

## **SECTION 617 – SANITARY SEWER CURED-IN-PLACE PIPE (CIPP)**

### **PART 1 – GENERAL**

#### **1-1. SUMMARY**

- A. This Section covers requirements and specifications for sanitary sewer installation of cured-in-place sanitary sewer pipe lining by installation of a resin impregnated flexible felt tube into the existing sewer line utilizing a vertical inversion standpipe and hydrostatic head, pulled in place, and curing by circulating hot water or other approved means to produce a hard, impermeable pipe.
- B. The finished liner shall extend over the installation length in a continuous, tight fitting, watertight pipe-within-a-pipe and shall be fabricated from materials which, when installed, will be chemically resistant to withstand internal exposure to domestic sewage. The finished pipe shall provide a minimum of 95% full flow capacity of original design.
- C. Major Items of Work Include
  - a. Gain access to manholes
  - b. Cleaning and preparation of sanitary sewer mains
  - c. Flow bypass
  - d. Installation of CIPP liner and reinstatement of services
  - e. CCTV inspection

#### **1-2. REFERENCES**

- A. Codes, specifications, and ASTM standards referred to by number or title shall form a part of this specification to the extent required by the references thereto. Latest revisions shall apply, unless otherwise shown or specified.
  - a. D 638 Test Method for Tensile Properties of Plastics
  - b. D 790 Test Methods for Flexural Properties of Un-reinforced and Reinforced Plastics and Electrical Insulating Materials
  - c. D 1222 Determining Dimensions of Thermoplastic Pipe and Fittings
  - d. D 2837 Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials
  - e. F 1216-98 Rehabilitation of Existing Pipelines and Conduits by Inversion and Curing of a Resin-impregnated Tube

#### **1-3. SUBMITTALS**

- A. Submit the Following Within 5 days of Bid Opening
  - a. The Contractor must provide three municipal references for similar Work experience in the commercial installation of the liner and must have installed a minimum of 100,000 lineal feet in the past 5 years. The inability to document such experience may be grounds for rejecting the proposed Contractor.

- i. Provide name and experience of onsite construction foreman and supervisor whom shall have a minimum of 3 years of direct experience installing CIPP liner.
  - b. Manufacturer's Certificate of Compliance certifying compliance with the applicable specifications and standards, a minimum of 500,000 linear feet of liner installed in U.S.
- B. Submit the Following Prior to Start of Construction
  - a. Sampling procedures and locations for obtaining representative samples of the finished liner.
  - b. Manufacturer's installation instructions and procedures. Long term flexural creep testing results including instantaneous flexural modulus and creep retention value for CIPP material installed by Contractor.
  - c. Contractor's procedures and materials for service renewal including time and duration of sewer service unavailability.
  - d. Data, measurements, assumptions and calculations for sizing liners and structural design, signed and sealed by a professional engineer and certified by the manufacturer as to the compliance of his materials to the values used in the calculations.
    - i. The liner manufacturer shall also submit a tabulation of time versus temperature. This tabulation shall show the lengths of time that exposed portions of the liner will endure without self-initiated cure or other deterioration beginning.
    - ii. Temperature and pressure for curing
  - e. End seals and other materials to be utilized during Work.
  - f. A description of methods for avoiding liner stoppage due to conflict and friction at such locations as the manhole entrance and the bend into the pipe entrance. The Contractor shall also present plans for dealing with a liner stopped by snagging within the pipe.
  - g. A final certificate of compliance with this specification shall be provided by the manufacturer for all lining material furnished. Tests for compliance by an independent laboratory shall be made according to the applicable ASTM specification and the manufacturer's quality control program.
- C. Furnish an extended warranty for liner materials from the Contractor and liner manufacturer for a total of five (5) years from date of Final Completion.
- D. Contractor shall keep logs of the liner temperatures at the upstream and downstream manholes during cure. Submittal of logs may be required by Engineer.

## **PART 2 – PRODUCTS**

### **2-1. GENERAL**

- A. Pipe lining products pre-approved by Owner include: Insituform (CIP Liner), National, Reynolds Inliner (Reichhold/Intech), SAK, and Layne.

- B. The materials used shall be designed, manufactured, and intended for sewer relining and the specific application in which they are used. All materials shall be stored and handled in accordance with recommendations of the manufacturer. All materials shall be installed in accordance with the manufacturer's written instructions.
- C. The finished pipe liner in place shall be fabricated from materials which when complete are chemically resistant to and will withstand internal exposure to domestic sewage having a pH range of 5 to 11, temperatures up to 150°F, and meet the chemical resistance requirements of ASTM F1216 Appendix X2.

**2-2. PIPE LINER**

- A. All cured-in-place lining products shall comply with ASTM F-1216 or intent thereof as determined by the Owner.
- B. The contractor shall use a polyester filter felt tube and a resin and catalyst system meeting the requirements of ASTM F1216 and compatible with the inversion process and having the physical properties for the cured pipe identified in the table below.

<b>CIPP Physical Property</b>	<b>Standard</b>	<b>PSI</b>
Tensile Strength	ASTM D638	4,000
Flexural Strength	ASTM D790	5,000
Flexural Modulus of Elasticity	ASTM D790	400,000
Modulus of Elasticity	ASTM D2990	150,000

- C. Unless specified otherwise, the liner shall be structurally designed in accordance with ASTM F1216 for a minimum service life of 50 years; fully deteriorated host pipe/direct bury condition; minimum 6 mm thickness for 8-12-inch host pipes; having parameters as identified in the table below.

<b>CIPP Design Parameters</b>	<b>PSI</b>
Design Factor of Safety	2.0
Retention Factor for Long-Term Flexural Modulus	As determined by long-term tests submitted and not to exceed 50%
Ovality	Calculated by ASTM F1216 and not being less than 2%
Groundwater Depth (above pipe invert)	Five feet below top of ground
Soil Depth (above crown of existing pipe)	Earth load minimum shall be 8-feet. Refer to Drawings for depths in excess of 8-feet.
Soil Modulus	700 psi
Soil Density	120 lb / cf
Live Load	AASHTO H20 except rail crossings

- D. The flexible tube shall be fabricated to a size that when installed will neatly fit the internal circumference of the existing sanitary sewer lines, of uniform thickness, and have sufficient strength to bridge missing pipe and stretch. Allowance shall be made for circumferential stretching during insertion so that the final cured product is snug against the wall of the host pipe. Layers shall be uniformly bonded and not be cleanly separable with a knife blade.
- E. The tube shall be marked along its entire length, not to exceed 5-feet. Markings shall include Manufacturer's name and identifying symbol indicating design parameters.
- F. The resin system shall be a corrosion resistant polyester, epoxy vinyl ester, or epoxy system including all required catalysts, initiators or hardeners that when cured within the tube create a composite that satisfies the requirements of ASTM F1216 and ASTM D5813, the physical properties herein, and those which are to be utilized in the design of the CIPP for this project. The resin shall produce a CIPP that will comply with the structural and chemical resistance requirements of this specification.

## **PART 3 – EXECUTION**

### **3-1. PRE-INSPECTION**

- A. Contractor to inspect site conditions prior to bidding and Work. This would include locating and providing access to manholes.
- B. Contractor to review software template file and provide digital inspection sample to ensure compatibility with City inspection software prior to Work.

### **3-2. PREPARATION**

- A. It is the responsibility of the Contractor to clean the line of any obstructions such as roots, extended taps, and solids that will prevent the insertion and proper installation of the CIPP.
  - a. Other defects such as an offset joint or broken/collapsed pipe not noted as a point repair on Drawings shall be identified by Contractor and reviewed with Engineer. Point repairs will be made at the direction of the Engineer at the specified unit prices.
- B. The Contractor shall inspect the pipeline in accordance with Section 616 Sanitary Sewer Line Cleaning and Inspection. All pre-liner and post liner inspections shall meet specification requirements. All measurements required for design, fabrication, installation of the CIPP liner, and reinstatement of services shall be obtained by the Contractor.
- C. The Contractor shall provide for the flow of sewage around the section or sections of pipe designated for lining.
  - a. Flow control shall be exercised as required to ensure that no flowing sewage comes into contact with sections of the sewer under repair.

- b. A sewer line plug shall be inserted into the sewer upstream from the section to be repaired. The plug shall be designed so that all or any portion of the sewage flows can be released. During the review, testing and installation portion of the operation, flows shall be shut off in order to properly install the cured-in-place pipe lining.
  - c. The upstream manholes shall be constantly monitored for degree of surcharging.
  - d. Wherever lines are blocked off and the possibility of backing up the sewage and causing harm to public and private property is foreseen, it shall be the contractor's responsibility to bypass flow from manhole to manhole.
  - e. Bypassing shall be accomplished using sewer plugs with pump connections, by pumping down surcharged manholes, or by other methods acceptable to the Owner.
  - f. All bypassed flow must be discharged to a sanitary sewer. Bypassed flow shall not be allowed to enter any storm line, drainage ditch or street gutter.
  - g. During a bypass operation, the pump shall be manned continuously; the contractor shall maintain the pump and bypass equipment; and shall be responsible for any damages to public or private property due to the malfunction of same.
  - h. After the installation is complete, flows shall be restored to normal level.
- D. Do not install liner if ground water temperatures and/or ambient temperatures are excessive for the product installation procedures.

### **3-3. INSTALLATION**

#### **A. General**

- a. All installation shall be in accordance with manufacturer's recommendations, which shall be available for verification by the inspector.
- b. Seal the area where the line enters or leaves each manhole. Finish the inside of the manhole with a quick set cement grout to raise the invert to the grade of the liner pipe. Also use this grout to dress up around the end of the liner. This space may be sealed with a mechanical seal, chemical seal, or combination of both.
- c. The Contractor shall immediately notify the Owner of any construction delays taking place during the insertion operation. Such delays shall possibly require sampling and testing by an independent laboratory of portions of the cured liner at the Owner's discretion. The cost of such test shall be borne by the contractor and no extra compensation will be allowed. Any failure of sample tests or a lack of immediate notification of delay shall be automatic cause for rejection of that part of the work at the Owner's discretion.
- d. The cost for maintaining sanitary sewer service for the property owners during construction shall be included in the prices bid and no additional compensation will be allowed. Prior to construction, the Contractor shall submit to the Owner for review a complete description of the methods he intends to use to reconnect the existing laterals.

## B. Cured-In-Place Liner

- a. The Contractor shall designate a location where the reconstruction tube will be vacuum impregnated prior to installation. The Contractor shall allow the Owner to inspect the materials and “wet out” procedure. Sufficient excess resin will be provided to insure excretion into cracked pipe and or joints of the hot pipe after curing and allowance for polymerization shrinkage. Point of vacuum shall be no further than 25-feet from point of resin induction and once vacuum is established, a vacuum point shall be no further than 75-feet from the leading edge of the resin. A roller system shall be used to uniformly distribute the resin throughout the tube.
- b. The wet out reconstruction tube shall be inserted through an existing manhole or other approved access and positioned in the pipeline by means of an steam inversion process.
- c. After inversion is completed the Contractor shall supply suitable heat source and recirculation equipment. The equipment shall be capable of delivering the heat source throughout the section uniformly to raise the temperature above the temperature required to affect a cure of the resin.
  - i. The heat source shall be fitted with suitable monitors to gauge the temperature of the incoming and outgoing heat source. Another such gauge shall be placed between the impregnated reconstruction tube and the pipe invert at the remote manhole to determine the temperatures during cure.
- d. Curing shall be accomplished by utilizing hot water under hydrostatic pressure or steam pressure in accordance with manufacturer’s recommendations. The CIPP shall be properly cooled to manufactures recommended temperature before carefully releasing the water column. 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 pipe.
- e. The finished CIPP shall be continuous over the entire length from manhole to manhole and be free from visual defects such as foreign inclusions, dry spots, keel, boat hull, pinholes, wrinkles and other deformities. Any defects, which will affect the integrity or strength of the pipeliner, discovered in the post-installation inspection and during the warranty period shall be repaired at the Contractor’s expense.
- f. Contractor shall retain a resin-impregnated sample (wick) to provide verification of the curing process taking place in the host pipe.

## C. Service Lateral Renewal

- a. Within the same working day, Contractor shall internally reinstate the service opening to 100% of the original opening after the mainline liner has fully cured.
- b. When it is necessary to shutdown a private sewer service line while work is in progress and before the service lines are reconnected, the residents are to be notified by the Contractor at least one day prior to the shutdown. Commercial sewer services shall be maintained at all times that the business is open.
- c. The Contractor is cautioned that only those sewer services that are active shall be repaired or reinstated after the sewer main has been lined or replaced. The number of service connections on some sewer segments may exceed the number of buildings actually served. It is the Contractor’s

responsibility to determine through dye testing, or other acceptable methods, the services that are live and require reinstatement prior to commencing lining of the sewer main. Services that are confirmed to be inactive shall not be reconnected. Services that are inactive, but reinstated, shall be plugged at the Contractor's expense. No additional payment will be made for excavations necessary to reinstate services.

- a. Inactive services to vacant parcels shall be renewed, unless otherwise directed by the Owner.
- b. Reinstating services shall be from the interior of the pipeline by means of a 360° television camera and a cutting device that re-establishes the service connection. When a remote cutting device is used and a cleanout is available, then a mini-camera down the service may also be used to assist the operator in cutting or trimming. All coupons shall be recovered at the downstream manhole and removed.
- c. The finished opening shall be brushed smooth with no ragged edges and shall prevent clogging or blockages. The Contractor shall maintain a back-up remote control cutting device onsite in-case of malfunction.

### **3-4. POST INSTALLATION**

- A. Where liners of any type are installed in two or more continuous manhole segments, the liner invert through the intermediate manholes shall be left intact. Final finishing of the installation in those intermediate manholes shall require removal of the top of the exposed liner and neat trimming of the liner edge where it touches the lip of the manhole bench. The top half shall be neatly cutoff at least 2-inches away from the walls. The Contractor shall build up the bench as necessary to maintain a 1:12 pitch towards the channel.
- B. Portions of any piece of liner material removed during installation shall be available for inspection and retention by the Owner.
- C. Reinstatement openings for all drop assemblies after relining mainline sewer. Everywhere possible, outside drop assemblies shall be lined with a cured-in-place liner compatible with the mainline liner, for the full length of the drop assembly and bend. The vertical pipe shall be lined, at a minimum. Drop assemblies inside of manholes are not required to be relined, unless directed by the Owner.
- D. The CIPP shall make a tight fitting seal with the existing pipes in the manhole. A ½-inch diameter activated oakum bank soaked in Scotch Seal 5600 or equal shall be applied circumferentially near the annular space touching the end of the existing pipe and properly encased with a cement based mortar. If misaligned pipe or other condition prevents liner from a tight seal, Contractor shall apply resin mix compatible with liner to seal void.

### **3-5. TESTING**

- A. The Contractor shall have an independent testing lab analyze finished liner samples taken from manhole cutoffs, service coupons, etc.
  - a. A minimum of 1 sample shall be taken of the first segment installed, or as directed by the Owner.

- b. A minimum of 2 samples shall be taken for each 2,500 LF of liner material installed or for each manufacturing lot, if less, or as directed by the Owner.
  - c. A minimum of 6 samples per project shall be taken for each type of liner furnished, or as directed by the Owner.
  - d. Tests in accordance with ASTM standards for Tensile Properties, Flexural Modulus and wall thickness shall be conducted including ASTM F1216.
  - e. The Contractor shall determine sampling location and procedures to ensure representative samples are obtained from the finished liner, subject to approval by the Owner.
  - f. For host pipe diameters 18" and smaller, the sample should 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.
    - i. The Contractor shall furnish removable sizing sleeves, when possible, to collect line samples, which accurately replicate the host pipe diameter.
  - g. Wall thickness at any point shall not be less than 87.5% of the design thickness.
- B. After completing lining, service renewals where required, and manhole rehabilitation/replacement, every pipe segment shall be CCTV inspected as per Section 616 Sanitary Sewer Line Cleaning and Inspection.

### **3-6. ACCEPTANCE**

- A. The finished liner shall be continuous over the entire segment between manholes and homogenous throughout.
- B. The finished liner shall be fully rounded and as free as commercially practicable from visible defects, including but not limited to damage, deflection, holes, delamination, ridges, cracks, uncured resin, foreign inclusions or other objectionable defects.
- C. There shall be no visible infiltration through the liner, around the liner at manhole connections, at lined service connections or in lined services. Contractor shall repair any visible leaks.
- D. Where a defect in the liner requires removal of a section of the liner, in the Owner's opinion, the Contractor shall make all repairs as required by the Owner and shall install a segmental liner, compatible with the liner, to accomplish a continuous finished liner. No separate payment will be made for such defect repair or for the post-repair segmental liner.
- E. The pipe shall be neatly and smoothly cut off at each manhole. The manhole trough shall be raised to the invert of the liner to preclude snagging and shoaling of debris.
- F. Service Connections:
  - a. The CIPP lateral lining shall not inhibit the CCTV post video inspection of the mainline or require an inspection reversal.