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## 02790 – SANITARY SEWER MANHOLE REHABILITATION

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(New 4/24/17)

### SELECTED LINKS TO SECTIONS WITHIN THIS SPECIFICATION

[Part 1- General](#)

[Part 2 – Products](#)

[Part 3 – Execution](#)

## [PART 1 – GENERAL](#)

### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this specification.
- B. Section 01000 – GENERAL REQUIREMENTS.
- C. Section 01200 – MEASUREMENT AND PAYMENT.
- D. Section 02200 – EARTHWORK.
- E. Section 02220 – TRENCHING, BACKFILLING, AND COMPACTION OF UTILITIES.
- F. Section 02500 – BASE COURSE AND PAVING.
- G. Section 02730 – SANITARY SEWER.
- H. Section 02750 – SEWER LINE CLEANING.
- I. [Section 02770](#) – SEWER FLOW CONTROL.

### 1.2 SUMMARY

- A. These specifications include requirements to provide a rehabilitation system for manholes that includes lining the manhole interiors, internal sealing of the frame-chimney joint area, and reconstructing manhole benches and channels. It is the Contractor's responsibility to stop active leaks in association with the lining of the manhole interiors.
- B. This Work shall include the furnishing of materials, equipment, tools, and labor as required for the rehabilitation of the manholes.
- C. The rehabilitation system shall be applied to the manhole from the cover seat to, and including, the benches. The rehabilitation system must stop infiltration, prohibit root intrusion, protect the existing structure from further deterioration, and provide a surface coating resistant to sewer gases and chemicals.

- D. The Contractor shall perform permanent landscape restoration of disturbed areas on private property and within the City or VDOT right-of-way upon completion of pipe rehabilitation, to pre-work conditions per Owner approval.
- E. Materials and supplies provided shall be the standard products of the coating system manufacturer. Materials in each rehabilitation system shall be the products of a single rehabilitation system manufacturer and components certified as compatible by the manufacturer.

### 1.3 SUBMITTALS

- A. Submit a Work Plan. At minimum, the plan shall include the following items:
  - 1) A proposed schedule.
  - 2) Identification of proposed access routes.
  - 3) Identification of set-up locations for rehabilitation activities.
  - 4) Description of rehabilitation activities, including cleaning, stoppage of active leaks, lining/coating and testing procedures.
  - 5) Flow Control, including bypass pumping, in accordance with Section 02770-*Sewer Flow Control*.
  - 6) Traffic Control Plan in accordance with City requirements and per Appendix C-*Procedures* of this manual, as appropriate.
  - 7) Health and Safety Plan that includes confined space entry, emergency response and first aid requirements.
- B. Submit a letter identifying the crew members performing the Work. If any of the crew members are not identified on the original certification letter received during the pre-qualification process, then a new certification letter listing the crew member(s) must be received from the rehabilitation system supplier prior to initiation of the specific project.
- C. Submit calculations (or letter from the manufacturer) supporting recommended rehabilitation system thicknesses or wall coverage thicknesses.
- D. Prior to initiation of a specific project, the Contractor shall submit the following information for review and approval.
  - 1) Shop drawings and product data for the manhole rehabilitation system and materials, including a report outlining the process to be used in the rehabilitation of identified structures. All submittals shall be in accordance with Section 01000 – *General Requirements*. The report shall also include:
    - a. Information specific to the job, such as coordination issues, access, timing, manufacturer's installation instructions, equipment, bypass

- pumping, proposed method of testing lines and manholes, and basis of design.
- b. Information on the chemical grout and additives, cementitious compound, waterproofing, and corrosion control materials that will be used. For the materials that will be used, identify and furnish references for successful use of the materials in similar applications.
  - c. Method for sealing pipe penetrations and other identified penetrations at the candidate structure.
- 2) Measurements made by the Contractor to verify structure depth.
- 3) Independent test report showing that the physical properties of the proposed rehabilitation system meet the requirements of these specifications and the requirements published in the manufacturer's literature, including but not limited to those listed below:
- a. Compressive strength as determined by appropriate ASTM standard.
  - b. Flexural strength as determined by appropriate ASTM standard.
  - c. Bond Strength as determined by appropriate ASTM standard.
  - d. Permeability rating as determined by appropriate ASTM standard.
  - e. Freeze-Thaw as determined by appropriate ASTM standard.
  - f. Setting time as determined by appropriate ASTM standard.
- 4) The manufacturer's certification that the proposed system for the project meets the requirements of these specifications and will meet or exceed the physical properties given in the manufacturer's published literature.
- E. Submit documentation of proof that the Contractor for the manhole rehabilitation has a minimum of 3 years of experience using the proposed product in at least 50 manholes. Submit documentation of proof that the Contractor employees and/or subcontractors performing Work on the manhole rehabilitation are currently certified by the manhole rehabilitation system supplier as qualified to perform Work with the proposed product.
- F. Submit required warranty documentation. Rehabilitation systems shall be non-prorated warranted for materials and workmanship for a minimum of 5 years. Contractor shall make repairs within 30 calendar days of notification by Owner, at no additional cost to the Owner.
- G. The Contractor shall provide daily reports as described in and required per this specification.
- H. Submit MSDS sheets for all materials used on the project.

## 1.4 QUALITY ASSURANCE

- A. Materials and operations shall comply with the latest revision of codes, laws, ordinances, standards and regulations pertaining to the provisions of this specification section, including but not limited to:

American Society for Testing and Materials (ASTM)

- B. The Contractor is responsible for the workmanship and quality of the rehabilitation system installation. Inspections by the Owner or the coating system manufacturer's technical representative will not relieve or limit the Contractor's responsibilities.
- 1) The Contractor's methods shall conform to requirements of this specification. Changes in the rehabilitation system installation requirements will be allowed only with the written acceptance of the Owner before work commences.
  - 2) Only personnel who are trained and certified by the rehabilitation system manufacturer's technical representative or who are approved by the rehabilitation system manufacturer shall be allowed to perform the rehabilitation system installation specified in this Section.
  - 3) Contaminated, outdated, diluted materials, and/or materials from previously opened containers shall not be used.
  - 4) For repairs, the Contractor shall provide the same products, or products recommended by the rehabilitation system manufacturer, as used for the original coating.
  - 5) The Contractor shall identify the points of access for inspection by the Owner. The Contractor shall provide ventilation, ingress and egress, and other means necessary for the Owner's personnel to safely access the work areas.
  - 6) The Contractor shall conduct the work so that the rehabilitation system is installed as specified and shall inspect the work continually to ensure that the coating system is installed as specified. Rehabilitation system work that does not conform to the specifications or is otherwise not acceptable shall be corrected as specified.
  - 7) The Contractor shall provide written daily reports that present, in summary form, test data, work progress, surfaces covered, ambient conditions, quality control inspection test findings, and other information pertinent to the rehabilitation system installation.

## 1.5 DELIVERY AND STORAGE

- A. Materials shall be delivered to the job site in their original, unopened containers. Each container shall be properly labeled. Materials shall be handled and stored to prevent damage to or loss of label.

- B. Labels on material containers shall show the following information:
- 1) Name or title of product.
  - 2) Rehabilitation system manufacturer's batch number.
  - 3) Rehabilitation system manufacturer's name.
  - 4) Generic type of material.
  - 5) Application and mixing instructions.
  - 6) Hazardous material identification label.
  - 7) Shelf life expiration date.
- C. Materials shall be stored in enclosed structures and shall be protected from weather and excessive heat or cold in accordance with the rehabilitation system manufacturer's recommendations. Flammable materials shall be stored in accordance with state and local requirements.
- D. Containers shall be clearly marked indicating personnel safety hazards associated with the use of or exposure to the materials.
- E. Material Safety Data Sheets (MSDS) for each material shall be provided to the Owner. The Contractor shall store and dispose of hazardous waste according to federal, state and local requirements. This requirement specifically addresses waste solvents and coatings.

## 1.6 STANDARD ABBREVIATIONS

<b>AASHTO</b>	American Association of State Highway and Transportation Officials
<b>ASTM</b>	American Society for Testing and Materials
<b>CIPM</b>	Cured in Place Manhole
<b>F</b>	Fahrenheit
<b>FT</b>	Feet
<b>HR</b>	Hour
<b>MG</b>	Milligrams
<b>MSDS</b>	Material Safety Data Sheet
<b>NSG</b>	Nepheline Synite Granite
<b>OSHA</b>	Occupational Safety and Health Administration

<b>PCF</b>	Pounds per Cubic Foot
<b>PSI</b>	Pounds per Square Inch
<b>RPZ</b>	Reduced Pressure Principle Zone Device
<b>VDOT</b>	Virginia Department of Transportation

## 1.7 COORDINATION

- A. The contractor shall remove and dispose of dirt, debris, rubbish and surplus, and unsuitable materials at the end of each work day at no additional cost to the owner.
- B. Whenever the contractor desires to use a hydrant for water supply, the contractor shall obtain the permission of Owner. Costs associated with the use of water supplied from hydrants shall not be paid for separately by the Owner, but shall be included in the bid price for manhole rehabilitation. Operation of the hydrant shall be in accordance with the City of Lynchburg Backflow Prevention Program. Use of a RPZ device or air gap is required.

## PART 2 – PRODUCTS

### 2.1 PRESSURE GROUT- POLYURETHANE- BASED

- A. **Description:** Material shall be a liquid polyurethane injection resin designed to seal leaks in concrete and masonry structures. Material shall be compatible with Liner Coating System specified in this section.
- B. **Applications:** Pressure Grout shall be used for the plugging of all active leaks. Refer to Part 3-EXECUTION of this specification for application guidelines.
  - 1) **Leaks at the base of manhole and pipe joints below the frost line:** Prime-Flex Hydro Gel SX (Prime Resins, Inc. Conyers, GA 1-800-321-7212) or approved equal.
  - 2) **Leaking manhole joints:** Prime-Flex 900XLV (Prime Resins, Inc. Conyers, GA 1-800-321-7212) or approved equal.
  - 3) **Void or Gushing Leaks:** Prime-Flex 920 (Prime Resins, Inc. Conyers, GA 1-800-321-7212) or approved equal.

### 2.2 PATCHING COMPOUND – CEMENT- BASED

- A. Patching Mix: Mix shall have the following minimum requirements.

Compressive Strength	ASTM C 109	6 hr 1,400 psi
Shrinkage	ASTM C 596	0% at 90% relative
Bond	ASTM C 321	28 day 150 psi
Cement	Sulfate resistant	
Density, when applied		105 +/-5 pcf

- B. Infiltration Control Mix: A rapid-setting cementitious product specifically formulated for leak control shall be used to stop minor water infiltration and shall have the following minimum requirements.

Compressive Strength	ASTM C 109	1 hr	600 psi
Compressive Strength	ASTM C 579 B	24hr	1,000 psi
Bond	ASTM C 321	1 hr	30 psi
Bond	ASTM C 321	24 hr	80psi.

- C. Pressure Grouting Mix. A cementitious grout shall be used for stopping very active infiltration and filling voids. The cementitious grout shall be volume stable and have a minimum 28-day compressive strength of 250 psi and a 1 day strength of 50 psi.

### 2.3 CEMENTITIOUS REHABILITATION SYSTEMS

- A. **Description:** Cementitious rehabilitation systems shall conform to ASTM F2551. Material shall be specifically designed for placement by low pressure spraying (shotcreting) to vertical and overhead surfaces of concrete and masonry structures and shall restore structural integrity to interior and exterior of concrete and masonry manhole structures, and be specifically designed to prevent infiltration. Material shall be a factory blended high strength cement based, polypropylene fiber reinforced, shrinkage compensated mortar enhanced with Nepheline Synite Granite (NSG) aggregate. Material shall be suitable for application with equipment using either low-pressure spray or centrifugal spin casting. Material shall be designed for monolithic one pass application. Thickness shall be uniform. Material shall be resistant to hydrogen sulfide bacterial corrosion and abrasion in municipal sanitary sewer systems.

The rehabilitation system shall be reinforced with alkaline resistant fiberglass rods or other similar fibers. The material shall meet or exceed industry standards and shall not have any basic ingredient that exceeds EPA maximum allowable limits for any heavy metals. Water used to mix product shall be clean and free from contaminants. Questionable water shall be tested by a laboratory per ASTM C-94 procedure. Potable water need not be tested.

When cured, the monolithic cementitious lining shall form a continuous, tight-fitting, hard, impermeable surfacing which is suitable for sewer system service and chemically resistant to any chemicals or vapors normally found in domestic sewage.

**B. Material Properties:**

- 1) **Compressive Strength:** ASTM C109, 9000 psi.
- 2) **Flexural Strength:** ASTM C293, 1600 psi.
- 3) **Shrinkage:** ASTM C596, 0% at 90% relative humidity
- 4) **Sulfate Resistance:** ASTM C267, Not visible at pH of 2 or less
- 5) **Density, when applied:** 127+/- 5lbs/ft<sup>3</sup>
- 6) **Bond Strength:** ASTM C882, 2500 psi.
- 7) **Permeability:** AASHTO T-277; Not to exceed 400 Coulombs.
- 8) **Freeze-Thaw:** ASTM C666, 300 cycles with no damage.

**C. Material Design:** All cementitious rehabilitation materials shall be approved for use based upon the following design conditions.

Cementitious coating materials shall be manufactured from 100% pure calcium aluminate cement and enhanced with high-density chemically stable aggregates. Materials shall contain poly fiber reinforcement and chemical admixtures.

**2.4 CURED IN PLACE MANHOLE (CIPM) LINERS**

- A. The liner design and selection of materials shall be suitable for field conditions and shall meet the minimum requirements outlined in Table 1. Thicker liners may be required based on actual conditions. The liner shall be custom designed to fit each manhole and the basis of design shall be submitted to the Owner in accordance with this Section. It is the Contractor's responsibility to supply a CIPM liner that is most suitable for the existing conditions and that meets the requirements of this specification. Contractor shall assume groundwater at grade for all sites for the purposes of liner thickness design unless otherwise instructed by the Owner.
- B. The CIPM liner shall provide a minimum service life of 25 years. The cured in place liner system shall be Poly-Triplex Liner System, Terre-Hill, or pre-approved equal.



**TABLE 1**  
**Minimum Liner Physical Properties**

Manhole Depth (grade to invert)	Minimum Liner Thickness <sup>(1)</sup> (inch) ASTM D5813	Minimum Pre-Saturated Fabric Weight (ounces)	Minimum Flexural Modulus of Elasticity (psi) ASTM D790	Minimum Compressive Strength (psi) ASTM D695	Chemical Resistance Testing in accordance with ASTM F1216 Appendix X2
0 to 10 FT	0.117	56	1,000,000	11,000	PASS
10.1 to 15 FT	0.117	56	1,000,000	11,000	PASS
15.1 to 20 FT	0.158	68	1,000,000	11,000	PASS
(1) Minimum liner thickness includes only the strength portion of the liner. Non-structural layers are not included in minimum thickness requirements.					

### C. EXTERNAL MANHOLE FRAME SEALS

- 1) External frame seals shall only be used when frame and covers are replaced on rehabilitated manholes, or where otherwise specified by the Owner.
- 2) Manhole frame seals shall be composed of irradiated and cross-linked polyethylene impermeable backing, coated with protective head-activated adhesive, and shall be designed to conform to the exterior shape of the chimney area of the manhole frames. The frame seal shall bond to primed concrete and metal, and be compatible with concrete, steel and iron.
- 3) The frame seal shall have the following minimum properties:
  - a. Thickness: 100 mils
  - b. Fully Recovered Thickness: 125 mils
  - c. Shrink Factor: 40%
  - d. Sleeve Softening Point, ASTM E 28: 212 degrees F
  - e. Sleeve Backing: Impermeable cross lined polyolefin, coated with a heat activated adhesive
  - f. Tensile Strength, ASTM D 638: 2,900 psi
  - g. Elongation, ASTM D 638: 600%
  - h. Hardness, ASTM D 2240: Shore D: 46
  - i. Abrasion Resistance, ASTM D 1044: 35 mg
- 4) The primer shall be compatible with the frame seal, and shall be capable of priming steel, concrete and iron.
- 5) Acceptable Product: WrapidSeal by CCI Pipeline Systems, Breaux Bridge, LA or equal.

#### D. INTERNAL MANHOLE FRAME SEALS

Manhole frame seals shall be composed of flexible, pleated, high quality rubber gland with Type 304 stainless steel expansion bands, and shall be designed to conform to the inside shape of the chimney area of the manhole frames.

- 1) The rubber gland material compound shall conform to the applicable requirements of ASTM C 923, with a minimum tensile strength of 1,500 psi, a maximum compression set of 18%, and a durometer hardness of 48 (plus/minus 5).
- 2) The manhole frame seals shall be contained in-place on the inside of the manhole frame chimney area through the use of stainless steel expansion bands designed to expand to form a compression seal between the rubber gland and the manhole chimney area surface.
- 3) The bands shall be fabricated of 16-gauge Type 304 stainless steel conforming to ASTM A 240, and shall be equipped with a positive locking, worm-screw type mechanism. Screw hardware shall be Type 304 stainless steel conforming to ASTM F 593 and ASTM F 594.
- 4) Frame seals shall only be installed with the cementitious lining and epoxy coating systems.
- 5) Acceptable Manufacturer: Cretex or equal.

#### E. MANHOLE FRAME SEALANTS

- 1) Internal manhole frame sealant shall be Cretex EasySeal SG, or equal, and shall be composed of a corrosion resistant aromatic flexible urethane resin coating to be applied to the internal wall of the adjustment ring area.

The cured Urethane Resin Liner shall have the following minimum requirements:

- a. Hardness, Shore A, 95-100 per ASTM D2240
  - b. Elongation, 379-473% per ASTM D638 or ASTM D412
  - c. Tensile Strength, 2616-3216 psi per ASTM D638 or ASTM D412
  - d. Peel Strength, 30.8-46.8 PLI (AL to AL) PER ASTM D1876
- 2) Frame sealants must be certified by the manufacturer as compatible with the other components of the rehabilitation system.
  - 3) Sealant shall equal or exceed “EasySeal SG” as manufactured by Cretex Specialty Products, Waukesha, WI.

### **PART 3 – EXECUTION**

#### **3.1 GENERAL**

- A. **FIELD VERIFICATION AND ASSESSMENT** - Prior to performance of the actual Work inspect the site and locate those manholes designated to be

rehabilitated. Site conditions may preclude the Contractor from mobilizing the rehabilitation system equipment near the manhole. If the manhole is inaccessible, as determined by the Contractor and the Owner, the Contractor shall hand apply the rehabilitation system per the manufacturer's instructions and recommendations. Hand application shall be completed at no additional cost to the Owner. The Contractor shall be responsible for performing the following repairs on manholes indicated for rehabilitation.

- 1) Clean and prep manholes.
- 2) Remove steps. Removal shall consist of neatly cutting steps flush with the wall prior to any lining installation. The Contractor shall be responsible for proper disposal of steps.
- 3) Per Owner direction, replace frames and/or covers not previously identified for replacement with compatible components per Section 02730- *Sanitary Sewer* if identified to be corroded or damaged by the Contractor during performance of the Work.
- 4) Adjust replaced manhole frames to match proposed grades, per Section 02730- *Sanitary Sewer*.
- 5) Seal leaks within manhole.
- 6) Repair and patch inverts/benches.
- 7) Apply line coating.

#### **B. MANHOLE CLEANING AND PREPARATION**

- 1) Cleaning and preparation of the manholes shall be done in accordance with the rehabilitation system manufacturer's recommendations. In the absence of any recommendations, the following steps should be performed
- 2) Place cover over invert to prevent extraneous material from entering the sewer lines.
- 3) Foreign material shall be removed from the manhole wall and bench using a high-pressure water spray (minimum 1200 psi). Loose and protruding brick, mortar, and concrete shall be removed using a mason's hammer and chisel and/or scraper. Fill large voids with quick-setting Patching Mix in accordance with the requirements of this specification. Mix shall be applied in accordance with manufacturer's recommendations. The surface to be repaired must be clean and free of loose materials with walls totally saturated with water.
- 4) Minor leaks shall be stopped using the quick-setting specially formulated Infiltration Control Mix per this specification and shall be mixed and applied per manufacturer's recommendations. Some leaks may require weep holes to localize the infiltration during the application, after which the weep holes shall be plugged with the quick-setting infiltration control mix prior to the final liner application. When severe infiltration is present, drilling may be required

to Pressure Grout using a cementitious or chemical grout. Manufacturer's recommendations shall be followed when pressure grouting is required.

- 5) After preparation work has been completed, remove loose material and pressure wash wall again.
- 6) Bench, invert, or service line repairs shall be made at this time using the quick-setting patching mix per manufacturer's recommendations.
- 7) Invert Repair:

Invert repair shall be performed on all inverts with visible damage or infiltration. After blocking flow through the manhole and thoroughly cleaning invert, the quick-setting patch mix shall be applied to the invert in an expeditious manner. The mix shall be troweled uniformly onto the damaged invert extending out onto the base of the manhole sufficiently to tie into the structural/structurally enhanced monolithic liner to be applied. The finished invert surfaces shall be smooth and free of ridges. The flow may be re-established in the manhole within 30 minutes after placement of the mix. Upon completion of the invert repair and lining, there shall be a smooth transition from the invert to all of the lined and unlined incoming and outgoing connections.

- 8) Watertight Seal between Pipe Liner and Manhole Liner: Where a manhole has been lined through with a pipeline liner, the Contractor shall prepare a watertight seal and smooth transition between the pipe liner and manhole liner system. No leakage or gaps will be allowed. The method of sealing and preparing a smooth transition shall be approved by the Owner.

### C. CEMENTITIOUS LINER INSTALLATION

Described below are procedures for manhole preparation, cleaning, application and testing. The applicator, approved and trained by the manufacturer, shall furnish labor, equipment and materials for applying a cementitious mix with machinery specially designed for the application. Installation shall be in accordance with the manufacturer's recommendations and with the following specifications which include:

- Elimination of active infiltration prior to the application,
- Removal of loose and unsound material and cleaning surfaces, in accordance with Section 02750 - *Sewer Line Cleaning* and per manufacturer's recommendations
- Repair and sealing of the invert and benches, and
- Spray application of a cementitious mix to form a liner.

- 1) Liner Application:
  - a. Prior to liner application onto walls, manhole bench area shall be covered with plywood sections, which conform to the internal dimensions of the manhole, to prevent accumulation of liner material on bench.
  - b. Material shall be applied to rehabilitation system manufacturer

recommended thickness based upon all pertinent existing conditions, but shall not be less than 1 inch thick, and to conform to structural rehabilitation requirements of this specification.

- c. No application shall be made to frozen surfaces or if freezing is expected to occur inside the manhole within 24 hours after application. If ambient temperatures are in excess of 95° F, precautions shall be taken to keep the mix temperature at time of application below 90° F. Mix water temperature shall not exceed 85° F. Chill with ice, if necessary. The monolithic cementitious lining shall cover the complete interior of the existing sewer manhole including the benches (shelves). The lining shall effectively seal the interior surfaces of the sewer manhole and prevent any penetration or leakage of groundwater infiltration.
  - d. The lining shall be compatible with the thermal condition of the existing sewer manhole surfaces. Surface temperatures will range from 20°F to 100°F. Provide test data on shrinkage of the cementitious lining based on ASTM C596.
  - e. If an internal flexible frame seal is called for in the Contract Documents, then the lining shall be installed 1 inch below the bottom of the manhole frame. If no internal flexible frame seal is called for in the Contract Documents, then the lining shall be installed to 2 to 3 inches above the bottom of the manhole frame.
  - f. The termination of and surface of the lining shall be suitable for proper installation of the manhole frame-chimney seal specified.
  - g. The cured rehabilitation system shall be continuously bonded to all brick, mortar, concrete, chemical sealant, grout, pipe and other surfaces inside the sewer manhole.
  - h. Chemical sealants, grouts or patching materials used to seal active manhole leaks, to patch cracks, to fill voids and to otherwise prepare the manhole surface prior to application of the rehabilitation system shall be fully compatible with the rehabilitation system.
- 2) Mixing: For each bag of product, use the amount of water specified by the manufacturer and mix for 30 seconds to 1 minute after all materials have been placed in the mixer, using equipment per manufacturer's recommendation.

Empty the mixed material into the holding hopper and prepare another batch with timing such that the nozzleman can spray in a continuous manner without interruption until each application is complete.

- 3) Spraying:
- a. First Application: The surface prior to spraying shall be damp without noticeable free water droplets or running water, but totally saturated. Materials shall be spray applied from the bottom of the wall to the top, to a minimum uniform thickness to ensure that all cracks, crevices, and voids are filled and a relatively smooth surface remains after light troweling. The light troweling is performed to compact the material into voids and to set the bond.

- b. Second Application (as necessary per manufacturer's recommendations): A second application is to be applied after the first application has begun to take an initial set (disappearance of surface sheen which could be 15 minutes to 1 hour depending upon ambient conditions) to assure a minimum total finished thickness of ½ inch. Again application shall be from the bottom up. The surface is then troweled to a smooth finish being careful not to over trowel to bring additional water to the surface and weaken it. Manufacturer's recommendations shall be followed when more than 24 hours have elapsed between applications.
  - c. Bench Application: The plywood covers shall be removed and the bench sprayed such that a gradual slope is produced from the walls to the invert with the thickness at the edge of the invert being no less than ½ inch. The wall bench intersection shall be rounded to a uniform radius equal to the full circumference of the intersection.
  - d. The Contractor shall take precautions to keep overspray or excess material from entering the newly installed liner pipe and any other pipes in the manhole.
- 4) Curing: Caution should be taken to minimize exposure of applied product to sunlight and air movement.

If application of second coat is to be longer than 15 minutes after completion of application of first coat, the manhole cover shall be set back in place. At no time should the finished product be exposed to sunlight or air movement for longer than 15 minutes before replacing the manhole cover.

The final application shall have a minimum of 4 hours cure time before being subjected to active flow.

Traffic shall not be allowed over manholes for 6 hours after rehabilitation is complete.

#### **D. CURED IN PLACE MANHOLE LINER (CIPM) INSTALLATION:**

- 1) The cured in place liner shall be installed on the benches, walls, channels, and inverts of existing manholes. The cured surface shall be smooth and continuous with proper sealing connections to all unsurfaced areas. The cured in place liner shall begin below the frame and the frame/liner interface shall be sealed using an epoxy.
- 2) The cured in place liner shall be continuously bonded to all the brick, mortar, concrete, chemical sealant, grout, pipe and other surfaces inside the sewer manhole. The cured in place liner shall form a continuous, tight-fitting, hard, impermeable surfacing which is suitable for sewer system service and chemically resistant to any chemicals or vapors normally found in domestic sewage. The liner shall effectively seal the interior surfaces of the sewer manhole and prevent any penetration or leakage of groundwater infiltration.

- 3) The finished liner must be repairable at any time during the life of the structure. The liner shall be flexible, and have an elongation sufficient to bridge up to a ¼-inch settling crack, without damaged to the liner. The liner shall be able to bridge expansion cracks that may occur.
- 4) Field acceptance of CIPM liner shall be based on the Owner's evaluation of the proper monolithic lining of the manhole. Field acceptance shall also be based on the Owner's evaluation of the appropriate installation and curing test data along with review of the manhole inspections.
- 5) The CIPM liner shall provide a continuous monolithic lining with uniform thickness throughout the manhole interior. If the thickness of the CIPM is not uniform or is less than specified, it shall be repaired or replaced at no additional cost to the Owner.
  - a. The Owner will measure the CIPM liner cured thickness by physically cutting through the lining (by drilling or coring) and making a direct measurement. There will be up to two thickness measurement locations in each CIPM liner. A suitable non-destructive type of thickness measurement may also be used.
  - b. All CIPM liner thickness measurement locations shall be repaired by the Contractor in accordance with the manufacturer's recommendations. These repairs shall be included in the two-year guarantee.
  - c. The Contractor shall also perform in-place testing in each manhole to verify the adhesion of the CIPM liner to the existing manhole substrate. Adhesion strength tests shall be in accordance with ASTM D7234 and the test area shall be isolated from the remaining portion of the manhole by coring through the liner into the substrate. Two tests shall be performed in each manhole at locations directed by the Owner. Testing shall consist of a calibrated pull off test. All equipment shall be provided by the contractor. Samples must meet a minimum pressure resistance of 400 psi.
- 6) There shall be no cracks, voids, pinholes, uncured spots, dry spots, lifts, delaminations or other type defects in the liner.

### **3.2 LINER AND COATING ACCEPTANCE AND TESTING**

- A. The Owner may enter the manholes to inspect the benching, invert channels, manhole wall/pipe connections, surface preparation, and other parts of the Work. The Contractor shall provide forced air ventilation, gas monitors and detectors, harnesses, lights, etc. for the Owner to enter the manhole and perform the inspection in complete accordance with OSHA requirements at no additional cost to the Owner.
- B. The finished manhole surface shall be continuous and as free as commercially practicable from significant defects. Any defects that will affect, in the foreseeable future, or warranty period, the integrity or strength of the manhole shall be

repaired at the Contractor's expense, in a manner mutually agreed upon by the Owner and the Contractor.

- C. There shall be no cracks, voids, pinholes, uncured spots, dry spots, lifts, delaminations or other type defects in the rehabilitation system. If any defects are discovered after liner has been installed, it shall be repaired or replaced in a satisfactory manner within 72 hours and at no additional cost to the Owner. This requirement shall apply for the entire guarantee period.
- D. Active infiltration through the rehabilitation system shall be zero.
- E. The Contractor is responsible for coordinating testing times with the Engineer as the field representative may be involved in other tasks for scope on this project.
- F. All rehabilitated manholes shall be tested. The Contractor shall submit proposed method for testing. One or more of the following tests shall be performed by the Contractor as directed by the Owner.

1) Cementitious

- a. Visually verify the absence of leaks or physical defects.
- b. Cementitious manholes rehabilitation thickness shall be tested by inserting a measurement device at eight (8) defined locations in the manhole, as directed by Owner.
- c. Four 3-inch by 6-inch test cylinders or six 2-inch cubes shall be cast each Day or from every 50 bags of product used. The test specimen shall be properly labeled and sent in for testing in accordance with the manufacturer's directions for compression strength testing as described in ASTM C 495. The frequency may be reduced by the Owner at their discretion if the samples pass the required strengths.
- d. Pull off test in accordance with ASTM D4541 with minimum acceptable pull strength of 250psi. The failure point of the pull must be located within the substrate, not within the coating thickness.

2) Cured in Place Manhole (CIPM) Liner

- a. Visually verify the absence of leaks or physical defects.
- b. Vacuum Test or Hydrostatic Test: Either a vacuum test conforming to the requirements of ASTM C1244 or the Exfiltration Test shall be performed for every lined manhole or circular structure where practical. The Exfiltration Test shall consist of plugging incoming and outgoing sewer lines (or performing prior to reinstating the holes) and filling the manhole with water up to the rim. After initial absorption (15 minutes), if the water loss exceeds one inch in depth in five minutes, the manhole shall have failed the test. Each manhole that fails the test shall be carefully inspected to determine the problem and then resealed and retested until the water loss is less than one inch in 15 minutes.



### 3.3 MANHOLE FRAME AND COVER REPLACEMENT

- A. Excavation and site restoration in paved and unpaved areas shall be in accordance with Sections 02200 – *Earthwork*, 02220 - *Trenching, Backfilling, and Compaction of Utilities*, and 02500 – *Base Course and Paving* to a minimum of established pre-construction conditions.
- B. The Contractor shall remove and dispose of the existing manhole frames and covers, as specified in the Contract Documents. It shall be the responsibility of the Contractor, at no additional cost to the Owner, to repair any damage to the chimney or corbel caused by the removal of the existing manhole frame.
- C. New replacement frames and covers shall be as specified in Section 02730 – *Sanitary Sewer*.
- D. Repair of Manhole Chimney and Corbel, Requiring Excavation (when directed by the Owner):
  - 1) In Paved Areas:
    - a. The removal of the manhole frame shall be accomplished by making a square cut of sufficient size in the pavement.
    - b. Material in the exposed area shall be dug out to a sufficient depth to permit the required repairs. All excess material, including pavement, shall be disposed of as surplus material in accordance with Section 02200 - *Earthwork*.
    - c. Backfill materials shall be in accordance with Section 02200 – *Earthwork* and Section 02220 *Trenching, Backfilling, and Compaction of Utilities*.
    - d. Backfill shall be replaced and compacted to prevent settlement and to restore the setting to a condition equal to or better than that found in accordance with Section 02200 – *Earthwork* and Section 02220 *Trenching, Backfilling, and Compaction of Utilities*. Backfill shall not cover the manhole.
    - e. The surfacing needed to cover the exposed area (concrete or asphalt) shall conform to the existing pavement. It shall be placed to the same elevation and grade and have a thickness equal to or greater than the existing pavement.
    - f. Replacement of pavement not satisfactorily performed by the Contractor shall be reworked at no expense to the Owner.
  - 2) In Unpaved Areas:
    - a. Only necessary excavation around manhole shall be performed.
    - b. Backfill shall be replaced and compacted to prevent settlement and to restore the setting to a condition equal to or better than that found in accordance with Section 02200 – *Earthwork* and Section 02220

*Trenching, Backfilling, and Compaction of Utilities.* Backfill shall not cover the manhole.

- c. Any private property element or structure that is removed for access to the manhole shall be replaced by the Contractor to existing or better condition to the satisfaction of the property owner.
- 3) The Contractor shall take all necessary precautions to prevent falling debris from damaging the manhole trough and/or entering the sewer. The damaged or deteriorated portions of the existing manhole chimney and corbel shall be removed and property disposed of by the Contractor.
- 4) The chimney and corbel shall be repaired or rebuilt with new brick or precast concrete grade rings as appropriate to reconstruct the chimney to the height needed for the frame and cover to meet the required grade. The manhole frame shall be sealed using either a manufactured or applied sealing method.

**END OF SECTION 02790**

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