SECTION 03362 – SANITARY SEWER MANHOLE REHABILITATION

PART 1 - GENERAL

1.01 SUMMARY

A. This section covers all labor, work, materials and equipment required for repairing voids, restoring the structural integrity of manholes in corrosive and noncorrosive environments, eliminating infiltration and providing corrosion protection (antimicrobial additive or epoxy).

B. This shall be accomplished by applying a monolithic fiber reinforced cementitious liner to the entire manhole including the corbel, wall, bench and channel surfaces after all necessary surface preparation as recommended by the manufacturer is completed, including performing proper cleaning, stopping infiltration and creating a correct surface profile.

1.02 SPECIFICATION MODIFICATIONS

A. It is understood that throughout this section these Specifications may be modified by appropriate items in Section 01015 – Specific Project Requirements, or as otherwise indicated on the Contract Drawings.

1.03 RELATED SECTIONS

A. Section 01000 – General Project Requirements.
B. Section 01015 – Specific Project Requirements.
C. Section 01300 – Submittals.
D. Section 01320 – Construction Progress Documentation.
E. Section 01700 – Traffic Control.
F. Section 02575 – Surface Restoration.
G. Section 02702 – Testing Requirements for Sanitary Sewer: Mains and Manholes.
H. Section 03370 – Sanitary Sewer Manhole Construction.
I. Section 05010 – Sanitary Sewer Manhole Castings.
J. Section 06010 – Cured-In-Place Pipe (CIPP), CIPP Point Repairs and End Seals.

1.04 CODES AND STANDARDS

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

B. American Society for Testing and Materials (ASTM):

ASTM C109	Standard Test Method for Compressive Strength of Hydraulic-Cement Mortar.
ASTM C267	Standard Test Methods for Chemical Resistance of Mortars, Grouts, and Monolithic Surfacings and Polymer Concretes.
ASTM C293	Standard Test Method for Flexural Strength of Concrete.
ASTM C496	Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens.
ASTM C596	Standard Test Method for Drying Shrinkage of Mortar Containing Hydraulic Cement.
ASTM C666	Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing.

ASTM C882	Test Method for Bond Strength of Epoxy-Resin Systems used with Concrete by Slant Shear.
ASTM D638	Test Method for Tensile Properties of Plastics.
ASTM D695	Test Method for Compressive Properties of Rigid Plastics.
ASTM D790	Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
ASTM D2240	Test Method for Rubber Property – Durometer Hardness.
ASTM D4541	Test Method for Pull-Off Strength of Coating Using Portable Adhesion Testers.

C. National Association of Corrosion Engineers (NACE International):

SP0188:2006	Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates.

1.05 INFORMATION PROVIDED BY THE CITY

A. As provided in the Contract Documents.

1.06 SUBMITTALS

A. Submit as specified in Section 01300 – Submittals.
B. Shop Drawings.
C. Product Data:
   1. Submittal detailed data pertaining to the manhole lining products, manufacturer's installation recommendations, product data, mix designs and manufacturer's installation instructions.
   2. Patching Materials.
   3. Infiltration control materials.
   4. Cementitious Liner:
      (a) Test Data:
         (i) Provide third party test data verifying the properties called for in the specifications including, but not limited to compressive strength, bond strength, tensile strength, and shrinkage.
         (ii) When an antimicrobial admixture is to be used (Type 2 Liners), the testing shall be performed on cementitious material with the antimicrobial admixture to be used for the Work.
         (iii) Testing data shall have been conducted within 3 years prior to the date of submittal.
      (b) Manufacturer's installation instructions shall include, but are not limited to, the following:
         (i) Recommendations for repairs.
         (ii) Minimum and maximum application temperatures.
         (iii) Instructions for material handling and mixing.
         (iv) Recommendations for environmental controls during application, safety, and spray equipment.
         (v) Requirements for surface preparation and surface conditions.
         (vi) Recommendations for curing time before the cementitious liner may be subject to flow.
         (vii) Recommendations for curing time before an epoxy topcoat can be applied to the cementitious liner.
      (c) Antimicrobial Additive: Provide Manufacturer's mixing and dosing recommendations.

(d) Admixture Identifier.

5. Epoxy Lining System:
   (a) Specifications.
   (b) Technical data sheets.
   (c) Installation instructions: Provide detailed and complete information pertaining to the manufacturer's instructions for installation and repair of the epoxy liner system. The information and instructions shall include, but not limited to, the following:
      (i) Recommendations for storage of materials.
      (ii) Minimum and maximum application temperatures.
      (iii) Instructions for material handling and mixing.
      (iv) Recommendations for environmental controls during application, safety, and spray equipment.
      (v) Requirements for surface preparation and surface conditions to receive the epoxy liner system.
      (vi) Recommendations for application of multiple coats including curing time between coats.
      (vii) Procedures to repair pinholes, blisters, evidence of uneven coverage, poor bonding, or other types of repairs.
6. Test Data: Provide test data verifying the properties of the epoxy liner system where called for in the specifications. Data is to include, but is not limited to, the following:
   (a) Adhesion strength.
   (b) Hardness, Shore D.
   (c) Compressive strength.
   (d) Flexural strength.
   (e) Tensile strength.
7. Results of all quality control tests performed on the shipments of the epoxy products provided.

D. Samples:
   1. Not a required submittal.

E. Testing:
   1. Product testing in conformance with paragraph CEMENTIOUS MANHOLE LINING.

F. Other Submittals:
   1. Qualifications:
      (a) Submit resumes for each worker as required by paragraph QUALITY ASSURANCE. Include years of experience and verification of OSHA 10-hour training.
      (b) Provide cementitious liner manufacturer's certification for Applicators as required by paragraph QUALITY ASSURANCE.
      (c) As applicable, provide antimicrobial admixture manufacturer's certification for Applicators as required by paragraph QUALITY ASSURANCE.
      (d) References: Submit Contractor's references in accordance with paragraph QUALITY ASSURANCE.
   2. Submit Work Plan in accordance with paragraph WORK PLAN.
   3. Results of all quality control tests performed on samples taken during application.
   4. Contractor shall submit manhole acceptance testing reports prior to final payment.

5. Manufacturer's warranty on the liner system(s) provided.

1.07 QUALITY ASSURANCE

A. The Contractor is responsible for the quality assurance and quality control of the Work.

B. Qualifications for reinforced structural cementitious liner installation:
   1. Manufacturer: Company specializing in manufacturing the products specified in this section shall have a minimum of ten (10) years of experience manufacturing the products provided and providing training for their Applicators.
   2. Applicators:
      (a) Submit certification from manufacturer of the cementitious liner system that the Applicator has been trained and approved in the handling, mixing and application of the products to be used.
      (b) As applicable, submit certification from manufacturer of the antimicrobial admixture that the Applicator has been trained and approved in the handling, mixing and application of the products to be used.
      (c) Each Applicator shall have a minimum of three (3) years of experience applying the liner materials that will be installed as part of the Work. Submit resumes for each Applicator showing experience with installation of the proposed products including Manufacturer's training requirements and certifications.
   3. Contractor shall provide the City three (3) references within the past three (3) years from the bid date for successful projects of similar size and difficulty for the exact cementitious products to be used by the Applicator. In lieu of references, an authorized manufacturer representative shall be onsite until they are satisfied with the performance of the Applicator.
   4. Equipment: Submit manufacturer's certification approving the equipment to be used for applying the material(s) used on this contract.

C. Qualifications for epoxy lining installation:
   1. Manufacturer: Company specializing in manufacturing the products specified in this section shall have a minimum of ten (10) years of experience manufacturing the products provided and providing training for their Applicators.
   2. Applicators:
      (a) Submit certification from the manufacturer of the epoxy lining system that the Applicator has been trained and approved in the handling, mixing and application of the products to be used.
      (b) As applicable, submit certification from manufacturer of the antimicrobial admixture that the Applicator has been trained and approved in the handling, mixing and application of the products to be used.
      (c) Each Applicator shall have a minimum of three (3) years of experience applying the liner materials that will be installed as part of the Work. Submit resumes for each Applicator showing experience with installation of the proposed products including Manufacturer's training requirements and certifications.
   3. Contractor shall provide the City three (3) references within the past three (3) years from the bid date for successful projects of similar size and difficulty for the exact cementitious products to be used by the Applicator. In lieu of references, an authorized manufacturer representative shall be onsite until they are satisfied with the performance of the Applicator.

4. Equipment: Submit manufacturer's certification approving the equipment to be used for applying the material(s) used on this contract. The equipment and materials to be utilized for the epoxy lining system shall be designed and manufactured to withstand the severe effects of hydrogen sulfide in a wastewater environment. Manufacturer of corrosion protection products shall have long proven experience in the production of the lining products utilized and shall have a satisfactory installation record.

D. All aspects of the installation of the liner system shall be in accordance with this specification and with the manufacturer's written information including specifications, technical data sheets and installation manual. If a discrepancy occurs between the manufacturer's recommendation and this specification, the City shall determine the appropriate action.

1.08 WORK PLAN

A. Contractor shall submit a Work Plan for approval by the City at least 30 days prior to the start of rehabilitation work.

B. Following approval by the City, Contractor shall review the Work Plan with the City's resident representative prior to starting work.

C. As a minimum, the following items shall be addressed in the work plan:
   1. Written description of construction procedures, including equipment layout plan, order of work, flow diversion plan (if needed), and traffic control.
   2. Detailed construction schedule for preparation, application and testing in accordance with Section 01320 – Construction Progress Documentation.
   3. For use of private property beyond the limits of the Site, the Contractor shall conform to Section 01000 – General Project Requirements, paragraph EASEMENTS AND RIGHTS-OF-WAY.
   4. Joint certificate of "Compliance with Specifications" between the manufacturer and applicator for the manhole rehabilitation material and installation.
   5. Traffic Control plan in accordance with Section 01700 – Traffic Control.
   6. Quality assurance requirements specified in paragraph QUALITY ASSURANCE.

1.09 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Store all materials per the manufacturer's recommendations to prevent contamination and deterioration. See also Section 01000 – General Project Requirements.

B. Store all materials in a manner that will permit easy access for inspection and identification of each shipment.

1.10 WARRANTY

A. The cementitious manufacturer(s) and the epoxy liner system manufacturer(s) shall provide a five (5) year warranty against material defects and other defects that affect the structural integrity of the applied product including but not limited to infiltration and inflow, cracks, fractures, delamination, deterioration and any other defect affecting the performance of the product. Manufacturer's warranty shall be submitted in accordance with paragraph SUBMITTALS.

B. During the correction period, Contractor shall repair any defects that affect the water tightness or strength of the applied materials. Repairs shall be made at no additional cost to the City.

PART 2 - PRODUCTS

2.01 PATCHING MATERIAL

A. Patching material shall be compatible with cementitious liner materials.
B. Patching material shall be a quick setting cementitious material meeting the following minimum requirements:

Table 1. Patching Materials

Characteristic	Minimum Requirement	Specification
Compressive Strength	>1,500 psi at 1 hour >4,500 psi at 24 hours >7,000 psi at 28 days	ASTM C109
Bond	> 1600 psi, 28 days	ASTM C882
Shrinkage	0% at 90% Relative Humidity	ASTM C596
Placement Time	Up to 15 minutes	
Set Time	15 to 30 minutes	

C. Mix and apply according to the manufacturer's recommendations.
D. Manufacturer shall provide documentation that the product will adhere to the substrate.
E. Allowable Product Manufacturers:
   1. Permacast® Patch 20 by AP/M Permaform Products of Johnson, Iowa.
   2. Strong-Shield QSR Plus be The Strong Company, Inc. Pine Bluff, Arkansas.
   3. City approved equal.

2.02 INFILTRATION CONTROL MATERIAL

A. Provide a material specifically designed for fast setting to seal active leaks in preparation for lining of manholes.
B. Cementitious Lining Products:
   1. A rapid setting cementitious product, specifically formulated for leak control, shall be used to stop minor water infiltration. The material shall be mixed and applied according to the manufacturer's recommendations.
   2. Infiltration control material shall meet the following minimum requirements:

Table 2. Infiltration Control Materials

Characteristic	Specification	Minimum Requirement
Compressive Strength at 1 hour	ASTM C109	1,000 psi
Compressive Strength at 24 hours	ASTM C109	2,000 psi
Set Time		< 1 minute

   3. Allowable Manufacturers:
      (a) Strong-Plug® by Strong Company, Inc., Pine Bluff, Arkansas.
      (b) Permacast® Quick Plug by AP/M Permaform Products of Johnson, Iowa.
      (c) Quadex Quad-Plug as manufactured by Quadex, Inc.

(d) City approved equal.

C. Chemical Grout:
   1. Grout for this purpose shall have a minimum 28-day compressive strength of 250 psi.
   2. Mix and apply per manufacturer's recommendations.
   3. Allowable Manufacturers:
      (a) Avanti International, Houston, Texas.
      (b) De Neef, Cambridge, Massachusetts.
      (c) City approved equal. .

2.03 CEMENTITIOUS LINER

A. A cementitious product shall be used to form a structural monolithic liner covering all interior surfaces.

B. The cementitious liner material shall have the following minimum requirements:

Table 3. Cementitious Liner Materials

Characteristic	Specification	Minimum Requirement
Compressive Strength at 28 days	ASTM C109	8,000 psi
Tensile Strength	ASTM C496	800 psi
Flexural Strength	ASTM C293	1,000 psi
Bond Strength	ASTM C882	2,000 psi
Shrinkage @ 90% R.H.	ASTM C596	0%

C. Materials shall be as manufactured by the following:
   1. Strong-Seal MS-2C by Strong Company, Inc. Pine Bluff, Arkansas
   2. Permacast CR-9000 by Permacast Products, Johnson, Iowa
   3. Permaform MS-1000 by Permacast Products, Johnson, Iowa
   4. City approved equal.

2.04 ANTIMICROBIAL ADDITIVE

A. Acceptable manufacturers include the following:
   1. ConShield HD® as manufactured by APM LLC.
   2. As specified in Section 01015 – Specific Project Requirements.
   3. City approved equal.

B. Admixture Identifier: ConTint as certified by APM LLC. The color tinting shall be included to verify the concrete contains the antimicrobial admixture. The identifier shall be brown in color, or as otherwise approved by the City.

2.05 EPOXY TOPCOAT

A. Epoxy topcoat shall conform to this Section.

2.06 EPOXY LINER SYSTEMS

A. Shall be a monolithic, 100% solids, solvent-free epoxy or polyurethane lining with exceptionally high physical strengths and a broad range of chemical resistance.

B. Shall be specifically designed for applications onto properly prepared concrete surfaces.

C. Resin system shall be 100% solid based free of volatile organic compounds (VOC).
   1. Coating on horizontal and vertical surfaces shall be an integral part of the new or rehabilitated sewer manhole.
   2. The final coating shall be a monolithic lining with uniform thickness, covering the entire interior of the manhole being rehabilitated, including but not limited to channel invert, bench, barrel, walls, cone section, and chimney.
   3. The product must be capable of providing a structural liner application in excess of 250 mils in one coating application.
   4. Epoxy liner system shall meet the following minimum requirements:

Table 1. Epoxy Liner Requirements

Characteristic	Minimum Requirement	Specification
Adhesive Strength	Substrate Failure	ASTM D4541
Hardness, Shore D	≥ 80	ASTM D2240
Compressive Strength	>10,000 psi	ASTM D695
Flexural Strength	>9,000 psi	ASTM D790
Tensile Strength	>6,000 psi	ASTM D638

   5. Mixing and Handling: All two component epoxies should be spray applied using a plural component application system capable of spraying at distances in excess of 300 feet from the spray rig, and at application temperatures per manufacturer's recommendations.

D. Allowable Lining product manufacturers includes the following:
   1. SprayWall® by SprayRoq Protective Lining Systems.
   2. Raven 405 as manufactured by Raven Lining Systems.
   3. Warren S301 as manufactured by Warren Environmental, Inc.
   4. Cor+Gard 301 as manufactured by Permaform.
   5. City-approved equal.

2.07 WATER

A. All water used to mix products shall be potable.

2.08 PIPE END SEAL

A. Pipe End Seals shall conform to the requirements of Section 06010 – Cured-in-Place-Pipe (CIPP), CIPP Point Repairs and End Seals.

2.09 OTHER MATERIALS

A. No other material shall be used with the mixes described above without City pre-approval.

2.10 MANHOLE FRAME AND COVER CASTINGS

A. As specified in Section 05010 – Sanitary Sewer Manhole Castings.

PART 3 - EXECUTION

3.01 WEATHER LIMITATIONS

A. Materials shall be applied in accordance with the Manufacturer's recommendations and as specified below.

B. No application of material shall be made while ambient temperature is below 40 degrees F, to frozen surfaces, or if freezing temperatures are expected to occur within twenty-four (24) hours after application.

3.02 MANHOLE PREPARARATION

A. Diversion of Flow:
   1. Flow through the manhole shall be blocked and bypassed as necessary.
   2. Provide all labor, equipment and materials to plug, divert, or bypass the flow from laterals and pipes entering the manhole. Adequately sized pumps shall be provided and used by the Contractor, as needed.

B. Manhole Cleaning:
   1. Place covers over invert channels to prevent material from entering the sanitary sewer. Wire mesh and fabric filters may be used to allow water to pass while preventing solid material from entering the sewer system.
   2. The floor and interior walls of the structure shall be thoroughly cleaned and made free of all foreign materials including dirt, grit, roots, grease, sludge and all debris or material that may be attached to the wall or bottom of the manhole. Cleaning shall result in a clean, sound surface that displays the concrete surface profile (CSP) recommended by the coating material manufacturer.
   3. High pressure water blasting with a minimum of 3500 psi shall be used to clean free all foreign material within the structure.
   4. When grease or oil are present within the structure, an approved detergent or muriatic acid shall be used integrally with the high-pressure cleaning water.
   5. Other means besides water blasting may be needed to obtain the appropriate concrete surface profile (CSP) such as sand blasting or abrasive blasting.
   6. Remove all loose and protruding mortar, brick, and concrete. Do not allow loose material to enter the sewer system.
   7. All manhole steps shall be removed flush with the wall and the wall repaired prior to lining.

C. Seal Active Leaks:
   1. All discernible voids behind the manhole wall shall be filled patching material or cementitious liner (based upon manufacturer's recommendations).
   2. Active leaks shall be stopped using infiltration control material in accordance with the manufacturer's recommendations.
   3. Some leaks may require weep holes to localize the infiltration during the application.
   4. After application, the weep holes shall be plugged with infiltration control material prior to applying the cementitious liner.
   5. If necessary, drilling may be required to pressure grout using a chemical grout.
   6. If fast setting concrete is used, leaks must be stopped for 12 hours before the liner can be installed.

D. Casting Adjustments:
   1. Manhole castings that are shifted from their original position or are not flush with pavement shall be adjusted to pavement elevation in accordance with Section 05010 – Sanitary Sewer Manhole Castings.

2. Center the manhole frame and cover over the manhole opening.
3. Adjust the frame and cover top elevation to be set ½-inch to ¾-inch below the adjacent street grade using adjustment rings in accordance with Section 03370 – Sanitary Sewer Manhole Construction.
4. Perform pavement removal and replacement in accordance with Sections 02575 – Surface Restoration and 03370 – Sanitary Sewer Manhole Construction.

E. Channel and Bench Repair:
1. At locations indicated on the Drawings, the manhole shall have the existing bench and channel rebuilt as specified herein.
2. Thoroughly clean the bench and invert surface by pressure washing. Loose bricks and mortar, unsound concrete, grease, roots, mud and debris shall be completely removed to a depth necessary to expose a sound substrate to allow for proper forming, shaping and finishing of the bench and invert.
3. Actively leaking areas shall be plugged.
4. Voids and cracks shall be patched.
5. Apply the patching material to the channel. The material shall be troweled uniformly onto the invert at a minimum half (½) inch thickness at the invert extending out onto the bench of the manhole sufficiently to tie into the structural monolithic liner. The cementitious patch material shall not be allowed to enter any pipes.
6. Reshape and repair all inverts to provide smooth, uniform flow characteristics through the structure. Benches and inverts shall be shaped and finished smooth and free of ridges so that the manholes will be self-cleaning and free of areas where solids may be deposited as sewage flows through the manhole from all in-flowing pipes to the out-flowing pipes.
7. The flow through the manhole may be re-established 30 minutes after the patch material sets, or as recommended by the patching material manufacturer, whichever is longer.

F. Manhole liners shall not be installed until sealing/replacement of manhole frame, grade adjustments, bench buildup, partial manhole replacement, manhole grouting, CIPP installation, and/or all sewer replacement/repairs are complete.

3.03 INSPECTION OF SURFACE PREPARATION

A. Contractor shall inspect all surfaces specified to receive a protective coating upon completion of surface preparation. Contractor shall notify the City of any noticeable disparity in the surfaces which may interfere with the proper preparation or application of the protective coating.
B. Provide a coating environment as recommended by the manufacturer of corrosion protection material including drying or wetting the structure surfaces to be coated and providing optimal temperature and moisture conditions in the structure.
C. The City reserves the right to inspect the surface preparation prior to application of the cementitious liner. When the final preparation is complete, the Contractor shall notify the City that the manhole is ready for the application of the liner material. Application of the liner material shall not be conducted until direction is provided by the City.
D. Application of liner shall commence within a time frame as recommended by the manufacturer.

3.04 MANHOLE LINING TYPE

A. The type of liner to be used for each rehabilitated manhole shall be as noted on the Drawings. Liner types associated with manhole rehabilitation include the following:
   1. Type 1 (see Figure 1):
      (a) Manhole Preparation.
      (b) Cementitious Liner.
   2. Type 2 (see Figure 2):
      (a) Manhole Preparation.
      (b) Cementitious Liner.
      (c) Antimicrobial Admixture.
   3. Type 3 (see Figure 3):
      (a) Manhole Preparation.
      (b) Cementitious Liner.
      (c) Epoxy Top Coat.

3.05 ANTIMICROBIAL ADMIXTURE

A. Where corrosive environments are indicated, antimicrobial additive shall be incorporated, in accordance with manufacturer's recommendations, into the mix of cementitious materials installed on the interior of the manhole.

3.06 CEMENTITIOUS LINER

A. The manhole surface shall be totally saturated with water just prior to application of the cementitious material, as recommended by the manufacturer.
B. Application equipment shall be as recommended by materials manufacturer.
C. Mixing:
   1. Mixing shall be done in accordance with the material manufacturer's recommendations.
   2. Addition of water, antimicrobial additive (as required), and color tinting (as required) shall be in accordance with the manufacturer's recommendations.
   3. As required, addition of antimicrobial additive and color tinting shall be performed in the presence of the City's representative.
   4. Re-mixing or tempering shall not be permitted. Rebound material shall not be re-used.
   5. The mixer shall be cleaned to remove all adherent materials from the mixing valves and from the drum at regular intervals as recommended by the manufacturer.
   6. Mix temperature at the time of application shall be below 90 degrees F.
   7. Mix water temperature shall be between 40 degrees F and 85 degrees F.
D. Spraying:
   1. Protect all connecting pipes from overspray by blocking each pipe entrance.
   2. Materials shall be applied a minimum of one (1) inch thick from the bottom of the frame or polymer grade rings. Contractor shall take at least one thickness measurement at the chimney, corbel, wall, bench and channel in the presence of the City's representative. Multiple measurements in each area may be required.
   3. Troweling shall be performed to compact the material into voids. A brush finish may be applied to the trowel finish surface.
   4. Bench application: The cementitious material shall be applied to the bench in such a manner that a gradual slope is produced from the walls to the channel with a minimum thickness of (1) inch covering the entire bench to the edge of the

channel. The wall/bench intersection shall be rounded to a uniform radius the full circumference of the intersection.

5. Surface Defect Repair: Continual inspection during the coating application shall be maintained. Any imperfections shall be removed and replaced with sound material.

E. Curing:
   1. Place cover on manhole within 15 minutes of finishing the application and keep in place for a period complying with manufacturer recommendations. The liner material shall have a minimum of four (4) hours cure time before being subjected to active flow.

3.07 EPOXY TOP COAT

A. Where indicated, epoxy top coat shall be applied as specified in this Section.

3.08 EPOXY LINER APPLICATION

A. Epoxy liner shall not be installed until the cementitious liner specified in this Section has cured in accordance with the manufacturer's requirements.
B. Application procedures shall conform to the recommendations of the manufacturer, including material handling, mixing, environmental controls during application, safety, and spray equipment. Contractor shall submit manufacturer's installation procedures in accordance with paragraph SUBMITTALS.
C. The surface to receive the epoxy liner system shall be prepared in accordance with the Manufacturer's recommendations.
D. The spray equipment shall be specifically designed to accurately ratio and apply the specified protective coating materials, shall be regularly maintained, in proper working order, and shall be approved by the manufacturer of the epoxy liner system.
E. The epoxy liner system shall be applied by the Applicator.
F. Re-mixing or tempering shall not be permitted. Rebound materials shall not be reused.
G. Specified surfaces shall be coated by spray application of a solventless, 100% solids, self-priming epoxy or polyurethane protective coating as called for in Section 2.
H. Epoxy Liner System Thickness:
   1. The thickness of the epoxy liner system shall be as indicated on the Drawings or as specified in Section 01015 – Specific Project Requirements.
   2. Minimum liner thickness: 125 mils
   3. Liner shall be uniform throughout.
   4. Liner thickness shall be regularly checked using a wet film gauge to ensure that the minimum thickness is being maintained.
I. Spray application equipment approved by the coating manufacturer shall be used to apply each coat of the protective coating.
J. If necessary, subsequent top-coating or additional coats of the epoxy liner system shall be done in accordance with the Manufacturer's recommendations.
K. The interior liner shall be applied to the manhole interior from the top of the manhole chimney to the bench/trough, including the bench/trough.
   1. Bench and trough shall be sprayed in such a manner as to blend with wall liner.
   2. Do not apply to epoxy liner system to metal castings. Casting shall be appropriately masked.
L. The minimum curing time between coatings shall be in accordance with the Manufacturer's recommendations.

M. The final application shall have a minimum of three (3) hours cure time before being subjected to active flow or as recommended by the manufacturer.

3.09 PROTECTION OF ADJACENT SURFACES

A. During progress of the work, where appearance is important, adjacent areas or grounds which may be permanently discolored, stained or otherwise damaged by dust and rebound, shall be adequately protected.
B. When directed by the City or as necessary, surfaces shall be cleaned by early scraping, brushing or washing as the surroundings permit.

3.10 INSPECTION AND TESTING

A. Cementitious Liner:
   1. Four (4) two-inch cube specimens shall be cast and properly packaged, labeled, and submitted by the Contractor for compression strength testing per ASTM C109.
   2. Testing shall be conducted by an independent testing laboratory at no additional cost to the City.
   3. At a minimum, testing shall be conducted based in the following frequencies:
      (a) Test specimens shall be prepared daily during the first week of work.
      (b) Test specimens shall be prepared each day the Contractor begins using a newly delivered batch of product.
      (c) Test specimens shall be prepared each day a new person mixes the material.
      (d) Test specimens shall be prepared each day the inspector deems necessary.
   4. Submit test results to the City's representative.
B. Visual Inspection:
   1. A visual inspection shall be made by the City.
   2. Any deficiencies in the liner system shall be marked and repaired according to the procedures set forth by manufacturer.
C. Epoxy Liner Discontinuity (Holiday) Testing:
   1. After the epoxy liner system has set hard to the touch, it shall be inspected with high-voltage holiday detection equipment. An induced holiday shall be made on to the coated concrete surface and shall serve to determine the minimum / maximum voltage to be used to test the coating for holidays at the particular area.
   2. The spark tester shall be initially set at 100 volts per 1 mil of film thickness applied but may be adjusted as necessary to detect in induced holiday.
   3. All detected holidays shall be marked and repaired by abrading the coating surface with grit disc paper or other hand tooling method.
   4. After abrading and cleaning, additional epoxy liner material can be applied to the repair area.
   5. All touch-up/repair procedures shall follow the protective coating manufacturer's recommendation.
D. Bond Strength Testing:
   1. The City reserves the right to perform measurements of the bond strength of the cementitious liner and the epoxy liner system to the substrate (structure or cementitious liner).
   2. Bond strength may be measured in accordance with ASTM D4541.
   3. Any measurements detected to have inadequate bond strength shall be evaluated by the City. Further bond tests may be performed in that area to determine the extent of potentially deficient bonded area and repairs shall be made by Applicator in strict accordance with manufacturer recommendations.

4. Contractor shall repair all holes or other defects occurring as required to perform the bond strength testing. Repairs shall be made at no additional cost to the City. Repairs should be made with manhole lining system manufacturer recommended products and procedures.

E. Vacuum Testing:
   1. Vacuum testing shall be conducted in accordance with Section 02702 – Testing Requirements for Sanitary Sewer: Mains and Manholes.
   2. The City shall identify which manholes are to be vacuum tested. Designation of manholes will be done after the cementitious liner has been installed.
   3. All manholes designated by the City to be vacuum tested shall have pipe end seals installed.
   4. End seals shall be installed on any connecting pipe that has not been rehabilitated with CIPP.
   5. End seals shall be installed after the cementitious liner in accordance with Section 06010 – Cured-In-Place Pipe (CIPP), CIPP Point Repairs and End Seals.
   6. A minimum of ½ inch of cementitious lining material shall be placed over each end seal's 2-inch wall overlap to ensure a seal between the end seal and the lining.
   7. Contractor shall perform initial vacuum testing on 20% (identified by the City) of the rehabilitated manholes (rounded up) with main line diameters of 15 inches or less. Contractor shall correct any deficiencies found and perform retesting. However, if liner deficiencies are found in more than 10% of the tested manholes, the Contractor shall test an additional 20% of the rehabilitated manholes, identified by the City, correct any deficiencies found, and perform retesting. If deficiencies in the cementitious liner are found in more than 10% of the second 20% of tested manholes, the contractor shall test all rehabilitated manholes, correct any deficiencies found and perform retesting, all at no additional cost to the City.

3.11 FLOW RESTORATION

A. The flow may be reestablished in the manhole when the repair material has properly cured so that the flow does not wash away the applied material.

3.12 QUALITY

A. The finished manhole surface shall be free of blisters, runs, sags, inconsistencies, voids, and other defects. Any defects which will affect the integrity or strength, of the manhole shall be repaired at the Contractor's expense, in a manner acceptable to the City.

3.13 CLEANUP

A. After installation and testing, the Contractor shall clean up the Site in accordance with Section 01566 – Cleanup Operations.

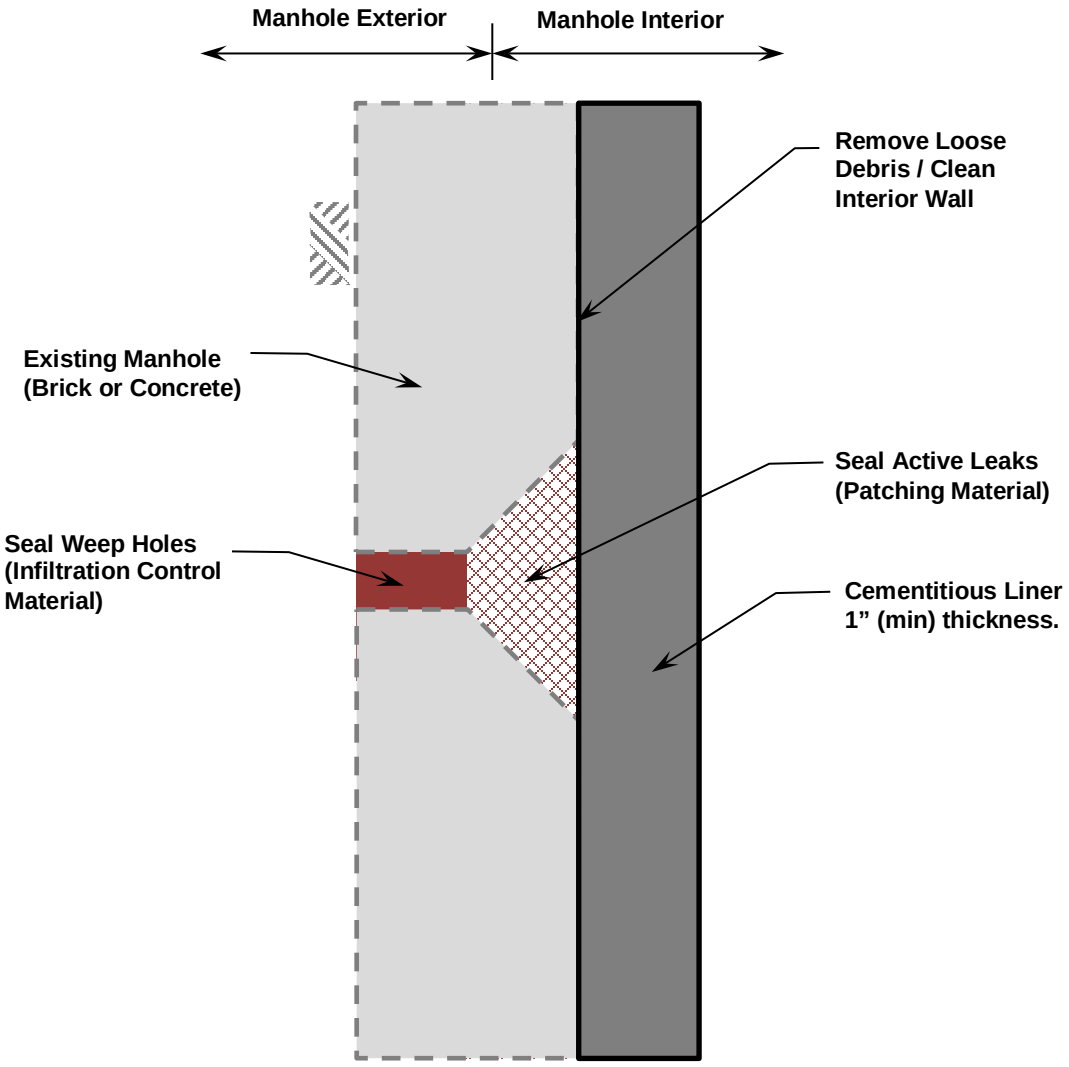

Figure 1 – Type 1 Liner / Cementitious Liner
(Non-corrosive environment)

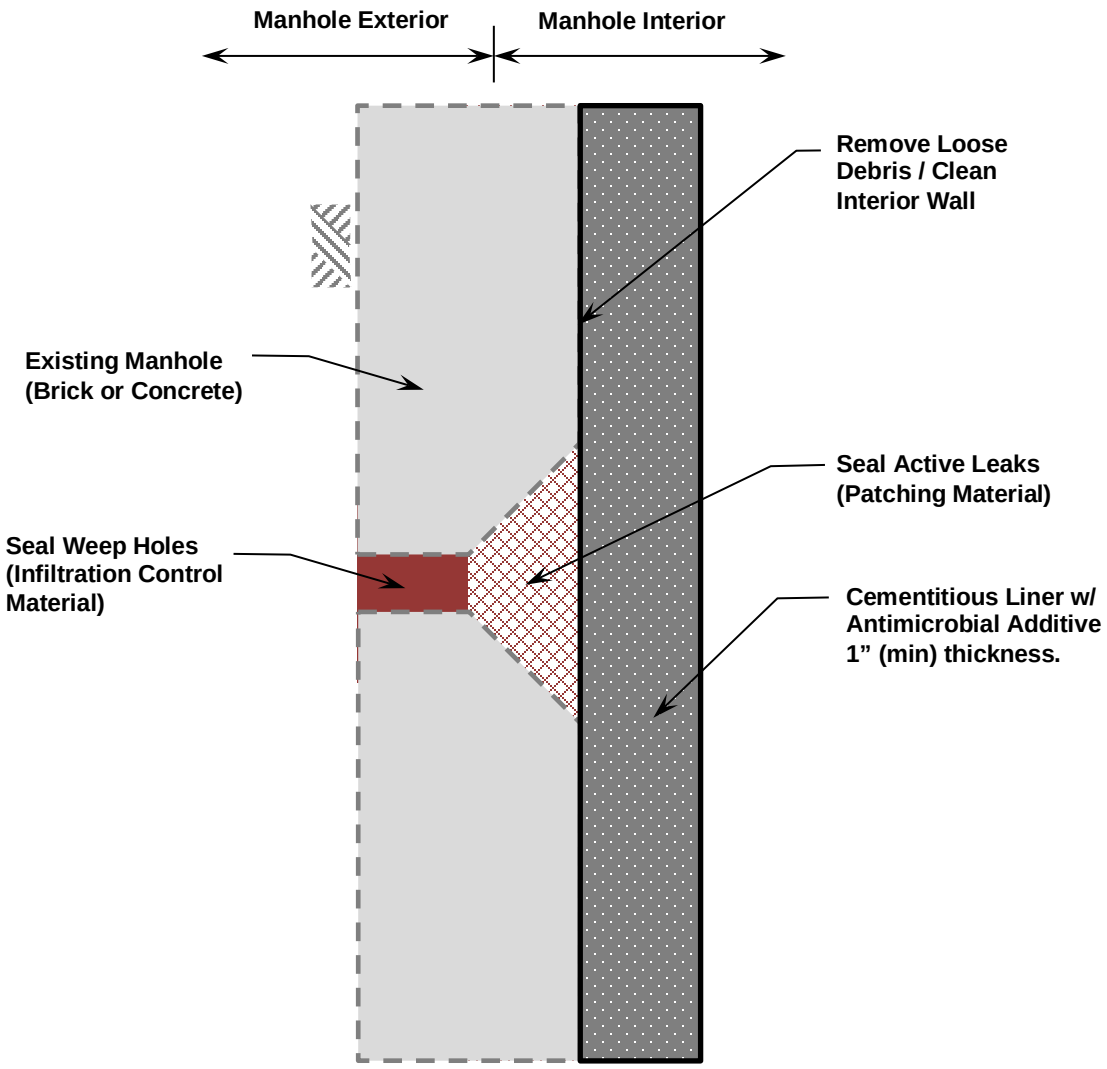

Figure 2 – Type 2 Liner / Cementitious Liner with Antimicrobial Additive
(Corrosive environment)

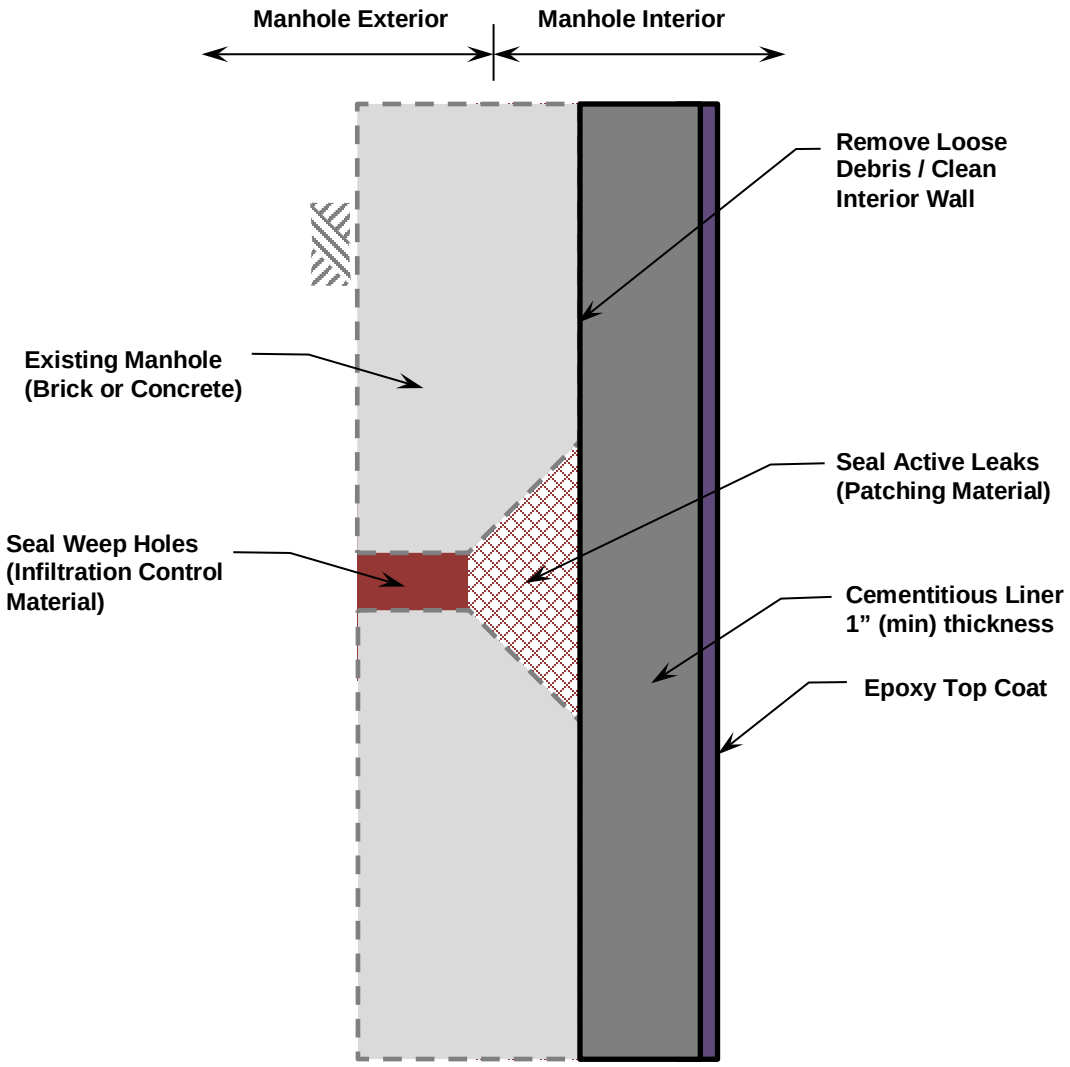

Figure 3 – Type 3 Liner / Cementitious Liner with Epoxy Top Coat
(Corrosive environments)

END OF SECTION