SECTION 02653

MANHOLE REHABILITATION

PART 1 GENERAL

1.01 SCOPE

A. The work under this Section includes the rehabilitation of existing manholes throughout the project and/or service area.

B. This Section covers the cleaning, repair, structural restoration, and rehabilitation of existing manholes as required to eliminate leakage into the manholes and to restore structural integrity. The work includes but is not limited to: cleaning entire manhole interior, repair/reconstruction of the failed sections of the structure; stopping active leaks through manhole walls and joints; preparation of surfaces to receive the application of coatings designed to resist the affects of hydrogen sulfide gas or the affects of aging; and, application of those coatings to provide a monolithic liner on the inside walls of the manhole as specified.

C. All ancillary work shall be constructed properly in accordance with the Drawings and Specifications. All defects shall be remedied to the engineer’s satisfaction prior to approval.

1.02 REFERENCE SPECIFICATION, CODES, AND STANDARDS

A. The Contractor shall ensure that the products and work comply with the reference specifications listed in the Contract Documents.

B. The Contractor shall ensure that the products and work comply with the current version of the following American Society for Testing and Materials (ASTM) standards:

1. ASTM C78 Standard Test Method for Flexural Strength of Concrete
2. ASTM C94 Standard Test for Ready Mix Concrete
4. ASTM C234 Standard Test Method for Comparing Concretes on the Basis of the Bond Developed with Reinforcing Steel
6. ASTM C321 Standard Test Method for Bond Strength of Chemical-Resistant Mortars
7. ASTM C496 Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens
8. ASTM C596 Standard Test Method for Drying Shrinkage of Mortar Containing Portland Cement
9. ASTM C666 Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing
10. ASTM C827 Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens from Cementitious Mixtures
11. ASTM C882 Test Method for Bond Strength of Epoxy-Resin Systems Used With Concrete by Slant Shear
12. ASTM C952 Standard Test Method for Bond Strength of Mortar to Masonry Units
13. ASTM C1072 Test Method for Measurement of Masonry Flexural Bond Strength
14. ASTM C1244 Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test

1.03 QUALIFICATIONS

A. The Contractor performing the work, as a company, must have at least five years of experience coating manholes with cementitious mortar, and shall have successfully installed a cementitious mortar lining product in a minimum of 2,000 manholes as documented by verifiable Owner references.

B. The Contractor performing the work shall be fully qualified, experienced and equipped to complete this work expeditiously and in a satisfactory manner and shall be an approved installer as certified and licensed by the product manufacturer.

C. The Contractor’s proposed superintendent/foreman for the work under this Contract shall have successfully installed a cementitious lining product in a minimum of 1,000 manholes as documented by verifiable Owner references. The Contractor shall submit information to demonstrate that the experience requirements are met.

D. The cementitious product shall have been manufactured for installation specifically in manholes for at least five years and shall have been installed in at least 10,000 manholes. References that are documented and that can be verified shall be submitted to demonstrate that the cementitious products meet these requirements. Contact names and numbers shall be included with the references.

E. Approved cementitious products are listed in these specifications. Even though the product may be listed as approved, the product manufacturer and Contractor(s) shall still meet the experience requirements specified above, or the products and Contractor will not be approved for this work.
1.04 SUBMITTALS

A. Three hard copies (one to be returned to Contractor after review, one to remain with the Engineer and one to remain with the Owner) and one pdf of all submittals specified herein shall be submitted to the Engineer.

B. The Contractor shall submit complete shop drawings of the manhole lining system to demonstrate compliance with these specifications, to show materials of construction and to detail installation procedures. Testing procedures and quality control procedures shall also be submitted.

C. Certifications that the manhole lining was manufactured in accordance with these specifications and the appropriate ASTM standards shall be submitted with each shipment.

D. For all products to be used for manhole rehabilitation, the Contractor shall submit manufacturer documents containing product technical information, ASTM test results and certification, application procedures and specifications for approval, and testing and quality control procedures.

E. References for the Contractor, superintendent and products shall be submitted to verify the specified experience.

F. The Contractor shall submit a plan for bypassing sewage around the work area and facilities where sewage flows must be interrupted to complete the work. The plan shall be reviewed by the Engineer and shall be acknowledged as acceptable before any work is started. The bypass designs should be sealed by a licensed North Carolina professional engineer.

1.05 WARRANTY

A. The materials used for the project shall be certified by the manufacturer for the specified purpose. The manufacturer shall warrant the cementitious liner material to be free from defects in raw materials for 1 year from the date of installation and acceptance by the Owner. The Contractor shall warrant the liner installation for a period of 1 year from final acceptance.

PART 2 PRODUCTS

2.01 MATERIALS – CEMENTITIOUS MORTAR LINING SYSTEM

A. The Contractor shall line the interior of the manholes with a cementitious mortar lining system where specified in accordance with the specifications of the manufacturer.
B. The cementitious manhole lining system for the interior of manholes shall be a monolithic system suitable for use as a trowel or spray applied monolithic surfacing in sewer manholes. The cementitious lining system shall be a calcium aluminate-based material and shall be one of the following specified products or approved equal:

- Strong Seal MS-2A, MS-2C, or High Performance by Strong Seal Systems
- QM-1s Restore or Aluminaliner by Quadex
- Cemtec Silatec MSM or CAM by A.W. Cook Cement
- Sewpercoat PG by Kerneos, Inc.
- Permacast MS-10,000 or CR-9000 by Action Products Marketing Corp.
- PerpetuCrete MSC or CA by Protective Liner Systems
- Mainstay ML-72, ML-CA or ML-PF by Madewell
- Reliner MSP or Maximum CA Cement by Standard Cement Materials

C. Where additional hydrogen sulfide resistance is required and when specified by the Engineer (identified on the drawings as hydrogen sulfide resistant cementitious mortar), the cementitious lining system shall be a 100% Calcium Aluminate Product (product comprised of calcium aluminate cement and calcium aluminate aggregate). Partial calcium aluminate products (or blended products) shall not be considered an equal and shall not be approved. The 100% Calcium Aluminate Product shall be one of the products listed below or approved equal. Any proposed equal product must have been manufactured and successfully installed in high, hydrogen-sulfide manholes for at least 10 years as documented by manufacturing records and detailed project references (project names, owner contact name and number, project description, etc.). There will be no exceptions to this requirement. The Engineer’s decision on whether a product is an “equal” shall be final and the Contractor shall not be due any adjustments in unit prices bid.

- High Performance by Strong Seal Systems
- Aluminaliner PF by Quadex
- Sewpercoat PG by Kerneos, Inc.
- Mainstay ML-PF by Madewell
- Cemtec HITECH 100 by A.W. Cook Cement
- Maximum CA Plus Cement by Standard Cement Materials

D. The cementitious lining system shall be a pumpable cement mixture. The lining shall be installed via low-pressure application only. The materials shall be suitable for all the specified design conditions. Trowel application may be approved by the Engineer.
E. The cementitious lining shall provide a minimum service life of 25 years. The cured cementitious lining shall be continuously bonded to all the brick, mortar, concrete, chemical sealant, grout, pipe and other surfaces inside the sewer manhole. Provide bond strength data on cured, cementitious lining based on ASTM test methods referenced herein.

F. The cementitious liner when cured shall have the following minimum characteristics at 28 days as measured by the applicable ASTM standards referenced herein:

1. Minimum compressive strength of 6,000 psi
2. Minimum bond strength of 130 psi
3. Shrinkage of less than 0.05%

F. The cementitious 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 the ASTM standards referenced herein.

F. Chemical sealants or grouts used to seal active manhole leaks, to patch cracks, to fill voids and to otherwise prepare the manhole surfaces for the lining installation shall be suitable for the intended purpose and shall be compatible with the lining as certified by the manufacturer.

G. **External Coating:** Whenever the outside of exposed manholes walls are specified to be coated with a special exterior cementitious mortar product, the exterior mortar shall be HB2 Repair Mortar by ThoRoc, SikaTop 123 by Sika Corporation, or approved equal. The installed thickness shall be at least 2 inches, toweled smooth after application.

### 2.02 MATERIALS – INJECTION GROUTING

A. The grout used to completely stop identified leaks shall be a polyurethane grout and shall be Hydro Active Cut by DeNeef Construction Chemicals, AV-202 Multigrout by Avanti International, or approved equal.

B. The grout shall be suitable for injection and shall expand to seal identified leaks. The grout shall be installed per the manufacturer’s recommendations. The material shall be suitable for all the specified design conditions.

C. The grout shall provide a minimum service life of 25 years. When cured, the grout shall be suitable for sewer system service and chemically resistant to any chemicals or vapors normally found in domestic sewage. The grout shall be compatible with the thermal condition of the existing sewer manhole surfaces. Surface temperatures will range from 20°F to 100°F.
D. The grout shall effectively seal the identified leak in the sewer manhole and prevent any penetration or leakage of groundwater infiltration at this location or other nearby locations or within the same pre-cast manhole joint as a direct result of the injected grout. Any leaks from such migration shall be sealed at no additional cost.

PART 3 EXECUTION

3.01 DELIVERY, STORAGE, AND SHIPPING

A. Care shall be taken in shipping, handling and placing to avoid damaging the lining products. Any lining product damaged in shipment, showing deterioration, or which has been exposed to any other adverse storage condition that may have caused damage, even though no such damage can be seen, shall be marked as rejected and removed at once from the work.

B. While stored, the lining products shall be adequately packaged and protected. The lining products shall be stored in a manner as recommended by the manufacturer.

3.02.1 INSTALLATION – CEMENTITIOUS LINING

A. The Contractor shall notify all property owners who discharge sewage directly to the manhole being rehabilitated 72 hours in advance, giving the date, start time and estimated completion time for the work being conducted and the impacts to the property owner.

B. Water for use on this project will be available from hydrants owned and operated by the Owner. The Owner will provide water for use by the Contractor free of charge. The Contractor shall coordinate with the Owner to obtain a bulk water meter to be used when obtaining water at hydrants. Water from the Owner’s hydrants may only be obtained by the connection of an Owner provided meter assembly.

C. The Contractor shall clean each sewer manhole to be surfaced and shall dispose of any resulting material. The cleaning shall be performed using a high power jet wash at a minimum of 3500 psi water pressure to remove all dust, biological growths, grease, oil, paint or any other surface contaminants or coatings. The tip of the nozzle shall be a maximum of 4 inches from the manhole wall during cleaning to ensure that 3,500 psi is being applied to the walls.

D. Coatings that cannot be removed shall be sanded with coarse sand paper to rough the surface sufficient to obtain and ensure adequate bonding of the lining. Roots shall be removed by manually cutting the roots from inside the manhole.
E. The Contractor shall conduct a visual inspection of each manhole after it is cleaned. All active, hydrostatic infiltration leaks shall be plugged or sealed with an appropriate grout compatible with the cementitious lining. Injection grouting may be required to seal active leaks including leaks in existing invert channels and benches. All loose mortar and rubble of existing walls, benches and inverts shall be removed.

F. Prior to installing the lining, the Engineer along with the Contractor must inspect and approve the surface preparation work. The Contractor shall notify the Engineer when the manholes are ready for inspection. The Contractor is responsible for ensuring proper preparation and installation conditions including temperature and moisture regardless of the findings by the Engineer during his inspection. The manhole lining shall be completed immediately after the inspection, or the manhole may need to be re-cleaned prior to spraying to remove accumulated debris on the benches and walls.

G. The Contractor shall prepare the manhole to receive cementitious lining as necessary by reshaping and repairing benches, inverts, and walls where required including smoothing out irregular shaped corbel and chimney sections prior to spray application. All interior surfaces shall be prepared as recommended by the manufacturer. Minimum requirements are as listed below.

1. All cracks and other voids must be repaired and filled with suitable non-shrinking cements, sealants or grouts, including all voids between the existing sewer pipes and manhole walls.
2. All patches shall be smooth and even with the manhole wall.
3. All existing manhole rungs/steps shall be removed and voids filled.
4. All surfaces shall be suitably prepared for the required bonding of the cementitious lining as recommended by the manufacturer.

H. A complete, watertight seal shall be provided at pipe and manhole wall connections including filling in all voids around the connection and completely covering the connection with an approved non-shrink grout. Contractor shall submit details of how the watertight connections will be made to the Engineer for review and approval. The invert channel shall be coated with an appropriate quick-set grout product in complete accordance with the manufacturer’s instructions.

I. When CIPP is installed in the connecting sewer(s), the invert channel shall be coated with an approved grout to build up the invert channel to the invert elevations of the new cured-in-place pipe lining (CIPP); to fill all voids, cracks, holes, etc.; and to form a smooth flow channel. The entire channel shall be coated. The coating shall be a minimum ¼-inch thick. The Contractor shall submit details of the proposed grout for this application.
J. The Contractor shall furnish and place the cementitious lining in each manhole as shown in the Details. The installation of the lining shall be in complete accordance with the applicable provisions of ASTM and the manufacturers' specifications.

K. The Contractor shall bypass pump sewage flows around the manhole when the work is being performed. Contractor shall submit a detailed bypass pumping plan to the Engineer prior to starting any work. The Contractor is advised that a number of manholes will surcharge during rain events.

L. The walls and benches shall be coated to the required minimum 1-inch thickness by spray-on methods. Invert channels shall also be coated as specified herein. Cementitious mortar may be trowel-applied if approved by the Engineer. Cementitious mortar lining shall be monolithically applied in one pass or application and shall be troweled smooth after application. The manhole lining shall not be installed until all required main sewer rehabilitation and other manhole rehabilitation work are complete.

M. The 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. When cured, the 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.

N. The Contractor shall plug off and/or protect the connecting pipes while coating the manhole walls to prevent any material from washing down the sewers. If material enters the sewer pipes, the Contractor will be required to clean the sewers from manhole to manhole to remove all material and then televise the sewer to demonstrate that all material is removed at no cost to the Owner.

O. The Contractor shall take precautions to avoid damage or flooding to public or private property being served by the manhole being rehabilitated. The Contractor shall be responsible for all flooding and pay for cleanup from flooding to the satisfaction of the property owner. The Contractor shall document all backups and submit documentation to the Engineer including the reason for the backup, the time and date of the backup, the property owner’s name, address and phone number, the resolution to problem, the time and date the problem was resolved, and any special cleanup work that had to be performed. This required documentation shall be submitted for all backups regardless of when they occur. All cleanup shall be completed within 4 hours of the backup.

P. **External Coating:** Whenever the outside of exposed manholes walls are specified to be coated with a special exterior cementitious mortar product, the exterior mortar shall be HB2 Repair Mortar by ThoRoc, SikaTop 123 by Sika
Corporation, or approved equal. The existing surface shall be completely cleaned and all loose material removed prior to applying the cementitious material. Installation shall be in strict accordance with the manufacturer’s recommendations including utilizing any required bonding agents and providing proper curing conditions. The installed thickness shall be at least 2 inches, toewed smooth after application.

3.02.2 INSTALLATION – INJECTION GROUTING

A. The Contractor shall notify all property owners who discharge sewage directly to the manhole being rehabilitated 72 hours in advance, giving the date, start time and estimated completion time for the work being conducted and the impacts to the property owner.

B. The Contractor shall inject grout to seal the specified leaks. The grout shall be injected in accordance with the manufacturer’s instructions. Grout shall continue to be pumped until the leak is completely sealed. The hole drilled to inject the grout shall be covered with non-shrink grout.

3.03.1 ACCEPTANCE TESTS - CEMENTITIOUS MORTAR LINING SYSTEM

A. Field acceptance of the cementitious lining shall be based on the Engineer's field inspections and evaluation of the appropriate installation and curing test data. The cementitious lining shall provide a continuous monolithic surfacing with uniform thickness throughout the manhole interior. If the thickness of the lining is not uniform or is less than specified, it shall be repaired or replaced at no additional cost to the Owner.

B. If the Engineer has to enter the manholes to inspect the work, the Contractor shall provide forced air ventilation, gas monitors and detectors, harnesses, lights, confined space entry permits, etc. for the Engineer or Owner to enter the manhole and perform the inspection in complete accordance with OSHA requirements at no additional cost to the Owner.

C. Samples shall be taken of the installed liner each day that cementitious lining is installed as follows: one sample if one to five manholes were coated that day, two samples if six to ten manholes were coated that day, three samples if eleven to fifteen manholes were coated that day, and four samples if sixteen or more manholes were coated that day. Samples shall be taken at equally spaced intervals throughout the day. The frequency of tests may be increased by the Engineer and performed by the Contractor at no additional cost to the Owner when the required tests show that the installed lining does not meet the specifications.

D. Samples shall be cube samples. At least six cubes shall be taken for each sample for testing. All cube samples shall be taken in the field from the material being
sprayed. The Contractor shall show the samples to the Engineer each day and the Engineer shall initial the samples for delivery to the testing laboratory. The Contractor shall properly take and store the samples and shall deliver the samples to the testing laboratory. The laboratory shall document that they received the initialed samples. The tests shall be performed by an independent testing laboratory. All costs associated with the tests shall be paid for by the Contractor. The test results shall be submitted to the Engineer immediately when available, no later than 30 days after the lining is installed, or payment will be withheld.

The samples shall be tested in accordance with the applicable ASTM standards to verify that the installed liner meets the compressive strength requirements specified herein and the lining manufacturer’s published data on the product. The Contractor shall provide information that the testing laboratory is certified and/or qualified to perform the tests to the applicable ASTM standards. Tests shall include 7-day and 28-day strength tests (3 tests/cubes for each time period for each sample). Shrinkage and bond strength tests shall be performed on each batch or lot of material shipped to the Contractor.

E. The Engineer will direct which manholes shall be tested via vacuum testing when all manhole rehabilitation work to that manhole is complete. Manholes shall not be vacuum tested until at least 7 days after the cementitious lining was installed. Vacuum testing shall be performed in accordance with ASTM C-1244 except that the minimum test time shall be 1 minute. The Engineer or Owner shall be present for all testing. The Contractor shall notify the Engineer 48 hours prior to testing.

The Contractor shall submit test reports of the testing which include the project name, manhole tested, data on testing (vacuum pressure, test duration, etc.), and whether the manholes passed or failed the test. Test reports must be submitted for failed tests with the reason for failure noted on the report. The Engineer shall sign all test reports to document that the Engineer was present for the testing. Any manhole that fails the vacuum test shall be repaired and retested immediately by the Contractor at no additional cost.

F. There shall be no groundwater infiltration or other leakage (active or previously active) through the manhole walls, benches, inverts or pipe connections at the manholes after it has been lined. If leakage is found, it shall be eliminated with an appropriate cement mortar, grout or sealant as recommended by the manufacturer and approved by the Engineer at no additional cost to the Owner. Injection grouting may be required to stop leaks around the pipe connections or in the invert channel or benches. The Engineer’s decision on how defective lining is repaired shall be final. If any defective lining is discovered after it has been installed or during the warranty period, it shall be repaired or replaced in a satisfactory manner at no additional cost to the Owner. Repaired manholes including those repaired during the warranty period shall be vacuum tested at no additional cost to the Owner.
G. Payment shall not be made for the installed cementitious lining until (1) the manhole passes the vacuum test, (2) all material tests are submitted, and (3) the final CCTV inspection of the CIPP liner is submitted as specified in Section 02651 (when CIPP is installed; final CCTV performed after manhole rehabilitation is completed).

3.03.2 ACCEPTANCE TESTS – INJECTION GROUTING

A. Field acceptance of the grout shall be based on the Engineer’s visual inspections, the Engineer’s evaluation of the appropriate installation, and the absence of any visible active leaks in the general area of the original leak location or within the same pre-cast manhole joint.

B. If the Engineer has to enter the manholes to inspect the work, the Contractor shall provide forced air ventilation, gas monitors and detectors, harnesses, lights, confined space entry permits, etc. for the Engineer or Owner to enter the manhole and perform the inspection in complete accordance with OSHA requirements at no additional cost to the Owner.

C. There shall be no groundwater infiltration or other leakage (active or previously active) at or near the original leak location or within the same the pre-cast manhole joint after it has been repaired. If leakage is found and deemed to be a direct result of the original repair as determined by the Engineer, it shall be eliminated as approved by the Engineer at no additional cost to the Owner. The Engineer’s decision on how additional leak(s) are repaired shall be final. If any additional leaks are discovered after it has been installed or during the warranty period, they shall be repaired in a satisfactory manner at no additional cost to the Owner.

END OF SECTION