

CURED-IN-PLACE PIPE LINING

PART 1 – GENERAL

1.1 THE REQUIREMENT

- A. This specification covers the work necessary to furnish, install, and complete the cured-in place thermosetting resin pipe (CIPP) lining system. This system involves the reconstruction of deteriorated sewer mains by the installation of a resin-impregnated flexible tube formed to the original conduit. The new CIPP will be seamless, jointless, tight fitting and continuous from manhole to manhole. The new CIPP shall serve as a fully functional stand-alone pipe and will not depend on the host pipe for any structural capacity. The Contractor shall provide all materials, labor, equipment, and services necessary for bypass pumping and/or diversion of sewage flows, cleaning and television inspection of sewer to be lined, liner installation, reconnection of sewer pipelines, and final television inspection and testing of lined pipe system.

1.2 JOB CONDITIONS

- A. The CCTV video logs of the sewer pipelines are available for inspection at the _____.
- B. The materials and conditions indicated in the video are the result of investigations made by the District. There is no guarantee, either expressed or implied, that the conditions represent existing conditions or that unforeseen developments may not occur. Interpretation of the reports presented is the responsibility of the Contractor.

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. The following references are part of this Specification. The latest edition of the following references shall be used:

ASTM D543 Standard Test Methods for Resistance of Plastics to Chemical Reagents.

ASTM D790 Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

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 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 (CIPP).

1.4 SUBMITTALS

- A. Provide submittals on all lining materials and resins, and furnish manufacturer certification that the liner materials are in compliance with the specifications, codes, and standards referenced herein. The submittals shall include details of all component materials and construction details including manufacturer's recommendations for storage procedures and temperature control, handling and inserting the liner, curing details, sewer and lateral reconnection methods, trimming, terminations, and finishing. Provide manufacturer's certification, field measurements, and pipe sizing calculations which demonstrate that the liner has been properly sized to avoid the creation of wrinkles or folds and to avoid gaps between the liner and the host pipe.
- B. Submit a sewage bypass pumping and/or diversion plan for review by the Engineer at least ten (10) working days prior to beginning pipe rehabilitation. The sewage bypass pumping and/or diversion plan shall comply with requirements in this Section, including an emergency response plan to be followed in the event of a failure of the bypass pumping and/or diversion system. The Contractor's plan for sewage bypass pumping and/or diversion shall be satisfactory to the Engineer before the Contractor shall be allowed to commence sewage bypass pumping and/or diversion.
- C. Submit the resin manufacturer's heating requirements and written general curing guidelines.
- D. Submit manufacturer's information showing that the specific CIPP system proposed to be used has been commercially proven and has been successfully installed in at least 4 wastewater collection systems in the United States.
- E. Submit manufacturer's certifications for the technicians that will be installing the liner showing that they have been certified to operate the equipment.
- F. Submit a statement listing projects under which the Installation Contractor has installed CIPP. Include project names, footage of CIPP installed, date work completed, and owner's contract name and phone number.
- G. Submit name and contact information for laboratory proposed to perform testing on pipe lining material.

H. Submit certified test results for testing performed on pipe lining materials.

1.5 QUALITY ASSURANCE

- A. The Contractor shall have a minimum of three (3) years of active experience in the commercial installation of CIPP liners, under the Contractor's license. Projects submitted for qualification which were not installed under the contractor's license used to bid will not be considered. These installations must have been in service for at least 1 year and must total over 50,000 lineal feet of CIPP liners.
- B. The finished liner shall be continuous over the entire length of an insertion run between two manholes or access points and shall be free from visual defects such as foreign inclusions, dry spots, pinholes, and delamination.
- C. Wrinkles in the finished liner pipe that cause a backwater greater than ½- inch or reduce the hydraulic capacity of the pipe are unacceptable and shall be removed and/or repaired by the Contractor at the Contractor's expense. The Contractor shall remove a section of pipe, if so directed by the Engineer, to determine if a void between the wrinkle and pipe wall exists. If so proven that a void does exist the Contractor shall repair and replace that section of pipe at the Contractor's expense. If a void does not exist, the Contractor shall repair and replace that section of pipe at the District's expense. Methods of repair shall be proposed by the Contractor and submitted to the Engineer for review.
- D. The Contractor shall televise the existing pipe in the presence of the Engineer within two working days prior to beginning construction. Pipe sections CCTV inspected after the cleaning or point repairs will not have to be re-inspected again until after the lining is placed and cured. The original recording and two copies of the TV inspection report shall be submitted to the Engineer in accordance with this section. The television inspection performed by the Contractor after the sewer cleaning operation shall be done with a CCTV pan and tilt color camera recorded in a format that is acceptable to the District. A written report shall highlight potential problem areas (e.g. sags, bends, etc.). The TV inspection shall be conducted during low flow periods or after the bypass pumping system is in operation. All video inspection shall include voice descriptions and stations on the video. Any inadequate quality or coverage, as determined by the Engineer, shall require the Contractor to reinspect and record that pipeline segment at no additional expense to the District.

PART 2 - PRODUCTS

Cured-In-Place Pipe Lining

2.1 MATERIALS

- A. The CIPP liner system and installation method shall be a commercially proven system.
- B. Liner Tube:
 - 1. The liner tube shall consist of one or more layers of flexible needled felt or an equivalent woven and/or nonwoven material capable of carrying resin, withstanding installation pressures and curing temperatures, and is compatible with the resin system used. The liner shall be fabricated to a size that, when installed, will tightly fit the internal circumference of the existing pipe without any annular space between the liner and existing pipe wall. The tube shall be homogenous across the entire wall thickness containing no immediate or encapsulated elastometric layers. No material shall be included in the total that may cause delamination in the cured CIPP. No dry or unsaturated layers shall be evident. The pipe diameters shown on the plans are nominal diameters.
 - 2. The resin used shall be compatible with the rehabilitation process, shall be able to cure in the presence or absence of water and the initiation temperature for cure shall be as recommended by the resin manufacturer and reviewed by the Engineer.
 - 3. The liner shall be fabricated from materials which when cured will be chemically resistant to withstand internal exposure to sewage gases containing quantities of hydrogen sulfide, carbon monoxide, methane, petroleum hydrocarbons, saturation with moisture, diluted sulfuric acid, and other chemical reagents determined by the Engineer. 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 inspection equipment may be made.
 - 4. The minimum tube length shall be that deemed necessary by the Contractor to effectively span the distance from the inlet to the outlet of the respective manholes, or access points, unless otherwise specified. The Contractor shall verify the lengths in the field before impregnation of the tube with resin. Individual insertion runs may be made over one or more manhole sections as determined in the field by the Contractor and reviewed by the Engineer.
 - 5. Prior to insertion, the liner shall be free of all visible tears, holes, cuts, foreign materials, and other defects.

6. Materials and manufacture of the CIPP lining shall conform to the requirements of ASTM D5813.

C. Resin:

1. The resin used shall be compatible with the rehabilitation process, shall be able to cure in the presence or absence of water and the initiation temperature for cure shall be as recommended by the resin manufacturer and reviewed by the Engineer.
2. The resin system shall be a corrosive resistant, thermosetting, polyester vinylester resin or epoxy resin able to cure in the presence or absence of water, and a catalyst system compatible with the insertion process.

2.2 PHYSICAL PROPERTIES

- A. The CIPP system shall conform to and comply with the minimum standards listed below.

<u>Characteristic</u>	<u>Test Method</u>	<u>Polyester Resin</u>	<u>Vinylester and Epoxy Resins</u>
Flexural Strength	ASTM D790	4,500 psi	5,000 psi
Flexural Modulus(short term)	ASTM D790	250,000 psi	300,000 psi
Flexural Modulus(long term)		125,000 psi	150,000 psi

- B. The liner thicknesses are based on a pipe ovality of 2 percent and the resin's physical properties shown in this specification herein and in accordance with the Design Equations in Appendix XI of ASTM F1216. If the Contractor uses resins having different physical properties, the Contractor shall submit detailed calculations of the proposed liner thickness for review by the Engineer. The calculations shall consider pipe diameter and pipe depth and assume:

1. Enhancement Factor $K = 7$
2. Minimum Required Thickness = 3.00 mm.
3. Groundwater level above pipe = as indicated on plans.
4. Live load = H20 Highway.
5. Soil Depth = as indicated on plans

6. Soil Density = 100lbs/cubic foot

- C. The physical properties of the installed liner shall be verified through field sampling and laboratory testing as approved and directed by the Engineer. The Contractor where directed shall cut a sample from a section of installed liner pipe at the upstream, downstream, or an intermediate manhole/access pit that has been inserted through a same diameter pipe acting as a mold. One sample per every 1,500 feet of 6 and 8-inch diameter liner will be required. Liner pipe samples shall be submitted to a registered independent third party laboratory which has been pre-approved by the Engineer and tested for flexural modulus (short term) in accordance to the requirements of ASTM 1216, ASTM 1743, and ASTM D790 to confirm that the liner pipe conforms to the minimum requirements specified. The cost of testing shall be paid by the Contractor.

PART 3 – EXECUTION

3.1 PREPARATION

A. Notification

1. Maintain service usage throughout duration of project.
 - a. Maximum amount of time of no service: 10 hours for any property served by sewer. Any service out longer than 10 hours will be bypassed to a sanitary sewer.
 - b. The Contractor is responsible for notifying homeowners and businesses whose sewer laterals may be impacted by the lining work by contacting all homeowners and businesses at least 48 hours prior to commencement of work. In addition, the Contractor shall place written notification (door hangers) on each home or business at least 24 hours prior to commencement of work.
 - 1) The written notification shall have the following minimum information:
 - a) Contractor Name
 - b) Summary of work to be completed
 - c) The date and time of when the work will commence
 - d) The duration of the impact (start and stop time)
 - e) Contractor contact information for questions

B. Bypass Pumping:

1. Bypass pumping (diversion of sewage flows and storm water around the sewer lateral reinstatement work areas) required if any service is out longer than 10 hours.
2. Furnish, install, and operate pumps, plugs, conduits, and other equipment to bypass/divert the flow of sewage around the pipeline reach in which work is to be performed. Plugs shall be designed so that all or any portion of the sewage can be released. The plug shall be provided with a tag line. The Contractor shall be prepared to provide a pumping system of sufficient capacity to handle the same volume flow as the existing sewer pipe, and the system shall run continuously until the existing sanitary sewer is back into service. If pumping is required on a 24-hour basis and engine drives are required, engines shall be equipped in a manner to keep noise to a minimum. Standby pumps shall be provided as required. Pumping shall be done in such a manner as will not damage public or private property or create a nuisance or health menace. After the work has been completed, flow shall be restored to normal.

C. Cleaning and Inspection of Existing Sewer:

1. The Contractor shall be responsible for cleaning, inspecting, confirming the inside diameter and determining the condition of each manhole-to-manhole segment of the existing sewer to be lined. The cleaning process shall include the removal of all roots, solids, or obstructions removable with sewer cleaning equipment, that will prevent the insertion of CIPP.
2. A television inspection shall be performed by the Contractor after the sewer cleaning operation and point repairs are completed. The television inspection shall be completed in the same direction each time and shall be done with a CCTV pan and tilt color camera recorded as specified in Paragraph 1.4 of this Section.

D. Repairs:

1. The Contractor shall repair the pipe where point repairs and protruding laterals are identified during Contractor's CCTV inspection. The Engineer must approve all point or protruding lateral repairs. The work shall include verifying the location of the point repair through internal television inspection of the pipe, locating all interfering utilities, excavation, dewatering, pipe repairs or replacement, backfilling, surface restoration, temporary flow bypassing, sewer dewatering, and traffic control. The Contractor will be paid as extra work for the number of point repairs or protruding laterals cut off.

2. It shall be the responsibility of the Contractor to clear the line of obstructions such as solids, offset joints, protruding service connections or collapsed pipe that will prevent liner insertion. If inspection reveals an obstruction that cannot be removed by conventional sewer cleaning equipment or by remotely performed point repair methods acceptable to the Engineer, then the Contractor shall make a point repair excavation to uncover and remove or repair the obstruction. Before any point repair or excavation is pursued, the Contractor shall give the Engineer three (3) working days notice. Point repair excavation shall proceed only with the Engineer's written authorization. Protruding laterals shall be removed either internally with a hydrojet cutter or by external point repair.
3. The replaced section of pipe shall provide a smooth transition from the existing pipe to the new pipe.
4. The Contractor may discover other point repairs during the pre-lining TV inspection. If additional point repairs are required, the Contractor shall recommend point repair method to the Engineer. Contractor shall make point repairs favorably reviewed by the Engineer. Payment for this extra work shall be in accordance with the General Conditions.

E. Manholes;

1. The Contractor shall protect the manholes to withstand forces generated by equipment, water or air pressure used while inserting the tube. The Contractor shall be fully responsible for any damages to existing utilities caused by the Contractor's operations.

3.2 INSTALLATION

A. Resin Impregnation:

1. The uncured resin in the original containers and the unimpregnated fiber-felt tube shall be impregnated by vacuum or other means prior to installation. The materials and "wet-out" procedure shall be subject to inspection by the Engineer. A resin and catalyst system that is compatible with the requirements of the method shall be used. 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.
2. After 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.

3. The impregnated liner bag shall be transported to and stored at the site in such a manner that will not be damaged, exposed to direct sunlight, or result in any public safety hazard. The impregnated liner bag shall be kept cool during shipment and storage at a temperature recommended by the manufacturer. All materials shall be subject to inspection and review by the Engineer prior to installation.

B. Liner Installation:

1. The impregnated tube shall be inserted through an existing manhole or other access approved by the Engineer by means of the installation process. The application of hydrostatic head, compressed air, or other means shall fully extend the liner to the next designated manhole or termination point and inflate and firmly adhere the liner to the pipe wall.
2. Install CIPP lining in accordance with the installation recommendations of ASTM F1216 (inversion method) or ASTM F1743 (pulled-in-place method).
3. The liner manufacturer shall provide the minimum pressure required to hold the liner tight against the host pipe and the maximum allowable pressure to avoid damage to the liner. The minimum pressure shall include consideration of potential groundwater pressure on the outside of the liner. The pressure shall be kept within those limits throughout the installation and curing process. The Contractor shall maintain a log of the pressure throughout the process.

C. Curing:

1. After placement is completed, provide a suitable heat source and distribution equipment. The equipment shall be capable of circulating hot water, air, and/or steam throughout the section by means of a pre-strung hose which has been perforated in accordance with the manufacturer's recommendations or other methods acceptable by the Engineer to raise the temperature uniformly above the temperature required to effect a resin cure. This temperature shall be determined by the manufacturer based on the resin/catalyst system employed.
2. The heat source piping shall be fitted with continuous monitoring thermocouples to gauge the temperature of the incoming and outgoing water, steam, and/or air supply. Water, steam, or air temperature during

the cure period shall meet the requirements of the resin manufacturer as measured at the heat source inflow and outflow return lines. At the direction of the Engineer, the Contractor shall provide standby equipment to maintain the heat source supply. An additional continuous monitoring thermocouple shall be placed between the impregnated felt tube and the pipe invert at the remote manhole to determine the temperature during the cure. The temperature during the cure shall be in accordance with the resin manufacturer's recommendation.

3. The initial cure shall be deemed to be completed when inspection of the exposed portions of the liner appear hard and sound and the remote temperature sensors indicate that an exotherm has occurred. The cure period shall be of duration recommended by the resin manufacturer during which time the recirculation of the water, steam, and/or air and cycling of the heat exchanger continuously maintain the required temperature.
4. Temperature shall be maintained during the curing period as recommended by the resin manufacturer, and shall follow the heating schedule supplied by the manufacturer and reviewed by the Engineer.

D. Cool Down:

1. The hardened liner shall be cooled to a temperature below 100 degrees F before relieving the static head or pressure in the lined pipe and returning normal flow back into the system. The cool down may be accomplished by introducing cool water or air into the lined pipe. Care shall be taken in the release of the static head or pressure so that a vacuum will not develop which could damage the newly installed liner.
2. To make a tight seal at the manhole walls, a seal consisting of a resin mixture compatible with the liner/resin system shall be applied in accordance with manufacturer specifications and approved by the Engineer.

E. Service Lateral Reinstatements

1. The Contractor shall be responsible for identifying and reconnecting the laterals to the lined pipe. Reinstatement of laterals as identified by CCTV, not as shown on the plans, shall be completed by an internal reinstatement by using a pivot-head CCTV camera and a remote cutting tool to locate the lateral from the inside of the lined pipe and cutting a hole matching the lateral diameter. The Contractor shall provide a nearly full-diameter hole, free from burrs or projections by brushing the lateral connection area to provide a smooth and crack-free edge. The hole shall be 95% minimum and 100% maximum of the original lateral connection. The

invert of the lateral connection shall match the bottom of the reinstated lateral opening and be flush with the rehabilitated sewer main.

3.3 TESTING

A. Material Testing:

1. All material testing shall be performed by a registered independent, third-party laboratory.
2. The Contractor shall provide certified test results of the in-place properties of the lining material from the actual installed liner at the minimum number of locations in accordance with Paragraph 2.2.C of this Section and at locations approved by the Engineer.
3. The installed liner shall be sampled and tested for wall thickness and flexural properties in accordance with the requirements of ASTM F1216 (inversion method) or ASTM F1743 (pulled-in-place) method and ASTM D790.
4. The Contractor shall replace the pipeline in any reach that the liner samples fail to meet the project requirements.
5. The layers of the cured CIPP shall be uniformly bonded. It shall not be possible to separate any two layers with a probe or point of a knife blade so that the layers separate certainly or the probe or knife blade moves freely between the layers. If separation of the layers occurs during testing of field samples, new samples will be cut from the work. Any reoccurrence may cause rejection of the work.

B. Field Testing:

1. After completion of all liner insertions, and finish work at the manholes, the sewer shall be televised with a color CCTV pan and tilt-head camera recorded in accordance with Paragraph 1.4 of this Section. The original and two copies of the recording shall be provided to the Engineer.

3.4 TV INSPECTION

- #### A.
- After installation and reinstatement of laterals the sewer line will be reviewed by TV inspection. The camera shall be a pan and tilt camera system and shall be specifically designed and constructed for the sewer environment. The camera shall include: a solid state color TV camera with a panning and rotational camera head, remote adjustable optional focus and automatic light compensation iris with remote override, camera controller with remote focus, iris and auto

centering control and camera lighting system. The camera shall measure and record video inspection length.

- B. The inspection report shall be in a format that includes, at a minimum, the following:
1. Summary list of all pipeline segments (assets) inspected (i.e., manhole to manhole, cleanout, flusher branch or drain inlet).
 2. Inspection Reports (log sheets) of each segment.
 3. Video of each segment.
 4. Identify each asset (e.g., cleanout, manhole, pipeline, etc.) based on nomenclature provided by the Engineer.
 5. Engineer will provide list of required attribute data (e.g., upstream and downstream manhole or cleanout number, pipe type, pipe diameter, joint length, TV length, operator name, date, direction forward or reverse setup, facility location, street name, tape number, etc.) to be used during inspection.
- C. The following shall be recorded, at a minimum, as audio information for each section:
1. Date of inspection
 2. Verbal confirmation of upstream and downstream manhole numbers
 3. Verbal descriptions of pipe size and type
 4. Verbal description and location of defect
- D. During the CCTV inspection, the running screen shall show the following information on the screen away from the central focus of the main:
1. Running footage (distance traveled)
 2. Date
 3. Time of day
- E. The maximum rate of videotaping shall be 30 feet per minute. One copy of the recording shall be turned over to the Engineer at the end of each work day that TV inspection is completed. A second copy shall be provided to the District within five (5) working days of completing all of the TV inspection on the

project. If video is not reviewable after review by the Engineer, the CCTV inspection shall be repeated.

- F. If the Engineer during review of the TV inspection of video identifies problems, the Engineer will notify the Contractor of the problem(s) in writing. The Contractor will then proceed to make those corrections at no additional cost to the District.

3.5 CIPP Spot Repair “Short Liners”

- A. CIPP spot repairs shall be a minimum of 3-5 feet in length up to the full length of the pipeline, the same materials and physical properties as the full length CIPP liners, with the addition of flexible end seals added. The CIPP spot repairs will be either ambient or heat cured and shall conform to the host pipe over the problem area.
- B. The CIPP spot repair shall be designed to be fully structural in the host pipe conditions it is to be installed in. The ends of the CIPP spot repair shall be tapered to allow flow, sewer cleaning, and inspection equipment to traverse with a minimum of restriction.
- C. Payment shall be per CIPP spot repair installed and televised for acceptance.