

[Brackets and italics indicate a decision point or note to the specifier/engineer and should be deleted once the decision is made]

SECTION 03000

SEWER STRUCTURE REHABILITATION

PART 1 - SUMMARY

- A. Section Includes:
 - 1. Sewer Structure Rehabilitation

- B. Scope: The work to be done under this section shall include all labor, materials and equipment to repair and rehabilitate existing sewer structures as outlined on the project drawings.

- C. Related Sections:
 - 1. Division 1 – General Requirements
 - 2. Division 2 – Submittals

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. American Society for Testing and Materials (ASTM)
 - a. C109, Standard Test Method for Compressive Strength of Hydraulic Cement Mortars
 - b. C293, Standard Test Method for Flexural Strength of Concrete
 - c. C267, Standard Test Method for Chemical Mortars, Grouts, and Monolithic Surfacing and Polymer Concrete
 - d. C321, Standard Test Method for Bond Strength of Chemical Resistant Mortars
 - e. C496, Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens
 - f. C596, Standard Test Method for Drying Shrinkage of Mortar Containing Hydraulic Cement
 - g. C666, Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing
 - h. C882, Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear
 - i. D638, Standard Test Method for Tensile Properties of Plastics
 - j. D695, Standard Test Method for Compressive Strength of Carbon and Graphite
 - k. D790, Standard Test Method for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

- I. D2240, Standard Test Method for Rubber Property – Durometer Hardness
- m. D4541, Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers

B. Qualifications

- 1. Manufacturers shall have a minimum of ten years experience in the production of the proposed manhole rehabilitation products.
- 2. The manufacturer shall certify that contractor's on-site superintendent has completed a training program for application of the rehabilitation products.

1.3 SUBMITTALS

A. Quality Assurance:

- 1. Material manufacturers shall provide a list of 30 projects completed within the last 3 years.
- 2. Contractor shall provide a list of projects that confirm their experience meets the qualifications required.

B. Shop Drawings:

- 1. See Section ##### – Shop Drawings, Product Data and Samples and Miscellaneous Submittals.
- 2. Product technical data including:
 - a. Manufacturer's installation instructions.
 - b. Physical properties datasheet.

C. Certifications:

- 1. Manufacturer certification of Contractor's on-site superintendent.
- 2. Manufacturer certification that products submitted meet requirements of standards referenced.

D. Phasing Plan including:

- 1. Order of construction
- 2. Traffic control plan for lane closures

E. Field Reports

- 1. Rehabilitation Report
- 2. Testing Report *[Delete this if testing is not required]*

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Grout Lining Materials
 - a. Strong Seal Systems
 - b. Quadex
 - c. Approved Equal.
2. Epoxy Top Coat
 - a. Raven Lining Systems
 - b. Neopoxy Corporation
 - c. Approved Equal.

B. Submit request for substitutions in accordance with Section ##### – Product Substitutions.

2.2 MATERIALS

- A. All materials shall be strictly mixed and applied in accordance with manufacturer’s recommendations.
- B. Patching Material - Used to fill voids and patch missing bricks or steps:
1. Quick setting cementitious material shall be used as a patching material and shall have the following minimum requirements:

Physical Properties	Test Procedures	Minimum Value
Comp. Strength	ASTM C-109	1400 psi, 6 hours
Bond	ASTM C-321	>130 psi, 28 days
Applied Density		105 pcf +/- 5 lbs
Shrinkage	ASTM C-596	0% @ 90% R.H.

Acceptable Materials:

- 1) Strong Seal QSR
- 2) Quadex Hyperform
- 3) Approved Equal

- C. Infiltration Control Materials:
1. For minor water infiltration:
 - a. Rapid setting, cementitious material specially formulated for leak control with the following minimum requirements:

Physical Properties	Test Procedures	Minimum Value
Comp. Strength	ASTM C109	1400 psi, 6 hours
Bond	ASTM C321	>130 psi, 28 days
Cement		Sulfate Resistant
Applied Density		105 pcf +/- 5 lbs
Shrinkage	ASTM C596	0% @ 90% R.H.

Acceptable Materials:

- 1) Strong Seal Strong Plug
- 2) Quadex Quad-Plug
- 3) Fastop
- 4) Meadow Plug
- 5) Approved Equal

2. For active water infiltration: Hydrophillic chemical grout specially formulated to stop active infiltration. This grout shall quickly react with water to form a waterproof membrane.
 - a. Acceptable Material: Avanti International AV202 or approved equal.

D. Grout Liner Material: The type of grout required on each manhole is indicated in the table on the project drawings. *[Specifier/engineer must provide a Table indicating which type of grout to use on each manhole or specify that all manholes use one type of grout and delete the others from this section]*

1. Grout Type "A" - Structural Repair Grout: Fiber reinforced grout made with Type I Portland Cement for use in manhole environments with no sulfuric acid conditions (pH 3.0 or higher). This grout shall have the following minimum properties:

Physical Properties	Test Procedures	Minimum Value
Comp. Strength	ASTM C109	9000 psi @ 28 days
Tensile Strength	ASTM C496	600 psi @ 28 days
Flexural Strength	ASTM C293	1400 psi @ 28 days
Shrinkage @ 90% R.H.	ASTM C596	0%
Bond	ASTM C321	Substrate Failed
Applied Density	-	134 pcf +/- 5 lbs
Freeze/Thaw	ASTM C666	100 cycles w/ no visible damage

Acceptable Materials:

- 1) Strong Seal MS-2A
- 2) Quadex QM-1s
- 3) Approved Equal

2. Grout Type "B" - Minor Corrosion Repair Grout: Fiber reinforced grout made with calcium aluminate cement for use in manhole environments with minor sulfuric acid conditions (pH 2.0 or higher). This grout shall have the following minimum properties:

Physical Properties	Test Procedures	Minimum Value
Comp. Strength	ASTM C109	8000 psi @ 28 days
Tensile Strength	ASTM C496	800 psi @ 28 days
Flexural Strength	ASTM C293	1100 psi @ 28 days
Shrinkage @ 90% R.H.	ASTM C596	0%
Bond	ASTM C321	Substrate Failed
Applied Density	-	127 pcf +/- 5 lbs
Freeze/Thaw	ASTM C666	100 cycles w/ no visible damage

Acceptable Materials:

- 1) Strong Seal MS-2C
- 2) Quadex Aluminaliner
- 3) Approved Equal

3. Grout Type "C" - Heavy Corrosion Repair Grout: Fiber reinforced grout made with pure, fused aluminate clinker and calcium aluminate cement for use in manhole environments with harsh sulfuric acid corrosion (pH less than 2.0). This grout shall have the following minimum properties:

Physical Properties	Test Procedures	Minimum Value
Comp. Strength	ASTM C109	8000 psi @ 28 days
Tensile Strength	ASTM C496	800 psi @ 28 days
Flexural Strength	ASTM C293	900 psi @ 28 days
Shrinkage @ 90% R.H.	ASTM C596	0%
Bond	ASTM C321	Substrate Failed
Applied Density	-	145 pcf +/- 5 lbs
Freeze/Thaw	ASTM C666	100 cycles w/ no visible damage

Acceptable Materials:

- 1) Strong Seal High Performance Mix
- 2) Quadex Dynastone
- 3) Approved Equal

- E. Water – Water used to mix product shall be clean and potable. Questionable water shall be tested by a laboratory in accordance with ASTM C94 procedures.
- F. Epoxy Topcoat – Corrosion resistant, rapid curing epoxy resin that will cure at low temperatures and in the presence of water. This material shall have the following minimum properties:

Properties	Test Procedures	Minimum Value
Color		Green or Light Blue
Solids Content:		100%
Solvent Content:		0%
Compressive Strength:	ASTM D695	13,500 psi
Tensile Strength	ASTM D638	7,500 psi
Tensile Elongation:	ASTM D638	1.5%
Flexural Strength	ASTM D790	11,500 psi
Shore Hardness, Type D	ASTM D2240	80
Bond Strength	ASTM D4541	> Tensile Strength of Concrete
Primer Req'd:		None – Self-Priming

Acceptable Materials:

- 1) Raven 405 Epoxy
- 2) Neopoxy NPR-5303 Epoxy
- 3) Approved Equal

[The specifier/engineer should indicate which type of grout to use underneath the epoxy topcoat. Usually this is the Type “A” grout and is indicated on the Rehabilitation Table in the project drawings]

PART 3 - EXECUTION

3.1 EQUIPMENT

- A. Grout Spraying Equipment – Equipment shall be specifically designed for spray application of manhole rehabilitation grout. The equipment shall consist of the following as a minimum:
 1. Water storage and metering system
 2. Progressive cavity pump
 3. Twin paddle mixer
 4. Air system for low pressure, low velocity grout spraying

- B. Epoxy Spraying Equipment – Specifically designed for application of epoxy and approved for use by the epoxy manufacturer. The equipment shall consist of a temperature controlled, plural component sprayer capable of either high-pressure, low-volume airless (HPLV) or low-pressure, high-volume air assisted (HVLP) spraying.

3.2 REHABILITATION PREPARATION

- A. Protection of Sewer System – Covers shall be placed over the invert to prevent extraneous materials from entering the sewer lines.
- B. Cleaning of Manholes – All foreign materials shall be removed from the manhole walls and bench using a high-pressure water spray with a minimum pressure of 5000 psi. The Contractor shall dispose of debris in a location approved by the Owner and in accordance with all Federal, State and Local regulations.
- C. Wall Repair – Loose or protruding brick, mortar and concrete shall be removed using a mason's hammer, chisel or scraper. Fill any large voids with quick setting patching material as specified.
- D. Invert Repair – Perform the following work on manholes where invert repair is indicated on the project drawings.
 - 1. Remove all loose material from the invert and dispose of properly.
 - 2. Block the flow through the manhole and setup bypass pumps if required.
 - 3. Mix and apply the quick setting patching material to the invert at a minimum thickness of ½". The mix shall be troweled uniformly onto the invert and out onto the bench so it will tie into the grout liner.
 - 4. Allow patching material to cure and re-establish flow within 30 minutes of placement of material.

[Specifier/Engineer should do a field survey of all manholes and provide bidders with the number of inverts to repair]
- E. Step Removal – Manhole steps shall be removed flush with the manhole wall. Any holes created by step removal shall be filled with patching material prior to grout liner application. *[This paragraph can be deleted if not required. Specifier/Engineer should do a field survey of all manholes and provide bidders with the number of manholes which require step removal]*

3.3 GROUT LINER APPLICATION

- A. Mixing – Mix the grout liner material with the amount of water recommended by the manufacturer. Water shall be metered into the mixing equipment to insure a proper consistency. Hand mixing is not allowed.

- B. Application Procedure:
1. The surface shall be clean, damp and thoroughly saturated with water just prior to application of grout liner material.
 2. The grout shall be sprayed onto the interior surface of the sewer structure in one continuous layer by air-assisted spray nozzle. Hand application is not acceptable.
 3. The minimum grout thickness shall be ½” and shall be checked during application with a thickness gauge such as a calibrated screwdriver or awl. *[Specifier should decide the thickness required for the grout and indicate it here. ½” is the minimum required by the manufacturers but more can be applied if the condition of the structure warrants it. The thickness can also be shown in the Rehabilitation Table for each manhole.]*
 4. Trowel the grout surface to a smooth finish while being careful not to over trowel.
 5. The bench shall be coated with grout liner material in the same manner.

3.4 EPOXY TOPCOAT APPLICATION

- A. Mixing – Epoxy shall be mixed automatically by the spraying equipment in accordance with the epoxy manufacturer’s requirements. Hand mixing is not acceptable.
- B. Epoxy Application Procedure:
1. Epoxy topcoat shall be applied over the grout liner material after the grout has cured for a minimum of 24 hours. Contractor shall inspect the grout to insure it has properly cured.
 2. Epoxy shall be sprayed in one continuous coating with a minimum thickness of 100 mils. During application, a wet film thickness gauge shall be used to ensure that the minimum thickness is being applied. *[Specifier/Engineer can adjust the req’d epoxy thickness based on the structure environment. If severe flow agitation is present (wet wells, force main receiving manholes, etc.) use at least 100 mils, otherwise, 80 mils is sufficient].*

3.5 RETURN TO SERVICE

- A. Grout Lined Structures – Four hours of cure time shall elapse before the grout is placed in contact with active flow. Curing time is not required if the flow is confined to the invert.
- B. Epoxy Lined Structures – The structure can be placed into active service as soon as the coating is hard to the touch without tackiness. If the sewage flow does not contact the epoxy then active service can begin immediately.

3.6 WEATHER

- A. Grout and epoxy shall not be applied to frozen surfaces or during temperatures below 40° F.
- B. Grout and epoxy shall be protected from direct sunlight during the application process to prevent early set up/cure.
- C. Precautions shall be taken to keep the grout mix below 90° F during application. Water mixed with grout shall be chilled with ice if necessary.

3.7 FIELD INSPECTION AND TESTING

- A. All linings shall be visually inspected for infiltration, blisters, pinholes and consistent coverage. Deficiencies shall be repaired in accordance with manufacturer's recommendations.

- B. Vacuum Testing of Grout Lined Structures (No epoxy top coat)
 - 1. Allow the grout liner to cure for 72 hours prior to vacuum testing.
 - 2. Sewer structures lined with grout only shall be vacuum tested in accordance with ASTM 1244-93.
 - a. Plug the incoming and outgoing sewer mains with sewer plugs and block to prevent movement.
 - b. Place the test head and seal it against the manhole lid.
 - c. Using a vacuum pump, draw a vacuum of 10 inches of mercury and shut the pump off.
 - d. Measure the time for the vacuum to drop to 9 inches.
 - e. The minimum allowable test times for manhole acceptance:

<u>Manhole Depth (ft)</u>	<u>TIME (Sec.)</u>		
	<u>48" Diam.</u>	<u>60" Diam.</u>	<u>72" Diam</u>
4	10	13	16
8	20	26	33
12	30	39	49
16	40	52	67
20	50	65	81
24	59	78	97

Add this time
for each 2 ft of depth: 5 7 8

- C. Holiday Testing of Epoxy Lined Structures
 - 1. For epoxy lined structures, holiday testing shall be performed in lieu of vacuum testing.
 - 2. After the coating has set hard to the touch, it can be inspected with high-voltage holiday detection equipment.

- a. An induced holiday shall be made into the coated surface and serve to determine the min/max voltage to be used to test the coating.
 - b. The holiday tester shall be initially set at 100 volts per mil of specified thickness but shall be increased if it cannot detect the induced holiday.
3. All detected holidays shall be marked and repaired in accordance with the epoxy manufacturer's recommendations.

[Vacuum testing and holiday testing will increase the price of the work significantly. Usually vacuum testing is not feasible because of the irregularity of the ring and cover which makes sealing impossible. This testing can be deleted if the work is properly inspected by the engineer/owner during application of the linings]

3.8 DOCUMENTATION

- A. Rehabilitation Documentation - Contractor shall complete a Rehabilitation Report for each sewer structure that includes the following information:
 1. Owner Name
 2. Project Location
 3. Rehabilitation Date
 4. Superintendent's Name
 5. Weather Conditions
 6. Structure Number
 7. Structure Location
 8. Structure Diameter or Dimensions
 9. Structure Height
 10. Structure Mat'l of Construction
 11. Grout Thickness Req'd
 12. Epoxy Thickness Req'd
 13. Type and Amount of Patching Material Used
 14. Type of Grout Liner Used
 15. # of Bags of Grout Liner Used
 16. Gallons of Epoxy Applied
 17. Steps Removed?
 18. Description of any problems during installation
- B. Test Reports - Contractor shall provide a Test Report for each sewer structure that includes the following information:

1. Owner Name
2. Project Location
3. Rehabilitation Date
4. Superintendent's Name
5. Weather Conditions
6. Structure Number
7. Structure Location
8. Structure Diameter or Dimensions
9. Structure Height
10. Duration of Vacuum Test
11. Holiday Test Voltage
12. Number of Holidays Found
13. Signature of Tester

[This Test Report section should be deleted if testing is not required]

3.9 SAFETY

- A. The Contractor shall carry out his operation in strict accordance with all applicable OSHA standards. Particular attention is drawn to those safety requirements involving entering and working in confined spaces.
- B. Work shall be stopped if confined space entry procedures are not followed.

3.10 TRAFFIC CONTROL

- A. Contractor shall provide traffic control devices to safely move traffic around the work area. This shall include barrels, cones, barricades signs and lights as necessary.
- B. Contractor shall keep two-way traffic going around the work area if possible. Single lane closures will be allowed after approval of Contractor's traffic control plan by the Engineer.

3.11 CLEAN UP

- A. After the installation has been completed, the project area affected by the Contractor's operation shall be reinstated to its original condition.
- B. No separate payment will be made for restoration but shall be considered incidental to the items of the Bid.

3.12 PAYMENT

- A. Payment for the work included in this section will be in accordance with the unit prices set forth in the Bid for the quantity of work performed. Work performed such as traffic control, by-pass pumping, dewatering,

and other activities not listed on the Bid Form shall not be paid for directly but shall be considered subsidiary to the items of the Bid.

Example of Typical Bid Items for Structure Rehab:

- | | |
|---|----------|
| 1. Mobilization | LS |
| 2. Invert Repair | EA |
| 3. Manhole Rehab - Type "A" | VF or SF |
| 4. Manhole Rehab - Type "B" | VF or SF |
| 5. Manhole Rehab - Type "C" | VF or SF |
| 6. Manhole Rehab – Type "A" Grout and Epoxy | VF or SF |
| 7. Traffic Control | LS |

If you are using VF for your Manhole Rehab units then there should be a Manhole Rehab bid item for each diameter of manhole.

Example of a Structure Rehabilitation Table which can be placed in the project drawings:

MH #	MH Location	MH Diam. (ft)	MH Depth (ft)	Grout Type Required	Epoxy Top Coat	Step Removal	Invert Repair	Groundwater Infiltration Present
1	1 st & Elm	4	8.3	A	Y	N	Y	N
2	2 nd & Elm	4	8.9	A	Y	Y	Y	N
3	3 rd & Elm	4	9.5	B	N	Y	N	Y