" the CIPP liner.

C. Chemical and Physical Properties

1. Unless otherwise specified, the Contractor shall furnish a general purpose, unsaturated, polyester or vinylester resin and catalyst system compatible with the CIPP process that provides cured physical strengths specified herein. The long-term flexural modulus to be used shall not exceed 50% of the short-term value for the resin system unless the tube contains reinforcements.
2. The finished Cured-In-Place Pipe (CIPP) shall be fabricated from materials which when cured will be chemically resistant to withstand internal exposure to domestic sewage.
3. The CIPP shall conform to the minimum structural standards in the Modified ASTM D-790

D. Material and Equipment Acceptance

1. At the time of manufacture, each lot of liner shall be inspected for defects. At the time of installation, the liner shall be homogeneous throughout, uniform in color, free of holes, foreign materials, blisters, or deleterious materials.

2. No sewer segment shall be lined without prior notification of the City. Each liner shall be subject to inspection by the City immediately before it is installed and defective liner shall be rejected.
3. The Contractor shall furnish, prior to use of the lining materials, satisfactory written guarantee of his/her compliance with the manufacturer's standards for all materials and techniques being used in the cured-in-place lining process. The Contractor shall provide certified test results from the manufacturer showing the material conforms with the applicable requirements. Materials not complying with requirements shall be rejected.

9.3 Sewer Rehabilitation Materials

B. General

1. The Felt Tube shall be fabricated to a size that, when installed, will neatly fit the internal circumference of the conduit. Allowance shall be made for circumferential stretching during insertion. Contractor is responsible to confirm pipe diameters and roundness for liner material calculations for each specific pipe location.
2. The minimum thickness for the liner material shall be verified by design calculations prepared by a Professional Engineer familiar with CIPP design for each specific pipe location. Design of the liner shall be based on the conditions of the existing pipe which shall be classified as fully deteriorated based on the definitions thereof contained in ASTM F1216 Appendix X1. The liner shall be designed to withstand all imposed loads, including live loads if applicable and hydrostatic pressure. The groundwater elevation above the invert of the existing sewer to receive lining shall be actual depth to crown. The proposed cured-in-place liner to be used shall be designed for a minimum fifty (50) year service life under continuous loading conditions.
3. The minimum length shall be that deemed necessary by the Contractor to effectively span the distance from the inlet to the outlet of the respective manholes unless otherwise specified. The Contractor shall verify the lengths in the field before impregnation. Individual inversion runs can be made over one or more manhole sections as determined in the field by the Contractor and approved by the City.

B. Tube

1. The sewn tube shall consist of one or more layers of absorbent non-woven felt fabric and meet the requirements of ASTM F1216, Section 5.1 or ASTM F1743, Section 5.2.1 or ASTM 5813, Section 5 and 6. 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 relatively uniform thickness so when compressed at installation pressures will equal or exceed the calculated minimum design CIPP wall thickness.
3. The tube shall be manufactured 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 installation.
4. No material shall be included in the tube which may cause delamination in the cured CIPP. No dry or unsaturated layers shall be evident.
5. The tube shall be marked for distance at regular intervals along its entire length, not to exceed five (5) feet. Such markings shall include the Manufacturer's name and identifying symbol.

C. Resin

The resin system shall be corrosion resistant polyester, vinyl ester, or epoxy, with initiators so when cured within the tube create a composite meeting the requirements of ASTM F1216, ASTM D5813 and ASTM F1743.

9.4 General Manhole Requirements

A. Summary

1. The Contractor shall perform the various types of manhole rehabilitation where shown on the plans and as specified in this section.
2. The rehabilitation of manholes shall be accomplished by the application or installation of a number of components either individually or together with other components. These may include but are not limited to grouts, bulkheads, protective coatings, linings, inserts, seals, castings and mechanical devices that, when installed, shall protect the structure from infiltration and inflow.
3. The manhole rehabilitation components shall not cause any adverse effects to any of the Owner's processes or facilities during or after application. The use of the product, by the Contractor, shall not result in the formation or production of any detrimental compounds or by-products at the wastewater treatment plant. The Contractor shall notify the City and identify any by-products produced as a result of the installation operations, test and monitor the levels, and comply with any and all local waste discharge requirements.
4. The Contractor shall cleanup and restore existing surface conditions and structures to original or better condition. Any rehabilitation component determined to be defective shall be repaired by the Contractor at no additional cost to the City. The Contractor shall conduct rehabilitation operations and cleanup in a manner to minimize obstruction and inconvenience to traffic, pedestrians, businesses, and property owners.

5. Regardless which activity occurs last, manhole rehabilitation or sewer main CIPP, all sewers and manholes within project shall be cleaned of all construction debris.

B. Description

1. These specifications cover all work necessary to furnish and install all manhole rehabilitation components. The Contractor shall deliver a finished product(s) including all materials, labor, and equipment for all dewatering, cleaning, removal of steps, bypass pumping, surface restoration, masonry work, cementitious lining, manhole bench/channel modifications or construction, protective coating of manhole interiors, frame, chimney, and cover repair; pipe and fittings, pipe seals, interior manhole drops, manhole inserts, external chimney seals, external joint seals, manhole frame seals and/or chimney seals, sanitary sewer manhole marking devices, new manhole castings, casting adjustments, grading and seeding needed to restore the area around the manholes to equal or better condition, root removal & prevention regardless of additional component work, and all other materials and operations necessary to complete the manholes and connections as shown on the plans, as specified, and as ordered by the City, except work which is specifically included under other contract items.
2. Lining of manholes shall include the bench unless manhole is to receive a new bench and channel as noted in the construction plans. Cost of work shall be included in the appropriate bid item as there will be no additional vertical linear foot calculation for payment of the bench lining.
3. Any obstruction(s) prohibiting access to a manhole shall be the Contractor's responsibility to remove at no cost to the City. The removal shall be coordinated with the property owner. No change order shall be given for obstruction removal and is the Contractor's responsibility to investigate site conditions and manholes prior to bid submittal and commencement of construction activities.

C. Requirements

1. Design drawings shall be submitted to the City Engineer for approval in accordance with the **Section 3** of these standards, General Rules and Requirements.
2. Product data, including manhole rehabilitation component, manufacturer, data sheets, ASTM references, material composition, manufacturer's recommended specifications, component physical properties and chemical resistance.
3. Manufacturer's recommended procedures for storing and handling materials, including Contractor's proposed method for complying to the storage and handling requirements.

4. Manufacturer's detailed description of the recommended material installation/application process including mixing, additives, set time, and all equipment required for quality product installation.
5. Technical data sheet on each manhole rehabilitation component applied/installed, stating the expected longevity of the component in a wastewater environment. Data sheet shall be based on independent third-party tests.
6. Manufacturer's detailed description of all required field-testing processes and procedures.
7. Copies of independent testing performed in the rehabilitation component, indicating that the product meets the requirements of these specifications.
8. By-pass pumping plan.
9. Certified statement from the manufacturer that the Contractor is approved to install the manhole rehabilitation component with certificates of completed training from each worker involved with the installation of the rehabilitation component.
10. Shop drawings shall be submitted to the City Engineer for approval for manhole castings, inside drop components, internal chimney seals, external joint sealants and wraps, epoxy frame and chimney seal, cementitious lining, sanitary sewer manhole markers, hydraulic cement mortar and extrudable gasket material. The submittal shall include documentation that the Contractor field verified the condition and sizes of all manhole frames and covers requiring replacement, along with the sizes of the proposed replacement frames and covers to insure the proper fit of all replacement castings. See Section 3, General Rules and Requirements, for more details on shop drawing submission.
11. A complete and accurate record of all work performed, and all components installed for each manhole rehabilitated.

9.5 Manhole Rehabilitation Products General

- A. "Interior Manhole Lining" includes cementitious products only as detailed herein.
- B. "Corrosion Barrier" includes either a Polymer/Polyurethane product as detailed herein or the Cementitious Coating AND an Epoxy coating as detailed herein. Both methods shall include cleaning and manhole repair as specified below.
- C. Manholes indicated to be both "Raised" and lined, shall receive lining on the existing manhole structure only.
- D. For details on initial manhole installation and product choice see **Section 5**.

9.6 Interior Manhole Lining

A. Hydraulic Cement Restoration Mortar

1. Restoration mortar and manhole frame seal/chimney seal shall be from a single manufacturer.
2. Materials shall be compatible with manhole substrate and with each other. Material shall also have a minimum of three years of successful service history in aggressive sewer environments where the restoration mortar and corrosion barrier coating were applied together.
3. Hydraulic Cement Mortar shall be used to stop leaks through cracks and holes. Material shall be Mainstay ML-10 as manufactured by Madewell Products Corporation, Strong-Plug by The Strong Company, Inc., or equal.
 - a. Composition: Blend of hydraulic cements and fillers
 - b. Compressive Strength – Conforming to ASTM C109
 - 1) One (1) Day: three thousand five hundred (3,500) psi
 - 2) Seven (7) Days: four thousand nine hundred (4,900) psi
 - 3) Twenty-Eight (28) Days: five thousand five hundred (5,500) psi
 - c. Tensile Strength – Conforming to ASTM C496
 - 1) Seven (7) Days: two hundred ninety (290) psi
 - 2) Twenty-Eight (28) Days: five hundred seventy-five (575) psi
 - d. Working Time: Forty-Five (45) to Ninety (90) seconds at seventy-seven degrees Fahrenheit (77° F)
 - e. Color: Dark Grey

B. Cementitious Coating

1. Cementitious Liner
 - a. Cementitious liner shall be a low shrinkage, high strength, polymer modified, sprayable microsilica mortar. Material shall be Mainstay ML-72 Sprayable Microsilica Cement Mortar as manufactured by Madewell Products Corporation or equal.
 - 1) Composition: Blend of cements, microsilica, thermoplastic fibers, densifiers, polymer admixtures and modifiers. Mortar shall not contain calcium aluminate cements or aggregates.

- 2) Thickness shall be a minimum of three quarters ($\frac{3}{4}$) inch and conform to manufacturer's direction.
- 3) Compressive Strength – Conforming to ASTM C109
 - a) One (1) Day: three thousand (3,000) psi
 - b) Twenty-Eight (28) Days: ten thousand (10,000) psi
- 4) Flexural Strength – Conforming to ASTM C-293
 - a) One (1) Day: five hundred thirty-five (535) psi
 - b) Twenty-Eight (28) Days: one thousand five (1,505) psi
- 5) Tensile Strength – Conforming to ASTM C-496
 - a) One (1) Day: three hundred thirty (330) psi
 - b) Twenty-Eight (28) Days: nine hundred ten (910) psi
- 6) Shrinkage – Conforming to ASTM C-490
 - a) Twenty-Eight (28) Days: @ 90% Rh percent – 0%
- 7) Uniaxial Tensile Bond Strength – Conforming to ASTM • C-882
 - a) Twenty-Eight (28) Days: three thousand four hundred forty (3,440) psi
 - b) Color: Dark Gray

2. Work Required

- a. Remove manhole steps.
- b. Prior to any repair work inside the manhole, all interior wall and invert surfaces shall be cleaned using a minimum of five thousand (5,000) pounds per square inch (psi) water to blast and remove all foreign matter, loose mortar, grease, oil residues, and to etch the surfaces. After pressure cleaning, surface is to be cleaned with degreaser or other solvents as needed in order to remove any film or residue on the surface. Structure shall then be pressure rinsed with water.
- c. Material removed from the manhole during cleaning capable of being washed down the sewer without causing any potential obstruction in the sewer may be washed down the sewer unless chemicals are used as part of the cleaning process. Objects that cannot be washed down the sewer shall be physically removed and disposed of at the Contractor's expense.
- d. If the initial water blast cannot be utilized due to structural conditions in the manhole or it does not remove all deposits, then a solution of muriatic acid (hydrochloric acid) at a ratio of one-part acid to ten parts water shall be applied by spraying from above the manhole.

After the acid solution is applied, it shall be washed off completely, and the manhole shall be allowed to dry. The mixing, application, and removal of the acid solution shall be done in strict accordance with the manufacturer's specifications and safety procedures. All waste materials resulting from the cleaning operation shall be removed from the manhole being cleaned and properly disposed of by the Contractor.

- e. Examine surface to receive restoration mortar. Notify the City if surfaces are not acceptable. Do not begin surface preparation or application until unacceptable conditions have been corrected.
- f. Prepare surfaces in accordance with lining manufacturer's instructions.
- g. Provide the City with a minimum of three (3) days advance notice of completion of surface preparation and start of application.
- h. Inspect cleaned surfaces to identify and mark corroded reinforcing steel, and to locate cracks, leaks and joints.
- i. Replace or treat corroded reinforcing steel, repair cracks and leaks and treat joints in accordance with manufacturer's instructions and as approved by the Engineer.
- j. All pipes penetrating manhole wall shall have exposed perimeters sealed.
- k. Refer to ICRI Technical Guideline No. 03730 – Surface Preparation Guidelines for the Repair of Deteriorated Concrete Resulting from Reinforcing Steel Corrosion.
- l. Apply Madewell Products Corporation's 1312P Epoxy Putty or approved equal after cleaning any exposed reinforcing steel to protect steel from contamination and re-rusting.
- m. Hydrostatic Leak Correction – All visible leaks shall be sealed by application of hydraulic cement mortar.
 - 1) Mix only one (1) to two (2) pounds hydraulic cement mortar at a time.
 - 2) Add water to form a viscous mass with consistency of modeling clay.
 - 3) Apply by hand trowel.
 - 4) Press mixed material firmly into place, starting at top of leak and working downward.
- n. Inject flowing leaks or cracks using a suitable polymer gel or foam approved by hydraulic cement mortar manufacturer. Remove excess or spilled material from concrete surface before application of cementitious liner.
- o. Inspect surfaces for soundness

- p. Prepare surfaces to have a minimum profile of $\frac{1}{16}$ -inch, with aggregate exposed.
- q. Before application of each material, surfaces to be lined will be inspected. Correct defects or deficiencies before application of subsequent material.
- r. Inspection by the City or the waiver of inspection of any portion of the work shall not relieve the Contractor of responsibility to perform the work as specified.
- s. Saturate all surfaces thoroughly with clean water.
- t. Apply restoration mortar, cementitious lining, as soon as water sheen is no longer visible.
- u. Apply cementitious liner in accordance with manufacturer's installation instructions. Apply coating to a point from below the cover's lip to a point where the bench and channel meet.
- v. Apply by one of the following methods:
 - 1) Low pressure, low volume spray equipment (rotor/stator or piston pumps).
 - 2) Wet mix shotcrete equipment.
 - 3) Hand trowel into place.
 - 4) Centrifugal application.
- w. Apply uniformly to substrate to the specified thickness. Do not apply to manhole frame.
- x. Do not trap air in corners, behind exposed reinforcing steel or between lifts.
- y. Finish surface with wood float, sponge float, broom or brush to produce textured surface upon which to apply corrosion barrier.
- z. Hot weather application:
 - 1) Follow manufacturer's instructions to reduce evaporation rate of surface moisture until Corrosion Barrier Mortar can be applied, if required.
 - 2) If applying mortar under conditions such as high temperatures of mortar, substrate or air, high winds and/or low humidity rapid evaporation of surface moisture can occur, causing plastic shrinkage cracking. Apply epoxy corrosion barrier a maximum of one (1) hour after placing cementitious liner.
 - 3) If conditions prevent application of epoxy corrosion barrier, refer to ACI 305R-91, Figure 2.1.5 to estimate the evaporation rate of surface moisture from the mortar. Cover with plastic film or wet burlap to limit evaporation rate to a maximum of 0.1 pounds per square foot per hour.

- aa. Cold weather application:
 - 1) Follow manufacturer's instructions for minimum application temperature and minimum number of days to protect from freezing.
 - 2) During cold weather, a period of three (3) or more days the average temperature drops below forty degrees Fahrenheit (40° F), place cementitious liner at a minimum temperature of fifty-five degrees Fahrenheit (55° F) and protect material from freezing for a minimum of three (3) days at a temperature between fifty-five degrees Fahrenheit (55° F) and seventy-five degrees Fahrenheit (75° F). Gradually reduce mortar temperature during the protection period so that the final twenty-four (24) hours is held as close to fifty-five degrees Fahrenheit (55° F) as practical.
 - 3) During periods not defined as cold weather, but when freezing temperatures may occur, protect the mortar against freezing as specified for cold weather for the first twenty-four (24) hours after application.
- bb. Clean manhole frame with a wire brush to remove all loose rust and any cementitious lining. Surface shall be clean and dry before application of manhole frame seal material.

C. Corrosion Barrier - Polymer/Polyurethane Foam Coating

- 1. Materials and Equipment
 - a. The materials to be utilized in the lining of manholes shall be designed and manufactured to withstand the severe effects of hydrogen sulfide in a wastewater environment. Manufacturer of corrosion protection products shall have long proven experience in the production of the lining products utilized and shall have satisfactory installation record.
 - b. Three thousand (3000) psi hydro blasting equipment shall be suited to remove corroded materials from the existing concrete/brick structure. Material removed from the manhole during cleaning, capable of being washed down the sewer without causing any potential obstruction in the sewer, may be washed down the sewer unless chemicals are used as part of the cleaning process. Objects not able to be washed down the sewer shall be physically removed and disposed of at the Contractor's expense.
 - c. Equipment for installation of lining materials shall be high quality grade and be as recommended by the manufacturer.
 - d. The lining system to be utilized for manhole structures shall be a multi-component stress skin panel liner system as described below:

e. Liner

| <u>Installation</u> | <u>Liner</u> |
|-------------------------|-------------------------------------|
| Moisture Barrier | Modified Polymer |
| Surfacer | Polyurethane / Polymeric blend foam |
| Final corrosion barrier | Modified Polymer |

- f. Modified polymer shall be sprayable, solvent free, two-component polymeric, moisture/chemical barrier specifically developed for the corrosive wastewater environment.
- g. Polyurethane Rigid Structure Foam, low viscosity two-component, containing flame retardants.
- h. Total thickness of multi-component stress skin panel liner shall be a minimum of five hundred (500) mils.

2. Inspection

- a. Prior to conducting any work, perform inspection of structure to determine need for protection against hazardous gases or oxygen depleted atmosphere and the need for flow control or flow diversion.
- b. Submit plan for flow control or bypass to the City for approval prior to conducting the work.

3. Surface Preparation

- a. Conduct surface preparation program to include monitoring of atmosphere for hydrogen sulfide, methane, low oxygen or other gases, approved flow control equipment, and hydro blasting equipment.
- b. Remove manhole steps.
- c. Hydro blasting equipment shall remove all corrosion from structure. Final product shall be a cleaned, dry surface ready for liner application.
- d. After completion of surface preparation, blasting phase, perform the seven-point check list, which is the inspection for:
 - 1) Leaks
 - 2) Cracks
 - 3) Holes
 - 4) Exposed Rebar
 - 5) Ring and Cover Condition
 - 6) Invert Condition
 - 7) Inlet and Outlet Pipe Condition
- e. After the defects in the structure are identified, repair all leaks with a chemical or hydraulic sealant designed for use in field sealing of

ground water. Severe cracks shall be “repaired with a urethane based chemical” sealant. Product to be utilized shall be as approved by City prior to installation. Repairs to exposed rebar, defective pipe penetrations or inverts, etc. shall be repaired utilizing non-shrink grout or approved alternative method.

4. Material Installation

- a. The limits of the corrosion protection system shall be all exposed concrete/brick surfaces including walls, tap sections, risers, etc., unless otherwise directed by the City.
- b. Application of multi-component system shall be in strict accordance with manufacturer’s recommendation. Final installation shall be a minimum of five hundred (500) mils. A permanent identification number and date of work performed shall be affixed to the structure in a readily visible location.
 - 1) Provide final written report to City detailing the location, date of report, and description of repair.

5. Inspection

- a. Final concrete/brick structure corrosion protection system shall be completely free of pinholes or voids. Entire exposed concrete/brick surface shall be protected with corrosion protection system. Liner thickness shall be the minimum value as described here.
- b. No leakage at base of sanitary system shall be acceptable.

6. Repair of Defects

- a. All defects identified during inspection such as pinholes, low film millage, etc. shall be repaired with same material.

D. Corrosion Barrier - Cementitious Coating and Epoxy Coating

1. Shall be either a Polymer/Polyurethane product OR a Cementitious Coating as specified herein AND an Epoxy coating as detailed as follows:
2. Epoxy coating - Material shall be Mainstay DS-5 Ultra High Build Epoxy Coating as manufactured by Madewell Products Corporation or approved equal.
 - a. Composition: one hundred (100) percent solids, modified epoxy coating.
 - b. Thickness: Minimum of one hundred (100) mils applied in one (1) or two (2) coats, depending on manufacture’s recommendation.
 - c. Number of Components: two (2)
 - d. Finish: Gloss
 - e. Color: White sky blue

9.7 Construct Manhole Channel or Bench

- A. Where indicated, the Contractor shall repair existing bench, adjust bench height, or create a new bench.
- B. The Contractor may be required as part of this work to temporarily restrict or eliminate flow from the existing sewer through the manhole while making the bench and flow channel modifications. It is anticipated this may be accomplished with the use of bypass pumping. At no time during the work shall raw sewage be discharged to the ground or any other location that would be in violation of the City's NPDES permit requirements.
- C. Bench shall be constructed using a high-strength cementitious product specifically designed for the intended use. Contractor shall supply Engineer with product data, including manufacturer and brand name, laboratory test results to verify twenty-eight (28) day compressive strengths, and a list of similar projects in which the product was used.
- D. All voids, irregularities, and leaks in the existing manhole shall be repaired with a high-strength, fast setting, hydraulic cement mortar prior to constructing bench.
- E. All surfaces shall be free of dirt, oil, grease, or other contaminants. Use a high-pressure washer to remove all foreign materials from the bench construction/repair areas. Construct bench (using form boards if required) in such a manner so as to produce a gradual slope towards the flow channel. Ensure that the thickness of the bench shall increase by no less than one (1) inch per foot from the top of the invert and continues in the direction of the wall so as to provide the required slope. The bench shall be free of voids. Level and smooth the surface of the bench.
- F. The cement material shall be given sufficient time to cure in accordance with the manufacturer's requirements prior to being subjected to active flow.

9.8 Interior Manhole Drop

- A. Internal drop pipes shall be installed where indicated in these specifications and on the plans in existing manholes following the installation of the manhole liner.
- B. Inside drop shall be constructed using RELINER Inside Drop Components as manufactured by Duran Inc., or equal. The bowl size shall be determined by incoming pipe size, flow rates, and manhole diameter and in accordance with manufacturer's recommendations. The bowl shall be installed as per manufacturer's instructions using stainless steel fasteners.
- C. The appropriately sized drop pipe of SDR 35 PVC shall be per **Section 5** and shall be securely attached to the manhole wall using stainless steel adjustable clamping brackets and stainless-steel fasteners. The connection of drop bowl to drop pipe shall be by flexible external pipe coupler. The turn-out at the base end of the drop pipe shall be accomplished with an appropriately angled PVC pipe elbow.

- D. Drop pipe will be installed where incoming invert of a pipe is greater than two (2) feet above the invert of the outgoing pipe. Interior drop component connections made to manhole walls shall be watertight.

9.9 New Manhole Castings and Covers

- A. Manhole frames and covers shall be in compliance with **Section 5** “Sanitary Sewer Materials.”
- B. Manhole lids shall be solid with two (2) inch letters stating, “Sanitary Sewer”.
- C. Manhole lids shall provide a gasket at the frame-lid interface for water tightness (Neenah self-sealing or Engineer approved equal).
- D. Frame to manhole seal shall be manufactured by Cretex Specialty Products of equal.
- E. Pick holes shall be concealed.
- F. Frames shall be placed on concrete rings or concrete cone, not on metal rings.
- G. All replaced castings shall be returned to the City.

9.10 Adjust Manhole Castings

- A. Castings shall be adjusted flush to ground level and be seated center to manhole entrance (cone, etc.). The ground surface shall slope away from the raised casting to prevent ponding and surface runoff from occurring over the casting.
- B. Castings to be adjusted above final grade per plans/specifications (or is pre-existing in this manner) with frame joint exposed shall receive an external chimney seal. All external joint(s) shall receive an external joint wrap.
- C. Precast adjustment rings, cone sections, barrel sections, etc. shall be used to adjust the top of the castings horizontal/vertical as needed to ground level or above grade as designated per the plans and/or specifications. Reposition the frame and seal to the manhole structure. The adjusting rings and top of casting are to be sealed with ½-inch extrudable gasket to produce watertight joints after casting has been wire brushed to remove all dirt and rust prior to being reinstalled. Adjustment rings shall be limited to one (1) foot of depth. Castings shall not be placed on metal rings.
- D. The Contractor shall be responsible for all demolition and surface restoration work required to complete raising the frame. Surface demolition and restoration work shall be in accordance with these specifications.

9.11 Raise Manholes

- A. Manholes shall be raised the height specified or shown in the Construction Plans.

- B. Four (4) foot diameter manhole riser sections and new flat top shall be provided, installed, and tested per **Section 8** and meet all applicable standards. Joints shall be sealed and wrapped per **Section 8**. Manhole casting riser rings up to twelve (12) inches shall be provided as necessary for final elevation.
- C. Existing castings and covers shall be re-set on the new flat tops unless casting and/or cover is noted to be replaced in the Existing Structure Rehabilitation Table in the Construction Plans.
- D. Payment shall be made based on vertical foot of increased elevation from current top of casting elevation to new top of casting elevation. Some existing manholes have cone sections. No additional payment shall be made for new riser sections necessary to replace current cone sections on existing manholes. This shall be included in vertical foot price for this item.
- E. The Engineer shall be notified if any existing manholes are determined to be structurally insufficient to support the extension. Direction on how to proceed will be provided by Engineer on a case by case basis.

9.12 Manhole Frame Seal/Chimney Seal

- A. A flexible epoxy shall be used to seal manhole frames and chimneys. The material shall be manufactured by Cretex Specialty Products or approved equal.
- B. Clean manhole frame with a wire brush to remove all loose rust, dirt and any cementitious lining. All surfaces shall be clean and dry before application of manhole frame seal material.
 - 1. If frame is loosed and/or offset, reposition the frame and seal to the manhole structure using one-half ($\frac{1}{2}$) inch extrudable gasket to produce a watertight joint. Frames shall be cleaned, and wire brushed to remove all dirt and rust prior to being reinstalled.
 - 2. Apply flexible epoxy manhole frame seal to a point two (2) inches above lower portion of manhole frame (e.g., where frame seats to cone) and to a point four (4) inches below lowest adjusting ring where there is no chimney. If adjusting rings are not present apply four (4) inches below joint between cone section or flat top section and frame. If chimney abuts frame, apply four (4) inches below said joint. Chimney shall be defined as any portion of manhole opening below the frame that has the same diameter as frame opening itself; therefore, epoxy coating shall cover entire portion to a point where it opens out to cone section or flat top section. Apply material with a putty knife to a uniform thickness and texture. Application shall be according to manufacturer's recommendations.
 - 3. Allow manhole frame seal to cure at least twenty-four (24) hours in load bearing applications. Do not apply below fifty degrees Fahrenheit (50 ° F). Protect from freezing for at least forty-eight (48) hours after application.

9.13 Structural Cone or Chimney Repairs

- A. Where indicated in these specifications and on the plans, the Contractor shall perform manhole cone or chimney repairs. The repairs shall generally consist of replacing missing mortar and brick. **Structural cone repairs shall be completed before installing interior manhole liner.**
- B. The manhole cones shall be repaired using a high-strength material specifically designed for the intended use. Contractor shall supply Engineer with product data, including manufacturer and brand name, laboratory test results to verify compressive strengths, and a list of similar projects in which the products were used.
- C. The cone areas requiring repair shall be thoroughly cleaned to remove all loose mortar and brick, dirt, vegetation, and other contaminants.
- D. Loose and/or offset frames shall be removed. Frames shall be cleaned, and wire brushed to remove all dirt and rust prior to being reinstalled.
- E. Voids resulting from missing brick and mortar shall be repaired with new brick and mortar. All brick used for the cone repairs shall be designed for use in the construction of sanitary manholes and sewers and be capable of withstanding the corrosive environments associated with wastewater. High strength mortar suitable for use in the construction of manholes and capable of withstanding the corrosive environments associated wastewater shall be used in the cone repairs.
- F. The original, cleaned frames shall be reset during the cone repairs. A watertight seal shall be provided between the frame and masonry.
- G. Exposed, exterior cone shall be coated with the same product used for the interior manhole lining to give the manhole a smooth finish. Exterior cone shall be lined from the rim to existing grade.

9.14 Pipe Seals

Where manholes do not receive interior manhole lining, pipes designated to be sealed on the plans shall be sealed along its outer perimeter (at wall of manhole) with a watertight, hydraulic sealant. No excavation will be allowed, unless authorized by the Engineer.

9.15 Reset Frame

If frame is loose, offset or otherwise directed to be performed as indicated in the plans, reposition the frame and seal to the manhole structure using one-half (½) inch extrudable gasket (Kent Seal or approved equal) to produce a watertight joint. Loose and/or offset frames shall be removed. Frames shall be cleaned, and wire brushed to remove all dirt and rust prior to being reinstalled.

9.16 Experience

Onsite supervisor shall have twenty-five thousand (25,000) feet and/or two hundred (200) line sections of lining experience installing the listed product, and the product should have a minimum of two hundred thousand (200,000) feet and/or one thousand (1,000) line sections installed. The Contractor and the Contractor's key personnel shall have a minimum of one hundred thousand (100,000) feet and/or three hundred (300) line sections of lining experience. The Contractor, supervisor and product shall have a minimum history of five (5) years together.

9.17 Sanitary Sewer Rehabilitation General Installation Procedures

The following installation procedures shall be adhered to unless otherwise approved by the Engineer.

A. Inspection of Pipelines

Inspection of pipelines shall be performed by experienced personnel trained in locating breaks, obstacles and service connections by closed circuit television (CCTV). The interior of the pipeline shall be carefully inspected to determine the location of any condition, which may prevent proper installation of the new pipe. Defects shall be noted so that these conditions can be corrected. The City shall keep a suitable log for later reference.

B. Safety

The Contractor shall carry out his operations in strict accordance with all applicable OSHA standards. Particular attention is drawn to those safety requirements involving working with scaffolding and entering confined spaces.

C. Cleaning and Root Treatment of Sewer Line

It shall be the responsibility of the Contractor to remove all internal debris and root growth from the sewer line necessary to complete this work (Refer to **Section 10**). All general cleaning shall be covered in this section.

D. Bypassing Sewage

The Contractor shall provide for the flow of sewage around the section or sections of pipe designated for liner. The bypass shall be made by plugging the line at an existing upstream manhole and pumping the flow into a downstream manhole or adjacent system. The pump and bypass lines shall be of adequate capacity and size to handle the flow. The Contractor shall be responsible to notify all property owners that will be affected by the diversion and/or the temporary loss of service two (2) weeks in advance. The Contractor shall not temporarily interrupt service from any one property owner for more than twenty-four (24) hours.

If required for service laterals, the contractor will be responsible to furnish all the necessary equipment to safely divert the flow around the work area. The diversion

shall be Engineer approved. No flow shall be discharged on the surface, into storm sewers, ditches, or in waterways.

E. Line Obstructions

It shall be the responsibility of the Contractor to clear the line of obstructions such as solids that will prevent the insertion of the liner. If inspection reveals an obstruction that cannot be removed by conventional sewer equipment, then the Contractor shall hydraulically re-round the pipe using a trenchless method or make a point repair excavation to uncover and remove or repair the obstruction. Such repair shall be approved in a Change Order prior to the commencement of the work.

9.18 Sanitary Sewer Mainline Liner Installation Procedures

A. Set-Up

1. In general, the CIPP installation shall be in accordance with ASTM F1216, Section 7 or ASTM F1743, Section 6.
2. The Contractor shall designate a location where the felt tube will be vacuum impregnated prior to installation. The Contractor shall allow the City to inspect the materials and "wet out" procedure. A catalyst system compatible with the resin and tube shall be used.
3. The wet-out tube shall be inserted through an existing manhole or other approved access by means of an inversion or cable and winch process. In the case of the inversion method, the application of a hydrostatic head shall be sufficient to fully extend the tube to the next designated manhole or termination point. The tube shall be inserted into the vertical inversion standpipe with the impermeable plastic membrane side out. At the lower end of the inversion standpipe, the tube shall be turned inside out and attached to the standpipe so that a leak proof seal is created. The inversion head will be adjusted to be of sufficient height to cause the impregnated tube to invert from manhole to manhole and hold the tube tight to the pipe wall, produce dimples at side connections and flared ends at the manholes. The Contractor shall use a lubricant as necessary. Care shall be taken during the elevated curing temperature so as not to over stress the felt fiber.

B. Curing

1. After installation is completed the Contractor shall supply a suitable heat source and hydrostatic water pressure recirculation equipment. The equipment shall be capable of delivering hot water throughout the section by means of a pre-strung hose to uniformly raise the temperature above the temperature required to effect a cure of the resin. This temperature shall be determined by the resin/catalyst system employed.
2. The heat source shall be fitted with suitable monitors to gauge the temperature of the incoming and outgoing water supply. Another such

gauge shall be placed between the impregnated tube and the pipe invert at the remote manhole to determine the temperatures during cure. Temperature in the line during the cure period shall be as recommended by the resin manufacturer.

3. Initial cure shall be deemed to be completed when inspection of the exposed portions of CIPP appears to be hard and sound and the remote temperature sensor indicates that the temperature is of a magnitude to realize an exotherm. The cure period shall be of a duration recommended by the resin manufacturer, as modified for the CIPP process, during which time the recirculation of the water and cycling of the heat exchanger to maintain the temperature continues.

C. Cool-Down

The Contractor shall cool the hardened CIPP to a temperature below 100°F before relieving the static head in the inversion standpipe. Cooldown may be accomplished by the introduction of cool water into the inversion standpipe to replace water being drained from a small hole made in the downstream end. Care shall be taken in the release of the static head so that a vacuum will not be developed that could damage the newly installed CIPP.

D. Finish

1. The finished CIPP shall be continuous over the entire length of an inversion run and be as free as commercially practicable from visual defects such as foreign inclusions, dry spots, pinholes, folds, lumps, and delamination.
2. During the warranty period any defects which will affect the integrity or strength of the CIPP shall be repaired at the Contractor's expense, in a manner mutually agreed by the Engineer and the Contractor.
3. Alternate methods of installing and curing the tube shall be submitted to the Engineer for approval.

E. Sealing the CIPP at Manholes (Watertight Seals)

The CIPP liner joint at all incoming pipes and outgoing pipes at manhole walls shall be made watertight (no exceptions) by the use of an injection grout such as Avanti 202 or Engineer approved equal and further sealed with a hydraulic mortar such as Mainstay ML-10 or Engineer approved equal.

F. Sewer Lateral Reinstatements

After the liner has been cured in place, the Contractor shall reconnect any existing active connections (laterals, outside drops, etc.). The Contractor shall be responsible to confirm the active laterals prior to reconnection. This shall be done without excavation from the interior of the pipeline by means of a television camera and a cutting device that re-establishes the service connections to not less than ninety-five (95) percent capacity. If after reconnection the lateral connection

continues to actively leak, the Contractor shall inform the Engineer and provide Engineer with CCTV video of the leaking lateral connection. After review of the CCTV video and if deemed not a result of Contractor activities, and If directed by the Engineer, the Contractor shall perform a point repair on the lateral connection. Such repair shall be approved in a Change Order prior to the commencement of the work. The Contractor is responsible for paying for any and all repairs if it is deemed to be damaged during the cut-out process for the service lateral or during CIPP installation. All work for trenchless lateral reconnection shall be paid for on a unit price basis based on the number of laterals reinstated. The City reserves the right not to reinstate a lateral determined to be inactive in the field. Under no circumstances shall a cookie from a lateral reinstatement be allowed to pass through the sanitary sewer system. Contractor shall capture all cookies at time of reinstatement.

9.19 Clean-Up

- A. Upon acceptance of the installation work and testing the Contractor shall restore the project area affected by his/her operations. The Contractor shall restore or replace all removed or damaged paving, curbing, sidewalks, gutters, or other disturbed surfaces or structures to a condition equal to that before the work began, to the satisfaction of the City. The Contractor shall furnish all labor and material incidental thereto, at no additional cost to the City.
- B. The Contractor shall remove surplus pipe, tools and temporary structures. All dirt, rubbish and pipe material from the operation shall be legally disposed of by the Contractor.

9.20 Patents and Warranties

- A. Sanitary Sewer Rehabilitation Warranty
 - 1. The Contractor shall warrant and save harmless the City against all claims for patent infringement and any loss thereof.
 - 2. The Contractor shall warrant all work to be free from defects in workmanship and materials for a period of one year from the date of substantial completion of all construction.
- B. Manhole Rehabilitation Warranty
 - 1. The materials used for the project shall be certified by the manufacturer for the specified purpose. The manufacturer shall warrant all manhole rehabilitation components to be free of defects in raw materials for one (1) year from the date of substantial completion. The Contractor shall warrant the installation of the manhole rehabilitation component for a period of one (1) year. During the one (1) year warranty period if any rehabilitation component fails, delaminates, peels, fractures or shows defect which may affect the integrity, strength, function, and/or operation of the manhole it shall be repaired at the Contractor's expense equal to better than the original condition.

2. Manhole lining and corrosion barrier shall have a ten (10) year warranty for leaks.

9.21 Pipe Liner Sections

All sections of pipe shall be the responsibility of the Contractor to verify the size, material, location of structures, number and location of laterals, and existing condition of the pipe prior to construction. The bid proposal contains estimates of the sizes and quantities of liner which will be installed. It shall be the Contractor's responsibility to verify the exact lengths necessary after the segments have been selected and prior to ordering or fabricating any liner materials.

9.22 Quality Assurance

A. Sanitary Sewer Quality Assurance

1. Contractor shall be responsible for implementing quality assurance/quality control procedures necessary to ensure that all post-CIPP CCTV inspection video and observation data meet the requirements of the specification. The City will compare the work products submitted as the Five Percent Submittal against the specification requirements contained herein. Necessary quality improvement requirements will be returned to the Contractor within five working days after the City receives the submittal. Thereafter, the City will conduct a quality review of the submittal and notify the Contractor of any deficiencies or rejected work products. The Contractor shall be responsible for correcting or re-televising any rejected segments identified by Engineer. No sewer pipe segment (manhole to manhole run) shall undergo CIPP lining until Engineer has reviewed and approved the respective pipe segment. Contractor shall be responsible for review of post-CIPP videos for accuracy, clear to view and completeness before submitting to Engineer for review and approval. Incomplete and/or inaccurate post-CIPP videos will be returned to Contractor for resubmittal.
2. Contractor shall resubmit videos to Engineer for review and approval that are accurate and complete and at no additional cost to City. No CIPP payment for installation will occur until accurate and complete post-CIPP books containing logs and videos are submitted, reviewed and approved by Engineer. Both log and video screen data shall be complete, clear to view and accurate.

B. Manhole Quality Assurance

1. A detailed quality assurance plan shall be submitted to the Engineer that conforms to the requirements of these specifications. At minimum the quality assurance plan shall include the following:
2. A detailed description of the proposed quality assurances to be performed by the Contractor.

3. Proposed procedures for quality assurance, product sampling and testing shall be defined.
4. Proposed methods for product performance controls, including method of and frequency of product sampling and testing both in raw material form and cured product form as applicable.
5. A scheduled performance and product test result reviews between the Contractor and the Customer at a scheduled job meeting.

9.23 Testing

A. Sanitary Sewer Testing

1. The water tightness of the CIPP shall be gauged while curing and under a positive head. Any leaks shall be repaired and retested to the satisfaction of the City. The finished liner shall be continuous over the entire length of the installation and conform to the walls of the host pipe.
2. As part of the testing requirement, upon completion of the installation and lateral reconnection, a visual inspection of the expanded in place pipe shall be performed via a closed-circuit television camera. Digital CCTV Recordings on DVD of the inspection shall be provided to the City.
3. At minimum Contractor shall perform one test per manhole to manhole. Section of CIPP placed and cured per NASSCO Standards. Contractor shall provide Engineer with written test report immediately for City records.

B. Manhole Testing

1. The liner system shall be visually inspected to be free of pinholes or voids.
2. The liner thickness shall be the minimum value as specified herein. Contractor shall test four (4) individual locations of liner for proper minimum thickness and provide written documentation to Inspector for each manhole.

9.24 Qualifications

The Contractor shall submit his/her qualification package detailing their experience and resumes of employees that will be performing the work within five (5) days after the submittal of the bid. The submittal shall include a minimum of three (3) projects similar in size and include the amount of pipe rehabilitated as well as contacts for those projects.