

SECTION 336080

MANHOLE REHABILITATION

PART 1 - GENERAL

1.1 SCOPE

- A. Furnish all labor, materials, equipment, and incidentals required to rehabilitate manholes as noted on the plans and as specified herein.
- B. Where indicated on the plans or as directed by the Engineer or NPU work may require, patching manhole exterior; stopping infiltration with chemical grout; rebuilding invert and benching; resetting or replacing manhole ring and cover assemblies; installing chimney seals, adjusting elevation of manhole frame and cover.
- C. Eliminate active infiltration observed in the frame seal, chimney (corbel for brick manholes), cone, wall, bench, invert, holes, or pipe connections prior to applying the manhole lining system.
- D. Reinstall existing manhole rings and covers removed to allow the completion of the rehabilitation work, unless otherwise specified in the Summary of Work or elsewhere in the Contract Documents. Restore the site to its pre-maintenance condition.
- E. The Contractor shall provide a written report including photographs for each completed manhole. This report should include the general masonry condition after preparation, the amount of infiltration, how infiltration was rectified, and what type and how much product was used.
- F. Maintain sanitary sewer flows as specified in Section 331030.

1.2 RELATED WORK

- A. Contract Drawings show the manholes included in the work and indicate the work required for each manhole.
- B. Cured-in-Place Pipe Liner is included in Section 336084.
- C. Existing Sanitary Sewers are included in Section 33130.
- D. Trenching, Backfilling and Compaction is included in Section 311020.

- E. Pavement Repair and Restoration is included in Section 321010.
- F. Monolithic Manhole Lining Systems is included in Section 336082.
- G. Sewer Line and Manhole Cleaning is included in Section 336070.
- J. Manholes, Rings and Covers are included in Section 336040.

1.3 SUBMITTALS

- A. Staging Area Plan: Provide plan at scale of 1"= 50'. Identify the staging area for deployment of manhole repair equipment for each work area.
- B. Submit to the Engineer and NPU in accordance with Section 013000, shop drawings and product data for all manhole rehabilitation materials specified in this Section for each manhole to be rehabilitated.
 - 1. Information on the chemical grout and additives, cementitious compound, waterproofing, and corrosion control materials that will be used, the installation method, and equipment. For the materials that will be used, identify and furnish references for successful use of the materials in similar applications.
 - 2. Method for sealing pipes at manholes.
- C. The Contractor shall submit a report described in section 1.1 Scope of this specification.

1.4 REFERENCES

- A. ASTM International (ASTM):
 - 1. ASTM C 109 - Standard Testing Methods for Compressive Strength of Hydraulic Cement Mortars (Using 2-in Cube Specimens).
 - 2. ASTM C 150 - Standard Specification for Portland Cement.
 - 3. ASTM C 267 - Standard Test Methods for Chemical Resistance of Mortars, Grouts, and Monolithic Surfacing and Polymer Concretes.
 - 4. ASTM C 293 - Test Method for Flexural Strength of Concrete.
 - 5. ASTM C 309 - Standard Specification for Liquid Membrane Forming Compounds for Curing Concrete.
 - 6. ASTM C 496 - Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens.

7. ASTM C 579B - Test Method for Compressive Strength of Chemical-Resistant Mortars, Grouts and Monolithic Surfacing.
8. ASTM C 596 - Test Method for Drying Shrinkage of Mortar Containing Portland Cement.
9. ASTM C 666 - Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing.
10. ASTM C 1244 - Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill.
11. ATSM F 2414 - Standard Practice for Rehabilitation of Sewers Using Chemical Grouting.

B. Occupational Safety and Health Administration (OSHA).

C. The revision of the above standards that is in effect at the time of bid opening will apply.

1.5 QUALITY ASSURANCE

A. The Contractor to perform the manhole rehabilitation and manhole lining shall be fully qualified, experienced, and equipped to complete the work in a timely and satisfactory manner. Submit the following information to the Engineer and NPU for review and approval before any work is performed.

1. Have a minimum of five (5) years' experience in performing this type of specialized work.
2. Have successfully installed the proposed lining system in a minimum of 500 manholes.
3. Name of the manufacturer and supplier for this work and previous work performed. The Contractor shall be certified by the manufacturer to install the monolithic lining system.
4. A list of all municipal installations performed by the manufacturer and Contractor over the past five (5) years along with the contact name, telephone number, and brief description of work performed.
5. Be capable of providing crews as needed to complete this work without undue delay.
6. The City reserves the right to disapprove the use of the Contractor based on the submitted qualifications.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Care shall be taken in shipping, handling and placing to avoid damaging the chemical grouts, cementitious materials, and other manhole rehabilitation products. Extra care may be necessary during cold weather construction. Any lining product or material damaged in shipment shall be replaced as directed by the Engineer or NPU.
- B. Any materials 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.
- C. While stored, the materials shall be adequately packaged and protected. The materials shall be stored in a manner as recommended by the manufacturer.

1.7 WARRANTY

- A. All manhole rehabilitation work shall be warranted by the Contractor for a period of two (2) years from the date of substantial completion. During this period, all defects in the lining shall be repaired in a manner satisfactory to the Engineer or NPU, or the lining shall be reapplied at no cost to the City. At 21 months following substantial completion of the manhole rehabilitation work, the City or Engineer shall inspect this work to ensure proper performance. If any deficiencies are found during these inspections, the Contractor shall repair them at no additional cost to the City.

PART 2 - PRODUCTS

2.1 MATERIALS TO STOP ACTIVE LEAKS

- A. To stop active leaks in the manhole, use any of the following materials and procedures to stop the active leaks prior to lining.
 1. Premixed Fast-Setting, Volume-Stable Waterproof Cement Plug: Hydraulic cement, graded silica aggregates, special plasticizing and accelerating agents, containing chlorides, gypsums, plasters, iron particles, aluminum powder or gas-forming agents, or promote the corrosion of steel it may come in contact with. The cement plug shall comply with the following minimum requirements:

Minimum Requirements		
Compressive Strength	ASTM C 109	>1000 psi, 1hr. >2500 psi, 24 hrs.

Sulfate Resistance	ASTM C 267	No weight loss after 15 cycles @ 2000 ppm
Freeze/Thaw	ASTM C 666 "Method A"	100 cycles
Pull Out Strength	ASTM C 234	14,000 lbs.
Set Time		<5.0 minutes

2. Chemical Grout: Repair work shall be in accordance with ASTM F 2414-04, and manufacturer's recommended installation methods. Use in accordance with the manufacturer's recommendations for the specific application.

- a. Drilling and injection method shall use a hydrophilic polyurethane chemical grout manufactured by Avanti or equal unless otherwise approved by the Engineer or NPU.
- b. Exterior chemical curtain grouting method shall use a hydrophobic polyurethane chemical grout manufactured by Avanti or equal unless otherwise approved by the Engineer or NPU.
- c. Expanded Gasket Procedure shall use Oil Free Oakum with hydrophilic polyurethane chemical grout manufactured by Avanti or equal used for sealing larger cracks and manhole joints, unless otherwise approved by the Engineer or NPU.

2.2 PATCHING, REPOINTING, FILLING, REPAIRING NO-LEAKING HOLES, CRACKS AND SPALLS IN THE CONCRETE AND MASONRY MANHOLES

A. Quick-Setting Cementitious Patching material shall comply with the following minimum requirements:

Physical Properties		
Compressive Strength	ASTM C 109	>1800 psi, 1 hr. >2600 psi, 24hr. >3000 psi, 28 days
Bond	ASTM C 882	>1600 psi, 28 days
Applied Density		105 lbs pcf ± 5 lbs
Shrinkage	ASTM C 596	0% at 90% R.H.
Placement Time		5 to 10 minutes
Set Time		15 to 30 minutes

B. The water used to mix product shall be clean and potable. No material (other than water) shall be used with or added to the patching product

without prior approval or recommendation from manufacturer.

2.3 COATINGS FOR ALL INVERTS

- A. A quick-setting material that complies with the following minimum requirements:

Physical Properties		
Compressive Strength	ASTM C 109	>1800 psi, 1 hr. >2600 psi, 24hr. >3000 psi, 28 days
Bond	ASTM C 882	>1600 psi, 28 days
Applied Density		105 lbs pcf ± 5 lbs
Shrinkage	ASTM C 596	0% at 90% R.H.
Placement Time		5 to 10 minutes
Set Time		15 to 30 minutes

- B. Water used to mix product shall be clean and potable. No material (other than water) shall be used with or added to the patching product without prior approval or recommendation from manufacturer.

2.4 INTERIOR FLEXIBLE CHIMNEY SEALS

- A. Provide a flexible seal to provide corrosion protection and to prevent infiltration through the interior of the manhole frame and chimney area of the manhole.
- B. Provide materials for interior flexible chimney seal to prevent leakage of water into the manhole through the frame joint area and the area above the manhole cone including all extensions to the chimney area. The seal shall remain flexible allowing for repeated vertical or horizontal movements of the frame due to ground movement or the thermal movement of pavement. The final liner material shall be made no less than 170 mils of corrosion resistant flexible urethane resin coating to be applied to the inside wall of the entire chimney area as described above. Mil thickness may vary depending on the local climate. The product shall have a minimum elongation of 800% and a Durometer hardness of 75. Final liner shall have a minimum tensile and adhesion strengths of 1150 psi and 175 lb. l/in. respectively. The manhole sealant shall conform to the physical requirements of ASTM D 412 Standard Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers-Tension. Sealant shall equal or exceed "Flex-Seal" as manufactured by Sealing Systems, Inc., Loretto, MN.

2.5 MANHOLE RING AND COVERS

- A. Refer to the Summary of Work, Contract Drawings and Technical Specification Section 336040 Manholes, Rings and Covers for manhole ring and cover requirements.

PART 3 – EXECUTION

3.1 GENERAL

- A. Each manhole to be rehabilitated shall be thoroughly cleaned and then inspected for loose or missing bricks, loose mortar, or holes. Remove any protrusions or obstructions into the manhole. Observed leaks shall be eliminated prior to applying the manhole lining system.
- B. Damage incurred to the manhole or pipe segments due to methods and equipment employed by the Contractor is the responsibility of the Contractor. Damage to public and private property from sewer surcharging that results from material or equipment left in the manhole or sewer or from any flow blockage is the responsibility of the Contractor. The cost to repair the manhole or pipe segments and expenses incurred by the City as a result of the damage shall be the responsibility of the Contractor.

3.2 SURFACE PREPARATION

- A. Pre-Rehabilitation Surface Preparation: Areas to be repaired which requires bonding of new cementitious, epoxy, chemical or waterproofing material to existing cement or masonry shall be prepared as follows.
 1. Clean the area with high velocity water cleaning equipment to remove all foreign matter, oil, grease, wax, and dirt, including removal of bitumastic coatings. Pressure shall not exceed that which may cause any permanent damage to the existing manhole walls or other parts of the structure.
 2. Foreign material remaining after high velocity water blasting shall be removed from the manhole surface using an acid wash. The acid wash shall be muriatic acid (hydrochloric acid) at a ratio of 1-part acid (HCl) to ten (10) parts of water. The mixing, application and removal of the acid solution shall be in accordance with the manufacturer's recommendations. The acid solution shall remain on the manhole surface until all foreign material have been removed and completely washed off with water.

3. Chip or chisel away all loose or defective material from the areas to be repaired. Furnish a firm mechanical key by undercutting whenever possible.
4. Allow interior surfaces of the manhole to dry before applying epoxy manhole lining systems.
5. Large voids including holes left by the manhole rung removal shall be filled with quick setting patching mix.
6. Remove protruding rubber gaskets between wall joints.

B. Sewer Line Protection: Place covers over the invert to prevent material from entering the sewer lines.

C. Drop Connections: Remove any interior drop connections anchored to manhole walls prior to installing the lining system. After installation and proper curing of the liner, reinstall interior drop connections to their original condition prior to removal. If the existing drop connection is already damaged and cannot be reused, Contractor shall request from the Engineer or NPU the best course of action.

D. 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 lining. Remove all loose mortar and rubble of existing chimney (corbelling), cone, walls, benches, and inverts. Prepare manhole to receive cementitious lining as necessary by reshaping and repairing benches, inverts, cone, walls, and corbelling where required. All interior surfaces shall be prepared as recommended by the lining manufacturer. Minimum requirements are as listed below:

1. Repair cracks and other voids and fill with suitable non-shrinking cements, sealants, or grouts, including all voids between the existing sewer pipes and manhole walls. Patches shall be smooth and even with the manhole wall.
2. Suitably prepare surfaces for required bonding of lining as recommended by the manufacturer.

3.3 SEALING OF LEAKS IN INVERTS, BENCHES, WALLS, CONE, AND CORBELLING

A. Premixed Fast-Setting, Volume-Stable Waterproof Cement Plug: Seal unsealed lifting holes and voids larger than one-half ($\frac{1}{2}$ ") inch in thickness with a waterproof, quick setting mortar. Place waterproof mortar according to manufacturer's instructions.

- B. Manhole Sealing by Chemical Grout Application: Chemical grouting shall include the following:
1. Transporting, delivering, and storing the chemical grout shall be according to the manufacturer's published directions and requirements.
 2. Manhole Preparation: Repair the manhole frame and rings, and complete structural repairs before grouting the manhole. Cut roots and trim roots before grouting the manhole. Remove cracked or deteriorated material from the areas to be grouted.
 3. Chemical Grout Formulation: Mix each batch of chemical grout according to the manufacturer's published directions and requirements.
 4. Sealing Active Leaks: Use the Expanded Gasket Procedure, drilling and injection procedure and/or chemical curtain grouting to stop active leaks.
 - a. Expanded Gasket Procedure (EGP): Perform per ASTM F 2414-04, and the chemical grout manufacturer's recommended installation methods. This is performed by soaking dry oil free oakum with hydrophilic polyurethane chemical grout. The resulting oakum/resin plug shall be forced into the opening until it sets. Perform the EGP to:
 - 1) Control flowing water in larger cracks, joints, or pipe to manhole boots.
 - 2) Seal drop or lateral connections, slip line terminal seals, and open joints in RCP manholes.
 - 3) Seal between the corbel and manhole rings.
 - 4) Seal between the manhole rings and manhole.
 5. Drilling and Injection Procedure: Perform per ASTM F 2414-04 (2009 or latest edition) and the chemical grout manufacturer's recommended installation methods to seal the manhole with chemical grout. Drill injection holes through the manhole at locations recommended by the manufacturer. Inject the chemical grout through the holes under pressure. Injection pressure shall not cause damage to the manhole structure or surrounding surface features. Inject chemical grout through the lowest holes first. Repeat the procedure until the manhole is externally sealed. Grout travel shall be verified by observation of grout to defects or adjacent injection holes. Drill additional injection holes as necessary to ensure grout travel. Do not inject grout from the ground surface. After chemical grout injection is complete, clean injection holes

with a drill and patch with a waterproof, quick setting mortar for brick and concrete manholes. Perform the drilling and injection procedure to control flowing water in cracks.

6. Curtain Grouting: Perform per ASTM F 2414-04 (2009 or latest edition) and the chemical grout manufacturer's recommended installation methods. Perform the curtain grouting procedure when there are multiple active leaks and the drilling and injection procedure does not eliminate the active leaks.

3.4 INVERT CHANNEL COATING

NOTE: In general manhole inverts should be coated when a liner has been installed in the upstream/downstream pipes or when the invert needs repair. This will ensure a monolithic lining system for the manhole. However, when the invert is in excellent condition it may not be necessary to coat the invert.

- A. Coat invert channels with a material compatible with the manhole lining system per the manhole lining manufacturer's recommendations to prevent infiltration and to build up the invert channel to the invert elevations of the new sewer main or cured-in-placed lined sewer and to form a smooth flow channel. The entire channel shall be coated. The coating shall be troweled uniformly onto the invert at a minimum one-half ($\frac{1}{2}$ ") inch in thickness or as recommended by the manufacturer. The coating shall extend out onto the bench of the manhole sufficiently to tie into the monolithic liner.
- B. The material used for the invert channel shall be suitable for the intended purpose and shall be compatible with the materials used for the manhole lining system. The material for the invert channel shall be as recommended by the cementitious liner manufacturer and installed in accordance with the manufacturer's recommended installation instructions and procedures. Coating the invert may be waived when the invert is in excellent condition and upon approval by the City or Engineer.

3.5 LOCATING, RAISING, RESETTING, AND/OR REPLACING MANHOLE RING AND COVER ASSEMBLIES

NOTE: The following items A-E are often site- specific and can be altered based on City specifications.

- A. Locate and uncover buried manhole ring and covers; remove existing manhole rings and covers; dispose of existing manhole rings and covers, if they are not being reused; and install new or reused manhole rings and covers as directed by the City and/or Engineer. Repair any damage to the manhole chimney or corbelling caused by the removal of the existing

manhole frame at no additional cost to the City.

- B. Existing rings and covers to be reused shall be thoroughly cleaned before reinstallation.
- C. If existing rings and covers are not to be reused, properly dispose of these materials in accordance with local laws and Engineer and NPU approval.
- D. When resetting existing rings and covers, apply preformed flexible joint sealant Kent Seal No. 2 by Hamilton-Kent or Ram-Nek by K.T. Snyder Company or equal.
- E. Install new or reused rings so that the tops of the covers are at the required grade. Utilize precast concrete grade rings to set the manhole frame and cover to the finished grade. Precast concrete grade rings shall be set in a bed of butyl mastic sealant.

3.6 CEMENT EXTERIOR

- A. For raised manholes with damaged exterior, masonry manholes without an exterior cement coating, manholes where ring and cover assemblies are being replaced or reset, where noted on the Drawings, or as directed by Engineer, repair existing or install new cement exterior coating for manholes as follows:
 1. Prepare exterior surface of manholes using procedures outlined in Section 3.2, A above.
 2. Following surface preparation, spray or hand trowel the exterior from existing/finished grade to above the frame/chimney seal using the product specified in Section 336080 Paragraph 2.1 and in accordance with the manufacturer's installation instructions. Apply a minimum finished thickness of two (2") inches.
 3. Apply a curing compound in accordance with ASTM C309-11 to the exterior cement.

3.7 FIELD TESTING AND ACCEPTANCE

- A. The Engineer or City may enter the manholes to inspect the benching, invert channels, manhole wall/pipe connections, surface preparation, and other parts of the work. Provide forced air ventilation, gas monitors and detectors, harnesses, lights, etc. for the Engineer or City to enter the manhole and perform the inspection in complete accordance with OSHA requirements.

- B. Contractor shall visually verify absence of leaks and perform a vacuum test. Vacuum test shall be performed as follows:

Vacuum Test: Test rehabilitated manholes using vacuum test method, following manufacturer's recommendations for proper and safe procedures. Vacuum testing of manholes and structures shall be performed after curing of linings. Vacuum testing will not be required on manholes with sewer lines greater than 16-inches in diameter due to safety concerns. Any visible leakage in manhole or structure, before, during, or after test shall be repaired regardless of test results. Vacuum test shall be performed in accordance with ASTM C 1244.

- C. The manhole wall surfaces shall be sufficiently prepared for the manhole lining system as recommended by the lining manufacturer. The manhole wall surfaces shall be free from significant defects. Defects which will affect, in the foreseeable future, or warranty period, the integrity or strength of the manhole shall be repaired at the Contractor's expense, in a manner mutually agreed upon by the Engineer and the Contractor.
- D. No active infiltration shall be observed in the manhole as confirmed by visual inspection of the City or Engineer. Infiltration found shall be repaired by the Contractor immediately.
- E. The Contractor is responsible for coordinating inspection times with the Engineer and NPU.
- F. The testing of each manhole lining system is described in Specification 336082.

GENERAL NOTE TO USER: Each type of manhole lining system will require a specific type of testing for approval and it is critical to have an experienced inspector or engineer onsite to observe the testing and approve the material was installed at the correct thickness and applied correctly. The specific tests performed are outlined in each section in 336082.

END OF SECTION