SECTION 02547
MANHOLE REHABILITATION

PART 1  GENERAL

1.1 SECTION INCLUDES

A. Rehabilitation of physically deteriorated, leaking or structurally unsound sanitary sewer manholes by spray applied epoxy coating or cementitious coating. Sauerisen, SprayWall, Aquatapoxy, and Raven’s high performance mix are the only approved epoxy coating methods for this project. Strong Seal - High Performance Mix, Quadex MS Alumina and permacast Fiberglass Top Coating are the only approved cementitious coatings for this project.

B. The repair and sealing of the manhole base, invert, walls, corbel/cone and chimney of brick, block or precast manholes.

C. Reinstallation or replacement of manhole frames and cover for grade adjustment, frame alignment, poor condition, or for inflow elimination as specified in Section 3.4.

D. The installation of manhole to frame (chimney) seals, as specified in Section 3.5.

E. Inspection and testing of the various types of work to insure compliance.

1.2 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.

1.3 SUBMITTALS

A. Product Data: Submit product data, including surface preparation instructions and application instructions, from manufacturer of coating wall repair materials, hydraulic cements, quick-set mortars, specialized sealants, and grouts.

B. Installer Qualifications: Installers of liners, coatings and wall repair systems shall submit qualifications to the Engineer at least 14 days prior to start of any material application. Submittal shall consist of:

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.

C. Progress Photographs:

1. After cleaning and preparing each manhole, submit 3" x 5" color photographs of manhole's interior walls for review by the Engineer. The Engineer may inspect the manhole before giving approval to begin lining.

2. After liner installation of each manhole, submit a minimum of three additional 3"x 5" color photographs to show final condition of rehabilitated manhole.

3. Provide photographs of sufficient quality and clarity so that interior condition can be readily determined by the Engineer.

4. Annotate each photograph. Give date, manhole number, material used, and appropriate remarks on the back using permanent ink.
1.4 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, immediately notify the Engineer.

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 Engineer 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.

1.5 SALVAGE

A. Manhole covers, frames, and adjusting rings from abandoned manholes and inlets remain the property of the Owner. Deliver salvaged items to locations designated by the Engineer.

PART 2 PRODUCTS

2.1 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 stored and handled in accordance with recommendations of the manufacturer and the American Concrete Institute. All materials shall be mixed and applied in accordance with the manufacturer's written instructions.

2. The installer shall warrant and save harmless the Owner and his Engineer against all claims for patent infringement and any loss thereof.

3. The Contractor shall handle and store all material and shall dispose of all wastes in accordance with applicable regulations.

4. 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. Stopping active leaks in concrete and masonry manholes:

1. A premixed fast-settling, volume-stable waterproof cement plug consisting of hydraulic cement, graded silica aggregates, special plasticizing and accelerating agents. It shall not contain chlorides, gypsums, plasters, iron particles, aluminum powder or gas-forming agents, or promote the corrosion of steel it may come in contact with. Set time shall be approximately 1 minute. Ten-minute compressive strength shall be approximately 500 psi.

2. A silicate-based liquid accelerator field mixed with Portland neat cement. The set time shall be approximately 1 minute.

C. Patching, repointing, filling, and repairing nonleaking holes, cracks, and spalls in concrete and masonry manholes:

1. A premixed nonshrink cement-based patching material consisting of hydraulic cement, graded silica aggregate, special plasticizing and accelerating agents, which has been formulated for vertical or overhead use. It shall not contain chlorides, gypsums, plasters, iron particles, aluminum powder, or gas-forming agents or promote the corrosion of steel it may come into contact with. Set time (ASTM C-191) shall be less than 60 minutes. Five-hour compressive strength (ASTM C109) shall be a minimum of 1000 psi and the ultimate compressive strengths (ASTM C882-Modified) shall be a minimum of 3000 psi.

D. Spray applied Cementitious manhole coating:

1. The material sprayed onto the surface of the manhole shall be a Cementitious blend of acid resistant binders, pozzolanic materials, silicious aggregates,
fiberglass rods and other additives for constructing a liner that is impervious to the flow of water, is resistant to sulfide attack, and restores structural integrity to existing manhole walls.

2. A monolithic liner shall be formed which covers all interior manhole surfaces and shall have the following minimum requirements at 28 days:

   a. Compressive Strength (ASTM C-579B) 4000 psi
   b. Tensile Strength (ASTM C-496) 1000 psi
   c. Flexural Strength (ASTM C-293) 3000 psi
   d. Shrinkage (ASTM C-596) 0% at 90% R.H.
   e. Bond (ASTM C-321) 130 psi
   f. Density, when applied 105" pcf

3. The cementitious mix shall include at least 20 pounds of fiberglass per cubic yard.

E. Spray applied Epoxy Coating for manholes:

   1. The material sprayed onto the surface of the manhole shall be an Epoxy blend of acid and alkaline resistant binder, Chemically-resistant furan resin, potassium and modified silicate mortars; epoxy setting beds; and sulfur cements for bonding acid resistant masonry units.

   A monolithic liner shall be formed which covers all manhole surfaces and shall have the following physical properties:

      Application time at 70 F    30 min
      Working time initial set    12-24 hrs
      Compressive strength (ASTM C-579) 7,000 psi
      Density (ASTM C-905)    85.7 pcf
      Flexural strength (ASTM C-580) 5,1000 psi
      Modulus of elasticity (ASTM C-580) 2.66 X 10 (5) psi
      Tensile strength (ASTM C-307) 2,700 psi

F. 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.

G. Manhole frames and covers.
   1. Standard and non-traffic bearing watertight frames and covers shall be as per KUB standards.
   2. Watertight frames and covers shall be installed in easement areas.

H. Manhole to frame seal.
   1. Frame-to-chimney seals shall be installed as specified in bid form.

I. Manhole Lid Plug
   1. Cretex Style No. 3 – For use in rough or irregular shaped holes or where easy removal is not desired. These plugs shall be installed as specified in bid form.

PART 3 EXECUTION

3.1 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. 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 utilizing a 210 degree steam unit and 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. 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.
3. Stopping Infiltration: After surface preparation and prior to the application of linings and coatings, infiltration shall be stopped either by plugging or chemical grout sealing.

4. Patching: All large holes or voids around steps, joints or pipes, all spalled areas and all holes caused by missing or cracked brick shall be patched and all missing mortar repointed using a non-shrink patching mortar. All cracked or disintegrated material shall be removed from the area to be patched or repointed, exposing a sound subbase. All cracks not subject to movement and greater than 1/16 inch in width shall be routed out to a minimum width and depth of 1/8 inch and patched with non-shrink patching mortar.

5. Maintaining waste water flows: The Contractor shall be responsible for maintaining sewer flows in accordance with bypass pumping requirements.

6. 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. Each lining system shall be installed in accordance with the manufacturer's recommendation to withstand a groundwater pressure of at least 15 feet above the manhole bench.

3.2 SPRAY APPLIED CEMENTITIOUS COATING

A. The surface prior to spraying shall be damp without noticeable free water droplets or running water. Materials shall be spray applied to a minimum uniform thickness to insure that all cracks, crevices, and voids are filled and a somewhat smooth surface remains after light trowelling. The light trowelling is performed to compact the materials into voids and to set the bond. Strong Seal - High Performance Mix, Quadex MS Alumina and Permacast Fiberglass Top Coating are the only approved methods for this project.

B. The first application shall have begun to take an initial set (disappearance of surface sheen which could be 15 minutes to 1 hour depending upon ambient conditions)
before the second application to assure a minimum total finished thickness of 1/8 inch for epoxy coatings. All cementitious coatings shall have a minimum top layer thickness of 1/8 inch and a minimum total thickness of ½ inch. A depth gauge shall be used during application at various locations to verify the required thickness. The surface then shall be trowelled to smooth finish with care taken not to over trowel so as to bring additional water to the surface and weaken it. Manufacturer's recommendations shall be followed whenever more than 24 hours have elapsed between applications.

C. The wooden bench covers shall be removed and the bench and invert 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.

D. No application shall be made to frozen surfaces or if freezing is expected to occur within the manhole for 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, using ice if necessary.

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

3.3 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. The material shall be a two-part 100% solid, corrosion resistant epoxy coating that can be applied to dry or wet surfaces. The material shall be white in color. The proposed coating system shall be AquataPoxy-A-6, Sauerisen, Raven High performance, or SprayWall Coating System.

B. The primer system shall be familiar to AquataPoxy DynaBond D-1, or approved equal.

C. The proposed system shall be 100% solids by volume and shall contain no volatile organic compounds (VOC's).

3.4 SPRAY POLYURETHANE 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. The material shall be a two-part 100% solid, corrosion resistant polyurethane coating that can be applied to dry or wet surfaces. The material shall be
light in color. The proposed coating system shall be Sauerisen, Raven High performance, or SprayWall Coating System.

B. The primer system shall be familiar to SprayWall ED-2103 “B”, or approved equal.

C. The proposed system shall be 100% solids by volume and shall contain no volatile organic compounds (VOC's).

3.5 MANHOLE FRAME AND COVER REINSTALLATION OR REPLACEMENT

A. The Contractor shall remove the existing manhole frame and cover and, if they are not being reused, dispose of them as directed by the Engineer. 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.

B. If the manhole frame is to be raised, a sufficient number of new precast concrete grade rings or brick shall be installed to enable the frame and cover to meet the new grade. The manhole cover may also be raised to meet the grade by installing an approved steel or iron manhole adjusting ring in the top of the existing manhole frame.

C. The frame and adjustment rings shall be set in a bed of Butyl Mastic Sealant.

D. Existing frames and covers that are to be reused shall be thoroughly cleaned before reinstallation. The Contractor shall then install the new or reused frames so that the top of the covers are at the required grade.

3.6 MANHOLE TO FRAME SEAL

A. Manhole to frame seals shall be installed as specified in the Bid Form. Manhole to frame seals (Chimney seals) shall be installed in pavement areas only as specified in the 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.

3.7 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.

3.8 MANHOLE VACUUM TESTING

A. Manholes shall be tested upon completion of the rehabilitation work as specified.

B. The CONTRACTOR shall provide all labor and equipment for vacuum and holiday testing.

C. All manholes are to be vacuum tested following rehabilitation. The ring and lid casting assembly shall be installed prior to testing. The testing equipment shall consist of a gasoline powered vacuum pump with sufficient vacuum hose length and a test head of proper size to fit the inside opening of the manhole. The test head shall be equipped with an inflatable rubber bladder to effect the seal to the manhole, an air pressure gauge, and 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.

D. 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.

E. With the vacuum tester in place, inflate the compression band to effect a seal between the vacuum base and the structure. Connect the vacuum pump to the outlet port with the valve open and evacuate the manhole to 10" Hg (0.3 bar), which is equivalent to approximately 5 PSIG back pressure.

F. Close vacuum inlet/outlet ball valve, disconnect the vacuum pump, 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 by sealing the leaks on the outside of the manhole to the satisfaction of the OWNER, and repeat test procedures until satisfactory results are obtained.

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<th>VACUUM TEST TIMETABLE</th>
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<tr>
<td>Manhole Diameter - Inches</td>
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<tr>
<td>Depth - Feet</td>
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<tr>
<td>4'</td>
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<td>8'</td>
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<td>12'</td>
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<td>16'</td>
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<td>20'</td>
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<td>24'</td>
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* Add extra testing time, "T", for each additional 2 foot depth. (The values listed above have been extrapolated for ASTM designation C924-85.)

G. The OWNER reserves the right to reject any and all manholes that do not pass vacuum testing requirements, and replacement shall be at the CONTRACTOR'S expense. A significant number of leaks on a single manhole, or a significant number of manholes leaking shall be considered as a basis for rejection and replacement of manholes.

END OF SECTION