

SECTION 02547
MANHOLE REHABILITATION

PART 1. GENERAL

1.01 SCOPE

- A. This specification details the materials, products, and performance requirements for the rehabilitation of sanitary sewer manholes. This specification includes lining manhole interiors, chimney liner seals, and reconstruction of manhole benches and channels.
- B. Refer to Specification 02547, Manholes, for frame and cover replacement, re-installations, and adjustments.

1.02 SUBMITTALS

- A. Action Submittals:
 - 1. Manufacturer's literature & product data describing the following:
 - a. Rehabilitation System
 - b. Equipment Components
 - c. Material/chemical properties
 - d. Mixing and proportioning requirements
 - e. Maximum pot life
 - f. Coating thickness
 - g. Curing
 - h. Environmental requirements for application
 - i. Epoxy Resins: Specifications, Characteristics, and Properties
 - j. Hydraulic cement
- B. Informational Submittals:
 - 1. Manufacturer's certificate of compliance
 - 2. Safety Data Sheets (SDS)
 - 3. Manufacturer's instructions on shipping, storage, and handling requirements
Manufacturer's application and repair instructions
 - 4. Testing, certification, and warranty sample statements
 - 5. Confined space entry plan
 - 6. Qualifications and experience history of installers

1.03 QUALITY PERFORMANCE

- A. Mortar mix for cementitious lining shall have at least 5 years of successful performance in similar applications, and shall be supplied by an ISO 9002 certified manufacturer. Manufacturer's ISO 9002 certificate shall be submitted to the OWNER.
- B. Installers shall have a minimum of 5 years of experience installing the product provided, and shall be certified by the manufacturer. Installers of liners, coatings, and wall repair systems shall submit qualifications and include:
 - 1. Manufacturer's approved equipment list, by name and model number for application of product and CONTRACTOR's equipment list showing approved equipment available for use in product application.
 - 2. List of CONTRACTOR's personnel who have satisfactorily completed manufacturer's training in product application within previous two years. Include date of certification for each person.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products as recommended by the manufacture to prevent damages. Deliver lining products to site in unopened containers that clearly show, at time of use, product name, date of manufacture, batch number, and name manufacturer. Materials shall be made safe from theft, vandalism, and damage.
- B. Store lining products in protected area with heating or cooling to maintain temperatures within range recommended by lining manufacturer.
- C. All products and materials specified herein shall be inspected at the request of OWNER or RESIDENT PROJECT REPRESENTATIVE. All materials that fail to conform to these Specifications shall be rejected. After delivery to the Site, any materials that have been damaged in transit or are otherwise unsuitable for use in the Work shall be rejected and removed from the Site by the CONTRACTOR at no cost to the OWNER.
- D. The CONTRACTOR shall dispose of all wastes in accordance with all applicable laws, codes, and regulations.

1.05 PERFORMANCE REQUIREMENTS

- A. Perform work needed to make manholes structurally sound, improve flow, prevent entrance of inflow or groundwater, prevent entrance of soil or debris, and provide protection against corrosion.

- B. **Manufacturer's Product Support:**
1. Through the CONTRACTOR, manufacturers of wall sealing, coating or lining systems shall submit to the Engineer for review and approval a detailed description of the proposed rehabilitation process. Describe surface preparation, independent laboratory test results, mix design procedures and methods of controlling uniform thickness.
 2. A representative employed by the manufacturer and having technical training in admixture and concrete mix design shall be named and available for consultation by telephone during business hours and on site upon 48 hours notice.
 3. Manufacturer's representative on concrete lining systems shall provide technical assistance to concrete batch plant operators to ensure proper usage of dispensing equipment and accurate proportions of admixtures.

1.06 PROJECT CONDITIONS

- A. **Manholes Containing Mechanical or Electrical Equipment:**
1. Contract Drawings may not show locations of flow monitoring equipment. If a manhole contains any mechanical hardware or electrical flow monitoring equipment, do not remove or disturb and immediately notify the OWNER or RESIDENT PROJECT REPRESENTATIVE.
 2. Reschedule work in such manholes until equipment has been removed by OWNER and further instructions are given.
 3. Do not subject manholes with mechanical hardware or electrical equipment to diversion/bypass pumping.
 4. Damage to installed equipment, due to negligence of CONTRACTOR, will be repaired by OWNER and cost of repairs charged to CONTRACTOR.
- B. **Field Location of Manholes, Cleanouts and Inlets:**
1. CONTRACTOR is responsible for locating and uncovering all manholes and cleanouts in lines being rehabilitated. If difficulty is encountered in locating a manhole or clean-out covered by ground or pavement, notify the OWNER or RESIDENT PROJECT REPRESENTATIVE and await instructions.
 2. Manholes may be located within project limits which are not part of the system being rehabilitated. Properly identify manholes before starting cleaning and sealing operations.

PART 2. PRODUCTS

2.01 MATERIALS

A. General:

1. The materials used shall be designed, manufactured and intended for sewer manhole rehabilitation and the specific application in which they are used. The materials shall have a proven history of performance in sewer manhole rehabilitation. The materials shall be delivered to the job site in original unopened packages and clearly labeled with the manufacturer's identification and printed instructions. All materials shall be mixed and applied in accordance with the manufacturer's written instructions.
2. Each lining system shall be designed for application over wet (but not active running water) surfaces without degradation of the final product and the bond between the product and the manhole surfaces.

B. Mortar:

1. Standard premixed in accordance with ASTM C387/C387M, or proportion one part Portland cement to two parts clean, well-graded sand that will pass a 1/8-inch screen.

C. Hydraulic Cements:

1. Rapid-setting, high early strength, cementitious product specifically formulated for high volume leak control.
 - a. Manufacturers and Products:
 - 1) Strong Systems, Inc; Strong-Seal Plug.
 - 2) Quadex; Quad-Plug.
 - 3) Improved Construction Methods (ICM); ThoRoc Plug.
2. Rapid setting, fiber-reinforced, high-early-strength, corrosion-resistant material formulated for filling voids and repairing inverts in concrete, brick, or other masonry constructed structures
 - a. Manufacturers and Products:
 - 1) Strong Systems, Inc; Strong-Seal QSR.
 - 2) Quadex; Hyperform.
 - 3) Improved Construction Methods (ICM); ThoRoc Patch.
 - 4) IPA; Octocrete.

D. Chemical Pressure Grouting System:

1. General: Where pressurized injection of chemical grout behind manhole chimney and joints is required, material supplied shall be urethane gel or polyurethane resin with following properties:
 - a. During injection, chemical sealant shall be able to react/perform in presence of infiltration water.

- b. Cured sealant capable of withstanding submerged conditions, freeze/thaw, and wet/dry cycles without degradation. Must prevent passage of water and must be flexible, chemically stable, and resistant to sewer environments.
- 2. Urethane Gel Products and Materials:
 - a. Avanti International; AV-350 multi-grout or AV-254 urethane gel.
- 3. Polyurethane Resin Grout:
 - a. Viscosity: 120 to 350 centipoise.
 - b. Weight Per Gallon: 8.65 pounds to 9.48 pounds per gallon.
 - c. Solids Content, ASTM D2834: 88 percent to 100 percent.
 - d. Induction Time: 3 minutes to 4 minutes.
 - e. Cure Time: 5 minutes to 6 minutes.
 - f. Tensile Strength, ASTM D3574: 40 psi to 450 psi.
 - g. Elongation, ASTM D3574: 3 percent to 350 percent. Shrinkage, ASTM D1042: Less than 2 percent. Initial Linear Shrinkage: 9 percent.
 - h. Tear Resistance, ASTM D3574: 21 pounds per inch.
 - i. Density, ASTM D3574: 38 pounds to 119 pounds per cubic foot.
 - j. No catalyst required; single component product.
- E. Spray applied Cementitious manhole coating:
 - 1. Design Mix:
 - a. Preblended mixture of cements, chemically active aggregates, glass fibers, and other additives. No material, other than potable water, shall be used with or added to design mix without prior approval or recommendation from the OWNER.
 - b. One-component, rheoplastic, fiber or polypropylene-reinforced, shrinkage compensated mortar lining system with the following minimum requirements at 28 days:
 - 1) Compressive Strength (ASTM C109/C109M): 8000 psi
 - 2) Tensile Strength (ASTM C-496/C496M): 800 psi
 - 3) Flexural Strength (ASTM C-293/C-293M): 1200 psi
 - 4) Shrinkage (ASTM C-596): 0% at 90% R.H.
 - 5) Minimum Bond (ASTM C-952): 200 psi
 - 6) Slant Shear Bond Strength (ASTM D882): 2400 psi
 - 7) Freeze/Thaw – 100 cycles, ASTM C666/C666M No Visible Damage
 - 8) Density, when applied 105" pcf
 - c. Product shall be made with calcium aluminate cement except in cases when cementitious lining is used as underlayment for epoxy lining.

- F. Spray applied Epoxy Coating for manholes:
1. Products shall meet federal, state, and local requirements limiting emissions of volatile organic compounds. Materials, including underlayment and monolithic lining shall be produced by same manufacturer.
 2. Characteristics:
 - a. Materials: 100 percent solids, plural component epoxy, capable of spray or roller application.
 - b. Moisture Tolerant: System capable of application to damp concrete surfaces in high relative humidity environment.
 - c. Chemical Resistance: Resistant to attack from hydrogen sulfide and sulfuric acids generated from microbiological sources.
 3. Properties:
 - a. Bond Strength, ASTM C478: Concrete failure
 - b. Tensile Strength, ASTM C307: 2,500 psi, minimum
 - c. Flexural Strength, ASTM C580: 4,800 psi
 - d. Moisture Absorption, ASTM C413: 0.1 percent
 - e. Shrinkage, ASTM C631: 0.11 percent, maximum.
- G. Forming and placing a concrete lining between the forms and existing manhole wall.
1. The concrete shall be Type I portland cement concrete with 3/4 inch minus coarse aggregate with fiber reinforcement and plasticizer producing a compressive strength of 4,000 psi at full cure. (Other formulations and filler materials may be selected to meet specific problems.) When corrosive elements are present, a white ribbed plastic liner shall be anchored into the new interior wall during the procedure to create an impermeable barrier.
 2. Cast-in-Place, seamless concrete wall lining within the existing manhole from the pipe invert to the bottom of the frame shall be by the Permaform process or approved equal.
- H. Chimney Liner Seals:
1. Manufacturers and Products:
 - a. Cretex Specialty Products; Internal Manhole Chimney Seal.
 - b. NPC, Inc.; FlexRib Chimney Seal.
 - c. Sealing Systems, Inc.; Flex-Seal.

PART 3. EXECUTION

3.01 REHABILITATION OF MANHOLE STRUCTURES

A. General Procedures:

1. **Safety:** The CONTRACTOR shall perform all work in strict accordance with all applicable OSHA standards. Particular attention is drawn to those safety requirements regarding confined space entry. Provide barricades, warning lights and signs for excavations.
2. **Maintaining waste water flows:** By-pass pumping shall be conducted in accordance with Section 02540, Sewer Flow Control.
3. **Cleaning:** All concrete and masonry surfaces to be rehabilitated shall be clean. All grease, oil, laitance, coating, loose bricks, mortar, unsound concrete and other foreign materials shall be completely removed. Water blasting with proper nozzles shall be the primary method of cleaning; however, other methods such as wet or dry sandblasting, acid wash, concrete cleaners, degreasers or mechanical means may be required to properly clean the surface to meet the manufacturer's requirements. All surfaces on which these methods are used shall be thoroughly rinsed, scrubbed, and neutralized to remove cleaning agents and their reactant products. Debris resulting from cleaning shall be removed from the manhole and not allowed to be carried downstream.
4. **Stopping Infiltration:** After surface preparation and prior to the application of linings and coatings, infiltration shall be eliminated with the materials specified herein and in accordance with the manufactures recommendation. Remove existing roots prior to application by cutting them flush with the manhole wall.
5. **Patching:** Prepare surfaces with any necessary patching in accordance with manufacturer's instructions. All holes, voids, cracks, and disintegrated material shall be patched or repointed, providing a subbase that meets the manufactures recommendations.
6. **Invert & channel repairs:** Remove all loose grout and rubble from existing channel. Rebuild channel if required by reshaping, repairing slope of shelves or benches. Work shall include aligning inflow and outflow ports in such a manner as to prevent the deposition of solids at the transition point. All inverts shall follow the grades of the pipe entering the manhole. Changes in direction of the sewer and entering branch or branches shall have a true curve as large a radius as the size of the manhole will permit, but will be shaped to allow easy entrance of maintenance equipment including buckets, T.V. camera, etc.
7. **Manhole steps:** Existing manhole steps shall be cut and removed and not replaced after rehabilitation.

8. All abandoned pipe and associated connections to the manhole shall be properly sealed with a bulkhead and filled with grout prior to manhole rehabilitation.

3.02 APPLICATION OF CEMENTITIOUS COATING

- A. Clean and prepare substrate surfaces in accordance with these specifications, and recommendations of manufacturer. Materials shall be spray applied to a minimum uniform thickness to insure that all cracks, crevices, and voids are filled and to a somewhat smooth surface.
- B. Bonding agent: Apply to existing surface per the manufactures recommendations to provide firm adhesion between original and new material.
- C. Apply cementitious lining material per manufactures recommendations to a minimum thickness of 1-inch for depth. For manhole depths greater than 12 feet increase the minimum thickness to 1 ½ inches below the 12 foot depth. Cementitious lining shall be applied to fresh mortar before new bacterial growth or debris can contaminate underlying mortar.
- D. The bench and invert shall be 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 1/8 inch. The wall-bench intersection shall be rounded to a uniform radius the full circumference of the intersection.
- E. No application shall be made to frozen surfaces or if freezing is expected to occur within the manhole for 24 hours after application. Do not apply materials if ambient temperature is below 40 degrees F. If ambient temperatures are in excess of 90 degrees F, precautions shall be taken to keep the mix temperature at time of application below 90 degrees F, using ice if necessary. Do not exceed a mix water temperature of 80 degrees F.
- F. The final application shall be allowed to cure for a minimum of four (4) hours before being subjected to active flow. If the manufacture recommends a longer cure time the CONTRACTOR shall follow the manufactures recommendation.

3.03 SPRAY APPLIED EPOXY COATING

- A. The material shall be spray applied to a minimum uniform dry film thickness of 50 mils to insure all cracks, crevices, and voids are filled and a somewhat smooth surface remains. Apply material per the manufactures recommendation to prevent material run or sag. After the epoxy liner has set, repair any visible pinholes or defects per the manufactures recommendations.

3.04 CHIMNEY LINER SEALS

- A. Chimney liner & seals shall be installed as specified in the Project Drawings and Bid Form.
- B. Internal double pleated elastomeric sleeve shall be mechanically attached to and sealed against the manhole frame and chimney with internal expanding bands.
- C. The inside diameter of both the base of the manhole frame and the chimney or cone/corbel section shall be accurately measured as recommended by the manufacturer to obtain the proper size and shape of the seal.
- D. The contact surfaces for the sleeve shall be circular, clean, reasonably smooth, and free of loose material and excessive voids. If the masonry surface is rough or irregular and will not provide an effective seal, it shall be smoothed with mortar. A bed of butyl rubber caulk shall be applied to the sealing surface of the sleeve to fill minor irregularities in the masonry surface. After the sleeve has been placed in proper position, the bands are positioned and individually tightened or expanded as required to provide a watertight seal. Detailed installation instructions shall be in accordance with the manufacturer's instructions.

3.05 MANHOLE REHABILITATION ACCEPTANCE

- A. After the manhole rehabilitation work has been completed, the manhole shall be visually inspected during high groundwater by the CONTRACTOR in the presence of the Engineer and the work shall be accepted if found satisfactory to the Engineer. No evidence of visible leaks shall be allowed. In addition, at the OWNER's request, the CONTRACTOR may be required within one year to visually inspect the manholes that were rehabilitated. Any work that has become defective within the one year period shall be redone by the CONTRACTOR at no additional expense to the OWNER.

3.06 MANHOLE VACUUM TESTING

- A. All manholes shall be negative air pressure (vacuum) tested in accordance with ASTM C1244.
- B. All manholes are to be vacuum tested following rehabilitation. The ring and lid casting assembly shall be installed prior to testing. The testing system shall be equipped with an inflatable bladder to effect the seal to the manhole, an air pressure gauge, a safety valve for filling the bladder, a 30-inch Hg liquid-filled vacuum gauge, a double air exhaust manifold with quarter turn ball valves, three bolt-on feet, and a bridge assembly with height adjustment rod.

- C. The CONTRACTOR shall plug all pipe openings, taking care to securely brace the plugs and the pipe. The plugs shall be placed a minimum of 6" beyond the manhole wall.
- D. The vacuum tester shall be placed on the manhole casting and operated in accordance with the manufacture's recommendation to evacuate the manhole to 10" Hg and monitor the vacuum for the specified time period. If the vacuum does not drop in excess of 1" Hg over the specified time period, the manhole is considered acceptable and passes the test. If the manhole fails the test, identify the leaking areas by removing the head assembly, coating the interior surfaces of the manhole with a soap and water solution, and repeating the vacuum test for approximately thirty seconds. Once the leaks have been identified, complete all necessary repairs with an OWNER approved method, and repeat test procedures until satisfactory results are obtained.
- E. Upon the approval of the OWNER, the CONTRACTOR may test manholes greater than 72-inches in diameter at a reduced negative pressure.

VACUUM TEST TIMETABLE			
Manhole Diameter - Inches			
Depth - Feet	48"	60"	72"
4'	10 sec.	13 sec.	16 sec.
6'	15 sec.	20 sec	25 sec.
8'	20 sec.	26 sec.	32 sec.
10'	25 sec	33 sec.	41 sec.
12'	30 sec.	39 sec.	48 sec.
14'	35 sec.	46 sec.	57 sec.
16'	40 sec.	52 sec.	64 sec.
18'	45 sec.	59 sec.	73 sec.
20'	50 sec.	65 sec.	80 sec.
22'	55 sec.	72 sec.	89 sec.
24'	60 sec.	78 sec.	97 sec.
26'	64 sec.	85 sec.	105 sec.
28'	69 sec.	91 sec.	113 sec.
30'	74 sec.	98 sec.	121 sec.

- F. Epoxy Lined Manhole Testing:
 - 1. Wet Film Thickness Gauge: During application, use wet film thickness gauge; meet ASTM D4414 to ensure monolithic coating and uniform thickness.

- G. Holiday Detection:
 - 1. In accordance with NACE SPO 188.
 - 2. After 24 hours minimum, spark test lining system to ensure pinhole-free lining.
 - 3. Mark defects and repaired per manufacturer's instructions.

END OF SECTION