

SECTION 02765

CURED-IN-PLACE-PIPE

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Provision and installment of Cured-In-Place Pipe (CIPP) for the rehabilitation of pipelines.

1.02 UNIT PRICES

- A. Measurement for CIPP of each specified thickness is on a linear foot basis, measured along the centerline of the pipe and between the centerline of adjacent manholes.
- B. The CIPP thickness established in these specifications and the depth of the sewer shall be the governing factor in making final payment.
- C. Payment for Pre-Installation Cleaning and Diversion Pumping shall be considered incidental.

1.03 PERFORMANCE REQUIREMENTS

- A. Rehabilitate deteriorated sewers by forming a tight-fitting CIPP within the existing sewer.
- B. The process generally consists of a flexible tube impregnated with an approved resin which is inserted into an existing sewer and cured with heat. Curing is accomplished by circulating heated water or steam to effect the desired cure throughout the length of the tube extending full length from manhole-to-manhole.
- C. The CIPP, including flexible tube impregnated with a heat-cured resin, shall cure into a hard, impermeable pipe of the required thickness.
- D. The system shall produce a structurally sound, uniformly smooth interior with hydraulic flow equal to or greater than the existing sewer when in new condition.
- E. ASTM F1216 shall be the general guide for the materials and installation of the CIPP as modified by this specification. The Owner reserves the right to approve any material or installation practice which may differ from ASTM F1216.

1.04 SUBMITTALS

- A. Submittals shall conform to requirements of all sections and provisions of these specifications.
- B. Submit certified copies of test reports on physical and chemical properties of the resin and the flexible tube.
- C. Relevant information from the resin manufacturer shall include specifications, characteristics, properties, and methods of application. A written certification that the resin material complies with the required application, along with curing temperature, and duration of the temperature depending upon the sewer size and CIPP thickness shall be submitted. A blanket letter shall not be sufficient in case of varying CIPP thicknesses and lengths. This information shall be used during field inspection to verify that proper curing procedures are being followed.
- D. Submit certified copies of test reports on CIPP coupons obtained during installation.
- E. Submit results of additional product testing performed for quality control. Provide name, designation, and schedule for in-house testing of resin and liner material.
- F. Submit an analysis of design criteria and calculations for CIPP thickness.
- G. Submit a schedule for verification and inspection of the resin material at the "wet out" of the flexible tube. The inspection shall be at the discretion of the Owner Representative. Also submit the insertion and heating schedule/plan at least 24 hours in advance of installation.
- H. Submit copies of curing temperature/time log sheets in an approved format immediately after curing is complete.

#### 1.05 QUALITY ASSURANCE

- A. ASTM F-1216 shall be the general guide for acceptable products and processes.
- B. Though the process may be licensed, the Contractor shall not change any material, design values, or procedures during the course of the Contract without the prior written approval of Owner Representative.
- C. The CIPP supplier shall maintain a filing/retrieval system to store certification statements from producers of resin and flexible tubes.
- D. Resins shall be tested upon arrival from the manufacturer before being placed in stock.

## PART 2 PRODUCTS

### 2.01 SUPPLIERS

- A. Suppliers of the cured-in-place pipe (CIPP) shall be preapproved by the Owner. Alternative suppliers shall not be considered by prequalification during bidding or substitution during construction.
- B. Preapproved suppliers of CIPP are:
  - 1. Inliner
  - 2. Insituform

## 2.02 MATERIALS

- A. Flexible Tube
  - 1. The flexible tube shall be manufactured and fabricated under quality-controlled conditions set by the process manufacturer. Tubes shall be sized so that, when installed, a tube will snugly fit the internal circumference of the existing sewer and produce the required thickness when the liquid thermosetting resin is cured.
  - 2. The minimum length of the flexible tube shall be as necessary to effectively and fully span the actual field distance between manholes, with extra allowance as needed for proper stretching or shrinkage due to pressure or expansion. Include a sufficient amount of material to provide for lateral service cuttings.
- B. Resin
  - 1. The liquid thermosetting resin used to impregnate the tube shall produce a properly cured tube which shall be resistant to abrasion due to solids, grit, and sand. The cured tube shall also be resistant to corrosion due to acids and gases such as sulfuric acid, carbonic acid, hydrogen sulfide, methane, and carbon monoxide. The resin selected shall have proven resistance to municipal wastewater.
  - 2. The resin system to be used shall be manufactured by approved company(ies) selected by the CIPP supplier. Only corrosion-resistant polyester and vinylester resins complying with the following requirements shall be used.
  - 3. Polyester Resin. A resin created by reaction products between isophthalic/terathalic acid, maleic anhydride, and a glycol characterized by reactive unsaturation located along the molecular chain. This resin is compounded with a reactive styrene monomer and reacted together with initiators/promoters to produce cross-linked copolymer matrices.

4. Vinylester Resin. A resin created by reaction products of epoxy resins with methacrylic acid and characterized by reactive unsaturation located in terminal positions of the molecular chain. This resin is compounded with a reactive styrene monomer and reacted together with initiators/promoters to produce cross-linked copolymer matrices.
5. The corrosion resistance of the resin system selected shall be tested by the resin manufacturer in accordance with ASTM C581. Exposure to the chemical solution listed below shall result in a loss of not more than twenty percent of the initial physical properties when tested in accordance with ASTM C581 for a period of not less than one year. For applications other than municipal wastewater, chemical resistance tests shall be conducted with actual samples of the fluid flowing in the pipe and in accordance with procedures approved by the Owner Representative.

CHEMICAL SOLUTION	CONCENTRATION, %
Tap Water (pH 6-9)	100
Nitric Acid	5
Phosphoric Acid	10
Sulfuric Acid	10
Gasoline	100
Vegetable Oil	100
Detergent	0.1
Soap	0.1

C. CIPP Properties

1. The installed CIPP after curing shall meet the minimum structural properties listed below:

PROPERTY	REFERENCE	MINIMUM VALUE
Flexural Strength	ASTM D790	4,500 psi
Flexural Modulus of Elasticity	ASTM D790	250,000 psi

## D. CIPP Thickness

- The installed CIPP after curing shall meet the minimum thickness specified in the following table. The minimum CIPP thickness has been rounded to the next highest multiple of 1.5 mm after adding an allowance of five percent for resin migration.

<b>MINIMUM CIPP THICKNESS</b>				
<b>NOMINAL SEWER DIAMETER (INCHES)</b>	<b>PIPE INVERT DEPTH</b>			
	<b>Up to 10 feet (mm)</b>	<b>10 – 15 feet (mm)</b>	<b>15 – 20 feet (mm)</b>	<b>20 – 25 feet (mm)</b>
6	4.5	4.5	4.5	-
8	6.0	6.0	6.0	-
10	6.0	6.0	7.5	-
12	6.0	7.5	9.0	-
15	7.5	9.0	10.5	
18	9.0	12.0	13.5	
21	10.5	13.5	15.0	
24	12.0	15.0	16.5	
30	15.0	18.0	21.0	
36	16.5	21.0	24.0	
42	19.5	24.0	28.5	
48	22.5	28.5	33.0	
54	25.5	30.0	36.0	

- The minimum thickness for the installed CIPP after curing has been calculated based on the following design conditions:

- a. The existing sewer is considered fully deteriorated.
  - b. The existing sewer is considered to have an ovality of 2 percent in circumference.
  - c. The CIPP is subjected to a full soil load of 120 pounds per cubic foot.
  - d. The CIPP is subjected to traffic line loads as calculated by AASHTO Standard Specifications for Highway Bridges, HS-20-44 Highway Loading.
  - e. The modulus of soil reaction for pipe zone backfill material is 700 psi.
  - f. The CIPP is subject to a groundwater elevation 5 feet below the ground surface.
  - g. The long-term flexural strength and long-term flexural modulus of elasticity for CIPP is equivalent to 50 percent of the initial flexural strength and initial flexural modulus of elasticity, respectively, as measured in accordance with ASTM D790.
  - h. The maximum deflection is 5 percent in the vertical axis.
  - i. The minimum overall factor of safety is 2.0.
3. Bidders shall review the table of CIPP thickness for correctness and, if disagreeing that the minimum CIPP thickness indicated is adequate to meet the design criteria, shall so advise the Owner Representative. If any modifications to increase CIPP thickness are required, the Owner Representative will issue such modifications by an addendum.
  4. The thickness of the CIPP shall be within minus 5% and plus 10% of the minimum thickness. Thickness greater than required shall not be allowed if hydraulic capacity of the pipe is reduced. The required thickness shall be measured accurately using properly calibrated calipers.

## PART 3 EXECUTION

### 3.01 PREPARATION

- A. Inform the Owner Representative of work schedules for CIPP installation.
- B. Conduct operations in accordance with applicable OSHA standards, including those safety requirements involving work on an elevated platform and entry into a confined space. Make suitable precautions to eliminate hazards to personnel near construction activities when pressurized air is being used.

### 3.02 PRE-INSTALLATION CLEANING AND INSPECTION

- A. Rewash and reclean existing sewer, as necessary, immediately before pre-installation television inspection.
- B. Perform a television inspection immediately before installation of the resin impregnated flexible tube. Verify that sewer is clean and pipe conditions are as anticipated.

### 3.03 OBSTRUCTION REMOVAL AND POINT REPAIR

- A. Complete point repairs and remove obstructions such as roots, rocks, or other debris prior to CIPP installation.
- B. Refer to Section 02763 for point repairs.
- C. Obstruction removal may be effected as a point repair or by use of a remote device. For removal by remote device, obtain prior approval of the Owner Representative.
- D. To remove obstructions by remote device, use a solid steel mandrel or porcupine mandrels winched from one manhole to another. Use mandrels of adequate size to remove obstructions encountered. Use of bucket machines to break obstruction is acceptable if no damage to sewer pipe is caused.

### 3.04 DIVERSION PUMPING

- A. Install and operate diversion pumping equipment to maintain sewage flow and to prevent backup or overflow. Obtain approval for diversion pumping equipment and procedures from the Owner Representative.
- B. Design all piping, joints, and accessories to withstand twice the maximum system pressure or 50 psi, whichever is greater.
- C. In the event of accidental spill or overflow, immediately stop the overflow and take action to clean up and disinfect spillage. Promptly notify the Owner Representative so that required reporting can be made to the Texas Commission on Environmental Quality and Environmental Protection Agency.

### 3.05 ACCESS PITS

- A. Use excavations at point repair locations as access pits when feasible.
- B. Before excavating check with utility companies and determine the location of utilities in the vicinity of the work area. Arrange for temporary construction easements and rights-of-way. Damage done to utilities and the resulting repair, temporary service cost, etc., shall be borne by the Contractor.

- C. Perform excavation and backfill in accordance with requirements of Section 02227.
- D. Perform work in accordance with OSHA standards. Employ a Trench Safety System as specified in Section 01526 for excavations over 5 feet deep.
- E. Install and operate necessary dewatering and surface water control measures in accordance with requirements of Section 01563.

### 3.06 INSTALLATION PROCEDURES

- A. Wet Out: Designate a location where the flexible tube will be impregnated or wet out with resin. Thoroughly saturate flexible tube prior to installation. A catalyst system, or additive compatible with the resin and flexible tube, may be used as recommended by the manufacturer and with approval of the Owner Representative. Handle the resin impregnated flexible tube to retard or prevent resin setting until it is ready for insertion.
- B. Insertion:
  - 1. Insert flexible tube through an existing manhole by means of an Inversion Procedure or Pulled-In Procedure. Connect tube ends by an attachment so that a leak-proof seal is created.
  - 2. Using the "Inversion Procedure", the flexible tube end shall initially be turned inside out and attached to a platform ring, standpipe, or as approved. The addition of water, air, or steam pressure will be adjusted to sufficient height or pressure to cause the impregnated flexible tube to invert from manhole to manhole and hold the tube tight against the existing sewer.
  - 3. Using the "Pulled-In Procedure", a calibration hose shall initially be turned inside out and attached to a platform ring, standpipe, or as approved. The addition of water, air, or steam pressure will be adjusted to sufficient height or pressure to cause the calibration hose to invert from manhole-to-manhole, and hold the tube tight against the existing sewer.
- C. Curing
  - 1. After insertion is completed, apply a suitable heat source with a water or steam recirculation system capable of delivering hot water or steam uniformly throughout the section to achieve a consistent cure of the resin. Curing temperature shall be as recommended by the resin/catalyst system manufacturer.
  - 2. The heat source shall be fitted with suitable monitors to gauge the temperature of incoming and outgoing water or steam supply. Another such gauge shall be

placed between impregnated tube and invert of the original pipe at the manholes to monitor outside liner temperatures during resin curing process.

3. Heating shall continue uninterrupted until the desired temperature is achieved. Temperatures shall be measured at both ends by accurate measuring devices. The initials of the Owner Representative shall be obtained on curing logs if the Owner Representative is present at the site. Initial cure may be considered completed when exposed portions of the flexible tube pipe take a hard set and temperatures are adequate, as recommended by the resin/catalyst system manufacturer, and approved by the Owner Representative.
- D. Cool Down: Cool the CIPP to a temperature below 110 degrees F before relieving water column or internal pressure. Cool water may be added to the water column while draining hot water from the opposite end of the CIPP, so that a constant water column height or constant internal pressure is maintained until cool-down is completed. Do not release water column or internal pressure in a way that creates a vacuum and damages the CIPP.
- E. Copies of curing temperature/time log sheet in approved format shall be submitted to the Owner Representative immediately after curing is completed. Attach log sheets to daily construction report.
- F. Finished Pipe: The finished CIPP shall be continuous and free as commercially practicable from visual defects such as foreign inclusions, dry spots, pinholes, and delamination. Finished CIPP shall also meet leakage or pressure test requirements.

### 3.07 MANHOLES

- A. The CIPP shall make a tight seal at the manhole opening with no annular gaps. Under all circumstances, a 1/2-inch-diameter activated Oakum band soaked in sealant shall be applied all around for an approved seal. Any annular spaces greater than 1/2-inch shall be sealed and then covered with a cementitious mortar. Complete the sealing procedure before proceeding to the next CIPP segment.
- B. Reshape and smooth the manhole invert as specified in Section 02764.
- C. Use cementitious grout to form a smooth transition with a reshaped invert and a raised manhole bench to eliminate sharp edges of CIPP, concrete bench, and channeled invert. Build up and smooth invert of manhole to match flow line of new CIPP.

### 3.08 SERVICE CONNECTIONS

- A. For making service reconnections, conform to requirements of Section 02762.

- B. Service reconnection may be made by remote-operated cutting tool, when approved by the Owner's Representative, or by excavation or mechanical connection, as specified in the construction plans or by the Owner.

### 3.09 FIELD QUALITY CONTROL

- A. Exotherm tests shall be performed on the resins prior to wet out of the flexible tube.
- B. A document shall be prepared during wet out of each CIPP segment showing information such as resin lot numbers, volumes of resin, and catalyst used. The document shall be arranged such that each critical step in the wet out process is checked off and initialized.
- C. Charts and/or graphs of the CIPP temperatures at the upstream and downstream manholes shall be made during the curing process to document that proper temperatures and cure times have been achieved.
- D. Low pressure air test before each CIPP segment has been sealed in place at the manholes and before any service reconnections have been made. Check integrity of joints that have been made and verify that the CIPP has not been damaged by inserting it into the sewer.
- E. Service lateral connection test after all service laterals have been completed for a particular sewer section. Verify integrity of connections at points where they join the CIPP and existing service lines. Refer to Section 02732 for applicable test procedures.
- F. Whenever required by the Owner's Representative, a short section of pipe similar to the existing sewer shall be placed in the manhole to install the CIPP under restrained conditions. This pipe section will be used to obtain samples for testing. All samples shall be labeled before shipment for testing. Provide a duplicate sample to the Owner's Representative for inspection and/or testing by an independent laboratory, if requested.

### 3.10 POST-TELEVISIONING OF COMPLETED WORK

- A. Provide a quality color DVD at standard play showing completed Work including condition of restored connections prior to requesting payment. Refer to Section 02732.
- B. Correction of failed CIPP or CIPP deemed unacceptable, as a result of post-television inspection or test reports for structural values, thickness, etc., shall be repaired at no extra cost to the City. Method of repair, which may require field or workshop demonstration, shall be approved by the Owner Representative.

### 3.11 FINAL CLEANUP

- A. Upon completion of installation work and testing, clean and restore project area affected by the Work, including removal and replacement of fences, damage to yards, lawns, sidewalks, and driveways due to movement of trucks and erection of equipment.
- B. Replace pavement or sidewalks removed or damaged by operations in accordance with Section 02571.
- C. In unpaved areas, bring surface to grade and slope of area surrounding disturbed portion. Replace a minimum of 4 inches of topsoil and seed the area in accordance with Section 02932 or sod the area in accordance with Section 02935, as required.

END OF SECTION