Sanitary Sewer Infrastructure
Severe Wastewater Epoxy Lining and Rehabilitation
Lift Stations, Wet Wells & Manholes

1.00 GENERAL

1.01 Scope:

A. This specification covers the work necessary to furnish and install a complete lining or rehabilitation system for sanitary sewer structures, as shown on the drawings and as specified herein. Work includes, but is not limited to, the following:

1. Stopping Leaks by repair and sealing of the concrete and/or masonry bench, channel, invert, pipe inlets, walls, cone, chimney and frame of all structures to include removal of unsound materials, preparation, chemical grouting, structural lining, patching, plugging and sealing compounds.

2. Surface preparation, and installation of Structural Lining, High Strength Corrosion Protection Lining to include protection of surfaces not to be treated, touch-up, clean-up, and appurtenant work all in accordance with the requirements of the Contract Documents and this Specification.

1.02 Related Work Specified in Other Sections

A.	Section 03300	Cast-in-Place Concrete
B.	Section 03251	Expansion and Construction Joints
C.	Section 07194	Under Slab Vapor Barrier
D.	Section 07200	Exterior Below Grade Waterproofing
E.	Section 07900	Joint Sealants
F.	Section 09900	Painting

1.03 Referenced Specifications Codes and Standards

A. Without limiting the generality of other requirements of these specifications, all work hereunder shall conform to the applicable requirements of the referenced portions of the following documents, to the extent that the requirements therein are not in conflict with the provisions of this Section. All references and standards listed shall be the latest revisions. Joint and individual documents are referenced.

1. SSPC – The Society for Protective Coatings
40 24th Street, 6th Floor
Pittsburgh, PA 15222-4643
(412) 281-2331

2. NACE – National Association of Corrosion Engineers
   P.O. Box 218340
   Houston, TX 77218-8340
   (281) 492-0535

   a. SSPC-SP 13/NACE No. 6 Surface Preparation of Concrete
   b. SSPC-TU 2/NACE 6G197 Design, Installation, and Maintenance of Coating Systems for Concrete Used in Secondary Containment
   c. SSPC-SP 5/NACE No. 1, White Metal Blast Cleaning
   d. SSPC-SP10/NACE No. 2, Near White Metal Blast Cleaning
   e. SSPC-SP 6/NACE No. 3,Commercial Blast Cleaning
   f. NACE RP0892 “Linings over Concrete for Immersion Service”
   g. NACE Standard RP0591 “Coatings for Concrete Surfaces in Non-Immersion and Atmospheric Service”
   h. NACE SP0188 “Discontinuity Holiday Testing of Protective Coatings”.
   i. NACE RP 6F-164 “Curing of Interior Tank Linings”.
   j. NACE RP 6F-166 “Recommended Practice for Inspection of Linings on Steel and Concrete”
   k. SSPC-SP 13/NACE 6, Surface Preparation of Concrete
   l. SSPC-SP CAB 1,2,3; Surface Prepararation of Concrete by Abrasive Blasting

3. ICRI – International Concrete Repair Institute
   3166 S. River Rd., Suite 132
   DesPlaines, Il 60018
   (847) 827-0830

   a. Technical Guideline No.03372, “Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays”
   b. Technical Guideline No. 03731, “Guide for Selecting Application Methods for the Repair of Concrete Surfaces”
   c. Technical Guideline No. 03730, “Guide for Surface Preparation for the Repair of Deteriorated Concrete Resulting from Reinforcing Steel Corrosion”

4. ASTM – American Society for Testing and Materials
   100 Barr Harbor Drive
   West Conshohocken, PA 19428-2959
   (610) 832-9585

   a. ASTM E-337: Test Method for Measuring Humidity with a Psychrometer
   b. ASTM D 4258 “Practice for Surface Cleaning Concrete for Coating”

c. ASTM D 4261 “Practice for Surface Cleaning Unit Masonry for Coating”
d. ASTM D 4262 “Test Method for pH of Chemically Cleaned or Etched Concrete Surfaces”
e. ASTM D 4414 “Standard Practice for Measurement of Wet Film Thickness by Notch Gages”
f. ASTM D 4787 “Standard Practice for Continuity Verification of Liquid or Sheet Linings Applied to Concrete Substrates”

5. ACI – American Concrete Institute
Box 19150, Redford Station
Detroit, Michigan 48219
(248) 848-3700

a. ACI 350-01 “Code Requirements for Environmental Engineering Concrete Structures”
b. ACI 350.1 “Testing of Reinforced Concrete Structures for Water Tightness”
c. ACI 350.2 “Concrete Structures for Containment of Hazardous Material”
f. ACI 503 “Use of Epoxy Compounds with Concrete”
g. ACI 504 “Guide to Sealing Joints in Concrete Structures”

1.04 Submittals:

A. Submit product data for each component specified including data substantiating that the proposed materials comply with specified requirements and recommendations by the manufacturer covering all materials.

B. Samples of the cured system as described in Part 3.03.D to include the following

1. Finish texture as determined by the owner or owners’ authorized representative.

2. Stepped samples showing stages of multi-layer applications.

1.05 Quality Assurance

A. Acceptable Manufacturers: The manufacturer of the specified products shall have in existence, for a minimum of three (3) years, a program of training, and technically supporting a nationally organized Certified Applicator Program. Manufacturer must provide five (5) project histories with names, dates, addresses, and phone numbers of contact persons for projects of similar scope, which have been completed at least three (3) or more years ago.

1. Submit manufacturer's representative name, address and telephone number who will be available to provide information and suggestions on the proper use of the products.

B. Single Source Supply: All products described in Part 2.01 shall be manufactured by or distributed by the manufacturer of the sanitary sewer infrastructure linings or rehabilitation system specified herein.

C. Installer Qualifications: Engage only factory trained, certified applicators that have successfully completed applications using specified materials on projects of similar size and scope.

1. Provide (3) three references with name, address, and telephone number.

2. Provide written proof of inclusion, in good standing, in manufacturers Certified Applicator Program.

3. All of the contractor's jobsite personnel must be trained in the hazards associated with confined space entry. All personnel entering a confine space shall be certified for confined space entry.

D. Equipment Requirements

1. Application equipment must be approved in writing by Sherwin-Williams Technical Service Group

E. Substitutions

1. Manufacturers seeking approval of products other than the specified system must supply cured samples, full product information, project histories and references, technical data with specifications, MSDS and certifications regarding conformity of performance properties from an independent testing laboratory. The product being submitted for approval must meet all requirements of the performance properties specified within this specification. Compliance with the above quality assurances must be provided in written form at least fourteen (14) days before bids are received. Omission or non-conformance of any item will result in rejection of the request.

F. Pre-Installation Conference

1. The contractor, the installation sub-contractor, and the sanitary sewer infrastructure lining and rehabilitation system manufacturer's representative shall meet on site with the owner's representative. Particular emphasis shall be placed on these specifications, safety,

weather conditions, surface preparation, material application, and inspection.

2. The contractor shall submit to the owner's representative any revisions or changes agreed upon, reasons thereof, and parties agreeing or disagreeing with them.

G. Substrate Conditions: Do not proceed with work until substrate preparation and tolerances have been approved by the owner's representative, sanitary sewer infrastructure lining and rehabilitation system manufacturer's representative, the approved installation sub-contractor, and the contractor.

1.06 Delivery, Storage, and Handling

A. Deliver products to the job site in manufacturer's original, unopened containers bearing manufacturer's name and label and the following information

1. Product name
2. Product description (generic product classification)
3. Manufacturer's lot number
4. Color

B. Store materials in sealed original manufacturer's containers. Store materials in a protected area out of direct sunlight. Keep containers clean and undamaged. Adhere to manufacturer's published storage temperature and shelf life recommendations. Protect all materials from freezing.

2.00 PRODUCTS

2.01 Acceptable Manufacturers and Materials

A. The Sanitary Sewer Infrastructure Lining or Rehabilitation System as manufactured by Sherwin-Williams will consist of, one or more systems for Stopping Leaks, Structural Lining, High Strength Corrosion Protection Lining where specified. All products are specified as the minimum standard of quality, and are manufactured or distributed by The Sherwin-Williams Company, Cleveland, Ohio (800-331-7979). Additional products may consist of one or more systems for infiltration leak stoppage and concrete repair.

1. **Stopping Leaks** - Infiltration leakage of all concrete and brick structures shall be stopped by trenchless technology method of chemical grouting with polyurethane grouts. Products shall be manufactured by Avanti Grouts and shall be classified as "Hydrophobic Foam", "Hydrophilic Gel" or "Hydrophilic Foam" grouting compounds or a combination of the listed materials and methods or as recommended by the manufacturer.

a. Hydrophobic Polyurethane Grouts are hydrophobic polyurethanes that when mixed and makes contact with the water, is designed to fill large voids in rock fissures, gravel layers, and cracks in concrete structures and for the cut-off of gushing water.
Product – Avanti Grouts AV-280 Hydrofoam with AV-281 Hydrocel

b. Hydrophilic Polyurethane Gels are hydrophilic polyurethanes designed to react with water and form a water impermeable gel mass. When they come into contact with water, the grout begins to foam and gel, and depending on the temperature and amount of water present, quickly cure to a flexible, impermeable foam or gel mass unaffected by mildly corrosive environments.
Product – Avanti Grouts AV350

c. Hydrophilic Polyurethane Foams are designed to form a flexible gaskets or plug in joints and cracks in concrete. When it comes into contact with water, the grout expands quickly and cures to tough. Flexible, adhesive, closed-cell, foam that is essentially unaffected by mildly corrosive environments.
Product – Avanti Grouts AV-202 Multi-Grout

d. Hydrophobic Polyurethane Grouts that are designed to form flexible gasket or plugs in very tight joints and hairline cracks. When they come into contact with water the grout expands and depending on temperature and the amount of accelerator used quickly cures to a tough, flexible closed cell polyurethane foam that is essentially unaffected by corrosive environments.
Product – Avanti Grouts AV-248 Flexseal LV with AV-249 Catalyst LV

2. **Resurfacing Materials** – Designated structures shall receive an application of resurfacing compounds/repair mortar. The resurfacing compounds/repair mortars are classified as Hydraulic Cements, Microsilica Repair Mortars or Calcium Aluminate Repair Mortars. Microsilica Repair Mortars shall be designated for areas of Mild H2s content or areas to be top coated with a corrosion resistant coating or lining as shown on the drawings. Calcium Aluminate Repair Mortars shall be designated for areas of moderate H2S content or areas to be top coated with corrosion resistant coating or lining as shown on the drawings. Thickness shall be sufficient to replace lost cross section and fill voids

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a. Hydraulic Cements shall be cement based, quick setting, hydraulic cement compound which instantly stops weeping water through

concrete or masonry walls and floors. They will become harder and more resistant when subjected to constant water pressure.
A.W. Cook Cement, CEMTEC Hydraulic Cement
Physical Properties (28 day cure)

Compressive Strength ASTM C-109	5,500 psi
Tensile Strength ASTM C-496	650 psi
Bond Strength ASTM C-882 (Modified)	880 psi
Setting Times (Gilmore) “Hot Mix”	65 seconds

b. Rapid Cure Vertical Grade repair mortars shall be a one part, polymer modified, fast setting, silica fume, fiber reinforced mortar designed for vertical and overhead repairs from ¼” to 2” in one lift. The product may be applied by hand trowel or sprayed with a low-pressure pump. *(Used to hand place large voids, bench repair, or hand troweled structural wall linings)*
A.W. Cook Cement, CEMTEC Silatec Rapid Cure Vertical Grade
Physical Properties (28 day cure)

Compressive Strength ASTM C-109	6,800 psi
Flexural Strength ASTM C-293	990 psi
Bond Strength ASTM C-882 (Modified)	1,600 psi
Shrinkage ASTM C-596	0.07%
Abrasion Resistance – ¼” APCI	1
Setting Times @ 77°F	
Initial Set – 35 min	
Final Set – 50 min	

c. Microsilica repair mortars shall be a blend of Portland cement, graded silica sand, fibers and silica fume. The mortar may be hand troweled or spray applied, usually from ½” to 1” in depth. Uses include repairing concrete walls, ceilings, lining brick or concrete manholes and lift stations, etc. Microsilica repair mortar provides an extremely dense matrix and will accept coatings at earlier ages than typical Portland cement repair products. *(Used primarily for structural wall linings)*
A.W. Cook Cement, CEMTEC Silatec MSM
Physical Properties (28 days cure)

Compressive Strength ASTM C-109	10,400 psi
Flexural Strength ASTM C-293	1,695 psi
Shrinkage ASTM C-596	0.00%
Freeze/Thaw ASTM C-666 100 cycles	No Effect
Bond Strength ASTM C-882 (Modified)	1,695 psi
Modulus of Elasticity ASTM C-469	4,533,333 psi
Tensile Strength ASTM C-496	750 psi

d. Calcium Aluminate repair mortars shall be a blend of quartz silica, fibers and calcium aluminate cement. They can be hand troweled or spray applied, usually from ½" to 1" in depth. Uses include repairing concrete wall and ceilings, lining brick or concrete CAPmanholes, lift stations, etc. They can be especially useful when coatings are required at early stages of cure. (Consult with coating manufacturer for specific times) *(Used primarily for structural wall linings)*

A.W. Cook Cement, CEMTEC Silatec CAM
Physical Performance (28 day cure)

Compressive Strength ASTM C-109	12,800 psi
Flexural Strength ASTM C-293	1,360 psi
Shrinkage ASTM C-596	0.03%
Tensile Strength ASTM C-496	650 psi
Freeze/Thaw, 300 cycles ASTM C-666	No Effect
Bond Strength ASTM C-882 (Modified)	1,765 psi

2.02 Performance Criteria

A. The Reinforced Epoxy Lining System shall consist of Sherwin-Williams Dura-Plate 6000 Reinforced Epoxy. This is a 100%, high build, glass flake reinforced, amine cured epoxy designed for the protection of concrete and steel in , potable water storage or highly corrosive hydrogen sulfide (microbial induced) environments associated with concrete tanks or clear wells & wastewater applications including lift stations, digesters, aeration basins, manholes and wet wells. The application thickness of the neat resin lining shall be 100 – 125 mils DFT, when applied to concrete, masonry or structural lining surfaces. The specified film thickness shall be applied by suitable airless spray equipment or by heated plural component spray application in a single coat with multiple passes.

Physical Properties:

Adhesion – Concrete- ASTM D7234 - Concrete Failure
Steel – ASTM D4541- > 3000 psi
Abrasion Resistance – ASTM D4060, 1,000 g, 1000 cycles, CS-17 Wheel – <120mg loss
Compressive Strength – ASTM D695 – 10,000 psi
Elongation Percent – ASTM D638 – 2%
Flexural Modulus – ASTM D790 – 670,000 psi
Flexural Strength – ASTM D790 – 12,000 psi
Hardness, Shore D – ASTM D2240 – 75
Impact Resistance – ASTM D2794 – 80 in. lbs.
Tensile Strength – ASTM D638 – 7300 psi
Water Vapor Transmission – ASTM D1653 – 0/gms/m^2 (24 hrs)

Humidity Resistance- ASTM D4585- Pass
Sever Wastewater Analysis Test- ASTM G210- Pass
NSF 61 Drinking Water – up to 125 mils as a lining
Return to Severe Sewer Service – 10 hours @77F

B. The High Strength Corrosion Protection Lining System shall consist of Sherwin-Williams Dura-Plate 6100 High Physical Strength Epoxy. This is a 100%, high build, high strength, amine cured epoxy designed for the protection of concrete and steel in highly corrosive hydrogen sulfide (microbial induced) environments associated with wastewater applications including lift stations, digesters, aeration basins, manholes and wet wells. The application thickness shall be 100 – 125 mils DFT, when applied to concrete, masonry or structural lining surfaces. The specified film thickness shall be applied via heated, plural component, spray application in a single coat with multiple passes.

Physical Properties:

Adhesion – ASTM D7234 - >2,000 psi, Concrete Failure
Abrasion Resistance – ASTM D4060, 1,000 g, 1000 cycles, CS-17 Wheel – <90 mg loss
Compressive Strength – ASTM D695 – 15,000 psi
Dry Heat Resistance – ASTM D2485 – 300°F
Elongation Percent – ASTM D638 – 4.8%
Flexural Modulus – ASTM D790 – 590,000 psi
Flexural Strength – ASTM D790 – 11,000 psi
Hardness, Shore D – ASTM D2240 – 83
Impact Resistance – ASTM D2794 – 30 in. lbs.
Tensile Strength – ASTM D638 – 5,600 psi
Water Absorption – ASTM D570 – 0.15%
Water Vapor Transmission – ASTM D1653 – 3.0/gms/m^2 (24 hrs)
Return to Severe Sewer Service – 6 hours @ 77F
Chemical Resistance at 120°F
- 5% Acetic Acid
- 5% Ammonium Hydroxide
- Diesel
- 1% Ferric Chloride
- Gasoline
- 10% Hydrochloric Acid
- Kerosene
- 10% Nitric Acid
- 10% Sodium Chloride
- 25% Sodium Hydroxide
- 1% Sodium Hypochlorite
- 20% Sulfuric Acid

3.0 EXECUTION

3.01 Surface Preparation

A. Inflow and Infiltrations

1. Active leakage of all concrete and brick structures shall be stopped by trenchless technology method of chemical grouting with polyurethane grouts. Grouts shall be installed per manufacturers directions and could include any of the hydrophilic or hydrophobic products listed or combination there of.

B. Concrete

1. The NACE/SSPC Joint Surface Preparation Standards for concrete surface preparation are incorporated in and made part of this specification. All references to SSPC SP-13/NACE No 6 designate the definitions and other requirements in these documents. The International Concrete Repair Institute (ICRI) Technical Guideline No. 0310.2R, Guide to Surface Preparation of Concrete to Receive Sealers, Coatings and Polymer Overlays shall be used to visually evaluate the concrete surface profile. Refer to Sherwin-Williams' Concrete Surface Preparation Guide.

2. Create a minimum surface profile for the system specified in accordance with the methods described in ICRI No. 0310.2R to achieve profile CSP-5 to CSP-7

3. Test surface for pH levels using an electronic pH meter, pH pencils or another method that records pH values in small increments to ensure the actual pH value is known. Gradient testing may be required. The pH of the Concrete shall be > 10 prior to the application of mortar repairs or linings.

4. Concrete surface defects, such as deteriorated concrete or masonry, hollow areas, bugholes, honeycombs, cracks and voids shall be filled flush and true with the specified structural lining compound in accordance with ICRI Technical Guide No 0310.2R "Guide for Selecting Application Methods for the Repair of Concrete Surfaces". Fins, trowel marks, and all protrusions or rough edges shall be removed. All active water leaks shall be stopped by use of polyurethane chemical grouting compounds.

5. Concrete Surface Repair: Surface voids and defects

   a. All surfaces shall receive a minimum of ½" thickness of the specified structural lining repair mortar.

6. Provide a clean, saturated surface dry (SSD) concrete surface with no free standing or moving water, with a minimum surface profile as defined

by ICRI in accordance with 0310.2R equal to a CSP 3-5. All substrates are to be vacuumed, swept and blown down with clean, dry air to remove spent abrasive, dust and other foreign material that might interfere with the adhesion of the primer and lining.

7. Debris resulting from surface preparation and cleaning shall not be allowed to enter any water streams and shall be removed form the structure.

C. Miscellaneous Metals

1. The NACE / SSPC Joint Surface Preparation Standards for abrasive blasting approved in October 1994 are incorporated in and made a part of this specification. All references to SSPC-SP6 / NACE No. 3 and SSPC-SP10 / NACE No. 2 designate the definitions and other requirements in these documents. SSPC VIS 1-89 Visual Standard for Abrasive Blast Cleaned steel shall be used to visually evaluate the blast cleanliness.

2. Remove all oil and grease form surface by solvent cleaning per SSPC-SP1. Minimum surface preparation is SSPC-SP10 / NACE No. 2, Near White Metal Blast Cleaning. Abrasive blast clean all surfaces using a sharp, angular abrasive for optimum surface profile (2-3 mils). Prime any bare steel the same day as it is cleaned and before flash rusting occurs. Refer to Sherwin-Williams Guidelines Procedures for Surface Preparation of Metals.

   a. Inspect the surfaces to be lined. All holes in the steel surfaces or pits greater than 1/8 inch shall be repaired in accordance with the owner's repair procedures.

   b. All substrates are to be vacuumed, swept and blown down with clean, dry air to remove spent abrasive, dust and other foreign material that might interfere with the adhesion of the primer or basecoat.

   c. The maximum allowable residual salt contamination, as measured with a KTA Scat Kit or equivalent field test method, immediately prior to the application of the first coat is as follows:
      - 5 micrograms per square centimeter (50mg/m^2) most commodities up to 120^{o}F

   d. Corrosion pits in the blasted steel shall be filled flush with the substrate using Sherwin-Williams Steel-Seam FT 910 patching and surfacing compound.

   e. Projections and lap joints on welded plates and on riveted plates to be coated shall be filled with Steel-Seam FT 910 patching and

surfacing compound in order to smooth out the surface and provide for a smooth transition of the lining over the substrate.

3.02 Application

A. The contractor shall at all times maintain traffic control measures in cooperation with local police details, property owners and the municipality.

B. The contractor shall maintain sewer flows in accordance with the contract documents. Diversion of the flow or plugging the flow of sewerage for the purposes of affecting repairs to the structure shall be coordinated at direction of the owner.

C. Comply with manufacturers written installation procedures and individual product data sheet application bulletins.

D. Apply materials in accordance with the following material coverage:

High Strength Corrosion Protection Lining System

Products	**Thickness (mils dft)**
Infiltration and Inflow Control	
Stop Leaks with Avanti Polyurethane Injection Grouts	As Needed
Repair/Patching and Structural Linings	
(Steel) Steel Seam FT910	As Needed
(Concrete)A.W. Cook CEMTEC Repair Mortars	½" minimum
Primer (optional for below grade structures)	
Macropoxy 5000	400-500SFG
H2S Resistant Corrosion Protection Lining	
Dura-Plate 6100 Epoxy or Dura-Plate 6000	100.0-125.0
Total Targeted Thickness	100.0-125.0

3.03. Inspection and Testing

A. The owner or owner's authorized representative may require the services of an independent testing laboratory to test the installed system.

B. All surfaces receiving any specified corrosion protection system shall be holiday tested in there entirety per NACE SP0188 @ 100 volts/mil after 24 hours cure to ensure the surface is free of all voids and defects.

C. If test results indicate noncompliance with the specification, the following corrective action may be required of the Contractor:

1. Remove non-compliant systems or components.
2. Replace system or components in (1)
3. Assume the testing expenses.

D. Minimum requirements of the corrosion protection coatings and/or lining system are that it be free of the following:

1. Uncured material
2. Inadequate thickness
3. Pinholes
4. Blisters
5. Delamination
6. Foreign matter
7. Unspecified materials

3.04. Protection

A. The corrosion protection coatings and/or lining system shall be protected from damage or detrimental elements during cure and until the time of final acceptance.

End of Section