

STANDARD SPECIFICATIONS
SECTION 02957
SEWER MANHOLE REHABILITATION

PART 1 GENERAL

1.1 DESCRIPTION

- A. Section includes requirements for repair and rehabilitation of sanitary sewer manholes.

1.2 QUALITY ASSURANCE

- A. Follow national standards and as specified herein.
- B. Personnel Involved in Installation of Manhole Rehabilitation Materials: Certified by manufacturer successfully completed training in handling, applying and finishing materials used.
- C. Commercially Proven Product:
 - 1. Successfully completed over period of at least 2 years, minimum of 1,000 vertical feet of manhole rehabilitation or 100 manholes.
 - a. Document to satisfaction of the Commission.

1.3 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM)
 - 1. C78, Standard Test Method for Flexural Strength of Concrete
 - 2. C109, Standard Test Method for Compressive Strength of Hydraulic Cement Mortars
 - 3. C157, Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete
 - 4. C307, Standard Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacing
 - 5. C580, Standard Test Method for Flexural Strength and Modulus of Elasticity of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes
 - 6. C596, Standard Test Method for Drying Shrinkage of Mortar Containing Hydraulic Cement
 - 7. C882, Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete By Slant Shear
 - 8. D638, Standard Test Method for Tensile Properties of Plastics
 - 9. D792, Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
 - 10. D4787, Standard Practice for Continuity Verification of Liquid or Sheet Linings Applied to Concrete Substrates

11. D4833, Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products
12. F2414, Standard Practice for Sealing Sewer Manholes Using Chemical Grouting

B. Federal Specification HH-P-117 for Dry Oakum

1.4 SUBMITTALS

A. Submit following Section 01330.

1. Working drawings showing design calculations, materials selected, and manufacturer's installation requirements.
2. Catalog data showing manufacturer's clarifications and updates, ASTM references, material composition, specifications, physical and chemical properties.
3. Manufacturer's recommended procedures for handling, storing, repairing, and installing materials selected.
4. Method of construction (as appropriate):
 - a. Access manholes and site locations.
 - b. Work dimensions.
 - c. Existing utilities.
 - d. Size of working area.
 - e. Impacted portions of existing sewer.
 - f. Site access points.
 - g. Bypass pumping plan: Follow Section 02960
5. Emergency plan detailing procedures followed in event of health and safety emergency, pump failures, overspray, chemical spills, sewer overflows, service backups, and sewage spillage. Maintain copy on site for duration of project
 - a. Address dangers associated with sewer rehabilitation work (i.e. working with large boiler trucks).
 - b. Identify health and safety officer (i.e. crew chief)
 - 1) Designated health and safety officer:
 - a) Responsible for providing health and safety oversight of personnel participating on project team.
 - b) Perform and document routine work area inspections, conduct safety meetings, and provide safety orientations for team members.
 - c) Have the following contact information in easily accessible place;
 - (1) Non emergency number.
 - (2) Contractor's health and safety representative name and number.
 - (3) Occupational health clinic number(s).
 - c. Submit the following;
 - 1) List of critical rehabilitation equipment, including boiler truck equipment, to be inspected on daily basis.
 - 2) Recently completed (previous month) monthly maintenance log.
 - 3) Annual third-party certified inspection for boiler truck(s) to be used on project.
 - 4) Certification of training for boiler truck operator.
 - 5) Noise attenuation.

6. Epoxy and cured-in-place (CIP) manhole liner products.
 - a. Infrared spectrograph chemical fingerprint and Certificate of Analysis for each lot of material:
 - 1) Lot number.
 - 2) Product name.
 - 3) Manufacturer.
 - 4) Brookfield Viscosity.
 - 5) Thix Index.
 - 6) Gel time at cure temperature.
 - 7) Peak temperature for failure.
 - 8) Percent of non-volatile solids.
 - 9) Specific Gravity.
 - 10) Catalyzed Stability time at optimum temperature.
 - 11) Catalyst to resin ratio.
 - 12) Analysis signature.
 - 13) Date tested.
 - 14) Batch ticket for each resin-catalyst-colorant batch made up and impregnated into felt liner material.
 - b. Shipping manifest:
 - 1) Date shipped.
 - 2) Origination and delivery locations.
 - 3) Shipping method and carrier.
 - 4) Shipping order number.
 - 5) Purchase order number.
 - 6) Shipped item.
 - 7) Stock number.
 - 8) Lot number.
 - 9) Manufacturer.
 - 10) Any shipping, storage, or safety requirements.
 - 11) Received by, and date.
 - 12) Signature of receiver.
7. Stock sheets, order forms, delivery forms, invoices, and Hazardous Material forms for material used.

B. Submit following Section 01450 and specified herein.

1. Certified statement from manufacturer approved installer of their system.
 - a. Include certificates of training from manufacturer for each crewmember involved in installation process.
2. Documentation of Products and Installers: Contract Manager's approval required before installation of rehabilitation materials.
 - a. Descriptions of projects completed in past 2 years where proposed rehabilitation material was used.
 - 1) Include vertical feet of manhole rehabilitated. Manhole identification number, work order number, Contract number, Contractor's name, operator's contact information, and date of readings.
3. Safety plan for steam curing of cured-in-place bag liners.

4. For manhole process involving materials that cure in field as component of their installation.
 - a. Provide ASTM certified lab test results for field installations completed in United States over the past two years.
 - 1) In place properties for actual field installations for proposed materials.
 - 2) Test results must verify physical properties specified herein have been achieved in previous field applications.
5. Detailed description of field testing processes and procedures.
 - a. Keep accurate record of work for each manhole rehabilitated under this contract.
 - 1) Show manhole identification number and location, quantities of rehabilitation material used, estimate of infiltration eliminated, and results of post-rehabilitation inspection.
 - b. DVD-ROM with Color video inspection reports and all digital records (original inspection videos, photographic stills, etc) made following manhole rehabilitation.
 - 1) Provide to Contract Manager within 10 days, following Section 02956.
 - c. Curing logs: Show material curing readings per unit of time collected during material installation.
 - 1) Store electronically on data logger. Submit printed copy with Post video inspection DVD-ROM.
 - d. For CIP liners, provide tabulation of time versus temperature by liner manufacturer with lengths of time exposed portions of liner will endure without self-initiated cure or other deterioration.
 - 1) Tabulate at 5 degrees F. increments, ranging from 70 degrees F. to 100 degrees F.
 - 2) Include analysis of progressive effects of such self-initiated cure on insertion and cured properties of liner.
 - e. Third party material testing report complete with samples, tests done, results and Analyst signature.
 - 1) Third party is defined as ASTM or equivalent accredited materials testing firm with no financial or directorial link to manufacturer or Contractor.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect, store, and handle materials during transportation and delivery, while stored on-site, and during installation following approved submittals.
 1. Maintain temperature less than 120 degrees F. while in storage.
 2. Contract Manager may inspect and test materials at factory, before delivery to site or while in storage.
- B. Material found to be defective or damaged due to manufacture or shipment:
 1. When Contract Manager deems repairable: Repair following manufacturer's recommendations.
 2. When Contract Manager deems not repairable: Rejected, removed from Contract site, and replaced under Contract Manager's direction.

3. Repair or replace defective or damaged material.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Acrylic or Acrylate Base Grout for non-structural infiltration control: Follow ASTM F2414 and as specified herein.
 1. Two-part chemical grout mixed at point of injection.
 2. Minimum 25 percent acrylic or acrylate base material by volume.
 - a. To increase strength or offset dilution during injection period, use higher concentration of base material as directed by Contract Manager.
 3. Controllable reaction time: 30 seconds to 1 hour.
 4. Viscosity: 1.5 centipoises water.
 - a. May be increased maximum of 2.5 centipoises water as directed by Contract Manager.
 - b. Remain constant throughout injection period.
 5. Tolerates dilution and reacts in moving water.
 6. Final reaction:
 - a. Produces chemically, continuous irreversible, non-biodegradable, flexible gel, impermeable to water at pressures up to 15 psi in pure form.
 - b. Produces stabilized soil in ground that will not become brittle or rigid.
 7. Gel does not bleed water under stress.
 8. Dehydrated gel returns to 90 percent of its original volume and form after prolonged period of low ground water.
 9. Do not use catalyst containing dimethyl amino propionitrile (DMAPM).
 10. Use root inhibitor (50% active dichlobenil) when roots are present in manholes, connecting pipes or laterals.
 - a. Change dye color to confirm root inhibited grout is being injected.
 11. Use latex additive for increased tensile strength.
 12. Tinted to allow detection of grout in drill holes or at leakage locations.
 13. Approved Manufacturers.
 - a. Grout.
 - 1) Avanti International, Acrylic Gel.
 - a) Additives
 - (1) AV-101 Catalyst T+
 - (2) AV-103 Catalyst SP
 - (3) AC50W – Root Inhibitor
 - (4) AC-257 Icoset
 - 2) De Neef, Inc.,
 - a) AC400 Acrylate Grout
 - (1) Additives
 - (a) TE 300 Triethanolamine
 - (a) P200 Sodium Persulfate
 - 3) Or Equal.

- B. Urethane Base Grout for non-structural infiltration control: Follow ASTM F2414 and as specified herein.
1. Ratio: One part urethane prepolymer to 10 parts water by volume (10 to 50 percent prepolymer).
 2. Liquid prepolymer:
 - a. Solids content: 77 to 83 percent.
 - b. Specific Gravity: 1.04
 - c. Flash Point: 20 degrees F.
 - d. Viscosity: 200 to 1,200 centipoises water at 70 degrees F.
 3. Water for reacting prepolymer: pH of 5 to 9.
 4. Use manufacturer recommended gel control agent to control cure time as required.
 5. Final Reaction:
 - a. Produces chemically continuous irreversible, non-biodegradable, flexible gel, impermeable to water at pressures up to 15 psi in pure form.
 - b. Produces stabilized soil in ground that will not become brittle or rigid.
 6. Dehydrated gel returns to 90 percent of its original volume and form after prolonged period of low ground water.
 7. Use root inhibitor (50% active dichlobenil) when roots are present in manholes, connecting pipes, or laterals.
 8. Use latex additive for increased tensile strength.
 9. Tinted to allow detection of grout in drill holes or at leakage locations.
 10. Approved Manufacturers.
 - a. Warren Environmental, Inc.
 - 1) SG-201 Grout.
 - b. Avanti.
 - 1) Norosac AC 50W Root Inhibitor.
 - 2) AV-254 Gelseal.
 - a) Additives
 - (1) AV-257 Icoset.
 - (2) AV-255G Grout Side Accelerator.
 - c. De Neef, Inc.
 - 1) Hydro Active Multigel NF.
 - a) Additives.
 - (1) Flexgel Cat Water Side Accelerant.
 - (2) Reinforcing Agent.
 - d. Sauereisen.
 - 1) F370, Hydroactive Polyurethane Grout.
 - e. Or Equal.
- C. Cementitious Reconstruction for Manhole Restoration.
1. Quick setting (under 20 minutes), high strength, sulfide resistant, calcium aluminate-based or portland cement material.
 2. Suitable for troweling or rotary spray application to inside of manhole.
 3. Use additives to increase corrosion resistance or bond strength at manufacturer's direction and with Contract Manager's approval.

4. Initial set time per manufacturer's recommendation and per project conditions.
5. Density when applied: 135 lb/cf +/- 5 lb/cf.
6. Compressive strength (ASTM C109) at 1 day.
 - a. Per manufacturer's recommendation.
 - b. Minimum acceptable: 2,000 psi.
7. Compressive strength (ASTM C109) at 28 days.
 - a. Per manufacturer's recommendation.
 - b. Minimum acceptable: 5,500 psi.
8. Bond Strength (ASTM C882) at 28 days.
 - a. Per manufacturer's recommendation.
 - b. Minimum acceptable: 1,640 psi.
9. Flexural Strength (ASTM C78) at 28 days.
 - a. Per manufacturer's recommendation.
 - b. Minimum acceptable: 1,500 psi.
10. Shrinkage (ASTM C596) at 28 days: 0 percent.
11. Approved Manufacturers.
 - a. IPA systems, Inc.
 - 1) Octocrete (trowel).
 - 2) Drycon (brush or trowel) (Non-Structural Application only).
 - 3) Drycon SM (spray gun).
 - 4) Drycon SMF fiber reinforced.
 - b. The Strong Company, Inc.
 - 1) Strong-Seal MS-2A.
 - 2) Strong-Seal MS-2C (mild corrosion resistance).
 - 3) Strong-Seal High Performance (high corrosion resistance).
 - c. AP/M Permaform.
 - 1) Permacast MS-10,000 (corrosion resistant).
 - 2) Permacast MS-10,000 with Con-Shield (anti-bacterial additive).
 - 3) Permacast CR-9,000 (calcium aluminate cement) (trowel).
 - d. Sauereisen.
 - 1) F-120 Underlayment (calcium aluminate cement) (trowel).
 - 2) F-120 FC Fast Setting Underlayment.
 - 3) F-121 Substrate Resurfacer.
 - e. QuadEx.
 - 1) Aluminaliner (calcium aluminum cement).
 - f. Or Equal.

D. Hydraulic Water Plugs for non-structural infiltration control.

1. Rapid setting to plug active leaks prior to other rehabilitation work.
2. Initial Set Time at 70 degrees F: 60 to 90 seconds.
3. Final Set Time at 70 degrees F: One hour.
4. Compressive Strength (ASTM C109) at 28 days:
 - a. Per manufacturer's recommendation.
 - b. Minimum acceptable "or equal" products: 4,000 psi.
5. Length Change (ASTM C157): 0 percent.
6. Approved Manufacturers.

- a. Sauereisen.
 - 1) Instaplug F-180.
 - b. IPA Systems, Inc.
 - 1) Octoplug Plus.
 - 2) IPANEX Rapid.
 - c. The Strong Company, Inc.
 - 1) Strong-Seal QSR (acid resistant)
 - 2) Strong-Plug.
 - d. AP/M Permaform,
 - 1) Permacast-Plug.
 - e. Or Equal.
- E. Oil-free Oakum Water Plugs for non-structural infiltration control.
- 1. Rapid setting oil-free oakum and hydrophilic grout to plug active water leaks prior to other rehabilitation work.
 - 2. Oil-free oakum meeting Federal Specification HH-P-117.
 - 3. Two-part urethane resin.
 - 4. Initial set time: 5 to 10 seconds.
 - a. Use accelerator to decrease initial set time.
 - 5. Approved Manufacturers.
 - a. Avanti International
 - 1) Oil-free Oakum (AV-219)
 - 2) Multigrout (AV-202).
 - b. DeNeef, Inc.
 - 1) Oil-free Oakum
 - 2) Hydro Active Sealfoam
 - 3) Hydro Active Flex LV grout.
 - c. Or Equal.
- F. Manhole Chimney Seals.
- 1. Cured in Place Chimney Liner.
 - a. Seamless tube liner formed in place within existing manhole, beginning just below cover seat extending downward maximum of 24 vertical inches.
 - 1) Structurally independent of existing manhole structure.
 - b. Resin impregnation method: On site.
 - c. Resin-Catalyst-Colorant Additive Mixture:
 - 1) Tested to certify design standards are met before impregnating felt material.
 - 2) Quantity of resin used for tube impregnation: Sufficient to fill volume of air voids in felt tube with additional allowances for polymerization shrinkage and loss of resin through cracks and irregularities in manhole walls.
 - d. Seams in felt tube.
 - 1) Stronger than non-seamed felt.
 - 2) Overlapped layers of felt in vertical seams that cause lumps in final product shall not be utilized.

- e. Cured Liner.
 - 1) 50-year life span.
 - 2) Chemically resistant to internal exposure to sewage containing small quantities of hydrogen sulfide, carbon dioxide, methane, mercaptans, kerosene, moisture and diluted sulfuric acid.
 - 3) Chemically and physically resistant to external exposure of soil bacteria, moisture, roots and chemical attack, this may be due to material in surrounding ground.
- 2. Approved Manufacturers.
 - a. Cured In Place Liner
 - 1) LMK
 - 2) CIPMH Chimney.
 - 3) Or Equal.

G. Manhole Liners.

- 1. Cured-in-Place Bag Liners.
 - a. Seamless manhole formed in place, within existing manhole extending from channel to frame.
 - 1) Structurally independent of existing manhole structure.
 - 2) Liner thickness: Designed by manufacturer related to location, loads, water table and condition of manhole.
 - b. Multiple structural layers of fiberglass with non-porous membrane layer between fiberglass or Polyvinyl Chloride/Polyester (PVCP) liner
 - 1) Fiberglass layer formed to manhole interior under pressure and cured with heat.
 - c. Liner fabricated to match manhole dimensions for custom fit.
 - 1) Continuous length from bench to manhole frame, just below cover seat.
 - a) Pieced together length: Not acceptable.
 - b) Separate lining allowed for channel: Compatible with bag liner.
 - 2) Stencil material type and name on liner: Viewable from inside.
 - d. Epoxy resin.
 - 1) Polyamide Bisphenol "A" Epichlorodhydrin for use with fiberglass liner.
 - 2) Modified epoxy resin for use with PVCP liner.
 - e. Approved Manufacturers.
 - 1) Terre-Hill.
 - a) Multi-Plexx Liner System.
 - 2) Poly-Triplex Technologies.
 - a) Poly Triplex Liner System.
 - 3) Or Equal.
- 2. Spray on Epoxy Liners.
 - a. Seamless manhole formed in place, within existing manhole extending from channel to frame.
 - b. Two or three part epoxy coating.
 - c. Existing wall preparation: Follow manufacturers recommendations.

- d. Minimum thickness: Structurally independent of existing manhole structure or sufficient to form protective barrier when used with Cementitious Manhole Restoration.
- e. Minimum Tensile Strength (ASTM C307): 2,500 psi.
- f. Minimum Flexural Strength (ASTM C580): 4,600 psi.
- g. Approved Manufacturers.
 - 1) Sauereisen.
 - a) Sewer Gard No. 210 Sprayable.
 - b) Sewer Gard No. 210 Rotary Spray.
 - c) Sewer Gard No. 210G (Non-Structural Application Only)
 - d) Sewer Gard No. 210 FS
 - e) Hi-Build Filler Compound No. 209HB (Non Structural Application Only).
 - 2) Raven.
 - a) Raven 400S (Non Structural Application Only).
 - 3) Terre Hill.
 - a) Hydropoxy (Non Structural Application Only).
 - 4) AP/M Permaform.
 - a) Cor+Gard (Non Structural Application Only)
 - 5) SprayRoq, Inc.
 - a) SR6100 (Non Structural Application Only). .
 - 6) Warren Environmental, Inc.
 - a) S-301-14 Epoxy Spray System.
 - b) M-301-18 Epoxy Trowel-On Mastic System.
 - c) S-301-20 Thermaflex (Non Structural Application Only).
 - d) SG-201 Injection Grout (Non Structural Application Only).
 - 7) Or Equal.
- 3. Panel Liners.
 - a. Seamless manhole formed in place within existing manhole, extending from channel to frame
 - 1) Structurally independent of existing manhole structure.
 - b. High density Polyethylene (HDPE) Panels.
 - 1) Integrally extruded sheets with anchoring studs, minimum 39 studs per square foot.
 - 2) Minimum thickness of panel sheet with anchoring studs: 2 mm.
 - 3) Minimum thickness of flat liner sheet at joint overlaps: 3 mm.
 - 4) Joints between panels sealed using thermal welding.
 - 5) Density (ASTM D792): 0.945 gm/cm³.
 - 6) Elongation at break (ASTM D638): Greater than 400 percent.
 - 7) Minimum abrasion resistance (ASTM D4833): 160 pounds.
 - 8) Steel frames for mounting liner.
 - a) Maintain minimum 2.5 inch annular space when filling with flowable concrete. Required thickness dependent on condition of manhole, location of manhole, loads applied to manhole and water table.
 - b) Maintain minimum 1 inch annular space when filling with grout.

- c) Anchor bolts: Minimum penetration of concrete on manhole wall: 1.5 inches.
 - d) Countersink screws to mount liner to frames.
 - 9) Cement in annular space.
 - a) Wall preparation: Determined by Contract Manager prior to placement of forms.
 - b) Minimum Compressive Strength: 4,000 psi at 28 days.
 - c) Minimum aggregate size: 8 mm.
 - d) Maximum aggregate size: 32 mm.
 - 10) Grout in annular space.
 - a) Minimum Compressive Strength: 6,000 psi at 28 days.
 - b) Low viscosity, high flowability to fill annular space without voids.
 - c) Bonds to manhole wall.
 - 11) Approved Manufacturer.
 - a) AGRU
 - (1) Sure Grip Concrete Protective Liner.
 - b) Or Equal.
 - c. Polyvinyl Chloride (PVC) Panels.
 - 1) Resin: Minimum 99 percent PVC by weight.
 - 2) Do not use copolymer resins or recycled materials.
 - 3) Minimum thickness: 1.65 mm, with integrally extruded anchoring extensions on maximum 2 inch center and minimum 1/4 inch deep.
 - 4) Joints between panels sealed using thermal welding.
 - 5) Minimum Tensile Strength (ASTM C307): 2,200 psi
 - 6) Maximum Elongation at Break (ASTM D638): 200 percent of original.
 - 7) Mastic primer and two-part mastic to bond panels to manhole walls.
 - 8) Approved Manufacturers.
 - a) Ameron
 - (1) Arrow-Lock.
 - b) Or Equal.
4. Cast in Place Panel Liners.
- a. Seamless manhole formed in place within existing manhole, extending from channel to frame.
 - 1) Structurally independent of existing manhole structure.
 - 2) Existing wall preparation as recommended by manufacturer.
 - b. Concrete.
 - 1) Type I/II Portland cement concrete.
 - 2) Non-Shrink.
 - 3) Corrosive resistant.
 - 4) Maximum Aggregate Size: 5/8 inch.
 - 5) Fiber reinforcement and plasticizers to produce minimum compressive strength of 4,000 psi at 28 days.
 - c. Formwork.
 - 1) Segmented forms in cylindrical and conical sections.
 - 2) Provide adequate annular space for concrete.
 - 3) Result in minimum finished manhole opening of 20 inches.

- 4) Sealed at bench and pipe openings to form water stop.
- 5) Removable from within newly cast in place manhole.
- d. As specified, provide PVC or polyethylene panels for cast in place wall surface.
 - 1) Minimum thickness: 0.065 inch.
 - 2) Ribbed or studded for embedment into concrete.
 - a) Minimum pull out strength: 100 pounds per linear inch.
 - 3) Fit securely to exterior of concrete forms.
 - 4) Joints between panels sealed using Heat fusion or thermal welding.
- e. Approved Manufacturers.
 - 1) AP/M Permaform.
 - a) Permaform Liner.
 - b) Permaform with Con-Shield (anti-bacterial additive).
 - 2) Or Equal.

H. Precast Concrete Manholes: See Section 02530 and Section 03400.

I. Manhole Frames and Covers: See Section 02530.

PART 3 EXECUTION

3.1 MAINTENANCE OF SERVICE

- A. Maintain service usage throughout duration of project.
 - 1. Maximum time without service: 8 hours for property served by sewer.
 - a. Without service longer than 8 hours will require bypass to sanitary sewer following Section 02530.

3.2 PUBLIC NOTIFICATION PROGRAM

- A. Follow Section 02950.

3.3 PREPARATION

- A. Manhole Preparation: Following approved submittals for rehabilitation products used.
 - 1. Divert flow from channel.
 - 2. Prevent extraneous material from entering sewer lines during cleaning and rehab work.
 - a. Filter solids-laden water through an approved de-silting device. No material shall be allowed to go downstream.
 - 3. Clean interior surface of manhole of debris, dirt, oil, grease, remains of old coating materials, and any other extraneous materials.
 - 4. Pressure wash interior of manholes to remove loose mortar, concrete and debris.
 - 5. Repair irregularities and missing material in manhole forming smooth surface.
 - 6. Stop leakage into manhole.

B. Chemical Grouting for Leakage Control.

1. Provide 48 hour notice to Contract Manager prior to start of work for equipment inspection and testing.
 - a. Allow measurements to be taken.
 - b. Demonstrate acceptable grout volumetric measuring technique.
2. Adjust chemical mixing ratios required for specific application.
 - a. Minimum gel time 30 seconds or as directed by Contract Manager.
3. Do not block pipes entering/exiting manhole with grout.
 - a. Use mirror or camera to confirm pipes are not blocked.
4. Do not damage manhole structure during operations.
 - a. Repair damage as directed by Contract Manager.
5. Protect area of manhole below repair work.
 - a. Do not allow solid material to enter sewage flow.
 - b. Remove protective devices as soon as practical.
6. Manhole Sealing: Follow ASTM F2414 and as specified herein.
 - a. Brick manholes.
 - 1) Drill only the amount of holes necessary to stop leakage following industry standards and chemical grout manufacturer's recommendations.
 - a) Do not use curtain of grout sealing method.
 - 2) Proceed with manhole reconstruction using reconstruction processes specified herein.
 - b. Precast manholes.
 - 1) Seal pipe connections as specified by drilling between pipe and manhole opening and injecting grout.
 - 2) When specified, seal precast manhole base by drilling holes at leakage points along bench to wall, and in channel.
 - 3) At precast joints inject grout through holes drilled at leaking joint.
7. Hydraulic Water Plugs: Following approved submittals.
 - a. Provide mechanical key by undercutting or square cutting opening and removing loose materials.
 - b. Mix, handle, place and cure material.
 - c. Finish surface as required for other rehabilitation work.
8. Oil-Free Oakum Water Plugs: Following approved submittals.
 - a. Saturate oakum with resin.
 - 1) Use additives as required.
 - b. Place, pack and cure material.

3.4 MANHOLE REHABILITATION

A. Locate Existing Manhole.

1. Using available records, drawings, land surveying, GPS, metal detectors or other technology and techniques, locate, excavate and expose existing manhole.

B. Reset/Replace and Adjust manhole frame and cover: Following Section 02530 and Standard Details.

- C. Chemical Grouting: As specified herein, following ASTM F2414 and specified herein.
- D. Manhole Chimney Seals: Following approved submittals.
 - 1. Provide smooth circular surface following manufacturer's requirements.
 - a. Install following Standard Details.
 - b. Realign manhole frame and cover if required following Section 02530, Standard Details, and specified herein.
 - 2. Mix, handle, and apply material.
- E. Cementitious Reconstruction: Following approved submittals and as specified herein.
 - 1. Mix and handle materials.
 - 2. Apply materials using rotary spray equipment or spray gun.
 - 3. Apply beginning at bottom of brickwork and work up to bottom of frame.
 - a. Seal around pipe connections and steps.
 - 4. Do not allow material to enter sewage flow.
 - 5. Apply.
 - a. Maximum applied thickness: 300 mils.
 - b. Minimum applied thickness: 150 mils.
 - c. Confirm with pictures and gauge.
 - 6. Trowel and brush for smooth finish.
 - 7. Cure using curing compound when recommended by manufacturer.
 - a. Do not allow flow in manhole or traffic over manhole, until manufacturer's minimum cure times have been achieved.
- F. MANHOLE LINERS: Following approved submittals.
 - 1. Cured in Place Liners.
 - a. Custom fabricate liner to individual manhole dimensions.
 - b. Line bench and channel area with compatible epoxy or resin material placed in bottom of manhole. Extend minimum 6 inches up manhole wall.
 - c. Remove manhole steps.
 - d. Saturate liner with resin, place in manhole, pressurize with air or water and cure with hot water, steam or hot air.
 - e. Finish liner.
 - f. Finished liner: Forms monolithic structure from manhole frame to bench.
 - 2. Epoxy Liners.
 - a. Mix and apply material.
 - 1) Sagging of material is not permitted.
 - b. Seal around pipe connections and steps.
 - c. Cure.
 - d. Finished liner: Forms monolithic structure from manhole frame to channel.
 - 3. Panel Liners.
 - a. Remove manhole steps.
 - b. Place pipe extensions in manhole at main line and pipes entering manhole as required.
 - c. Insert liner and attach to wall using supports.

- 1) Apply bonding agent compatible with grout or concrete to manhole wall before placing liner.
- 2) Provide adequate annular space between liner sheet and manhole wall to allow placement of concrete or grout.
- 3) Secure liner supports to manhole walls.
- 4) Secure liner to supports.
- 5) Form liner seams.
- 6) Place concrete or grout with no wrinkling of liner.
 - a) Vibrate to prevent voids.
- 7) After curing remove internal forms or supports.
- 8) Finish seams.
- d. Liner Attached to Wall Using Mastic.
 - 1) Apply mastic primer to manhole wall and cure.
 - 2) Apply mastic to primed manhole wall.
 - 3) Apply liner to mastic.
 - a) Embed anchoring extensions in mastic.
 - b) Wrinkling of liner not permitted.
 - 4) Finish liner seams.
 - 5) Finished liner: Forms monolithic structure from manhole frame to channel.
4. Cast in Place Panel Liner.
 - a. Remove manhole steps.
 - b. Erect internal forms.
 - 1) Place PVC or PE liner with forms when specified.
 - 2) Seal forms at bench to prevent concrete leakage.
 - c. Place concrete to prevent segregation of aggregate and cement.
 - d. Consolidate concrete to fill pockets, seams and cracks in existing manhole wall.
 - e. Remove formwork when concrete is cured.
 - f. Finish liner seams.
 - g. Seal concrete liner at frame and pipe penetrations.
 - h. Cured liner: Forms monolithic structure from manhole frame to channel.

G. Trim and seal incoming laterals and pipes.

I. Remove all construction and cleaning debris from site and dispose of properly at certified waste disposal facility.

3.5 REPLACE OR INSTALL MANHOLE

A. Follow Section 02530 and Standard Details.

1. Brick Manhole: Remove and install new precast manhole.
 - a. Replace existing exterior drops with inside drop connections following Section 02530, Standard Details, and specified herein.

3.6 FIELD TESTING

- A. Follow Section 01450 and specified herein.
 - 1. Monitor, record, and report to Contract Manager defects or damage to materials during installation.
 - 2. Collect, label, and store representative product samples.
 - a. Submit product samples specified herein.
 - b. Additional product samples maybe required, as directed by Contract Manager.
 - c. Store and maintain products samples until contract maintenance bond has expired.
 - 3. Verify required testing is performed by approved laboratory.
 - 4. Contract Manager may inspect pre-rehabilitation work, rehabilitation operations, and post-rehabilitation work.
- B. Video Inspections of post-rehabilitation condition of manhole.
 - 1. See Section 02956 for video inspection requirements.
 - 2. Submit to Contract Manager within 10 days following Section 02956.
- C. Visual Inspection: Determine integrity of rehabilitation materials and water-tightness.
 - 1. Verify no inflow or infiltration.
 - 2. Verify services are reinstated and unobstructed.
- D. Defects.
 - 1. When Contract Manager Deems Repairable: Repair defect, replace liner, install new manhole.
 - 2. Document with CCTV recording following Section 02956
- E. Manhole Lining: Test for continuity following ASTM D4787 and approved submittals.
 - 1. Conduct holiday test and gauge depth test on spray-on liners.
 - 2. Perform CCTV inspection of liner following Section 02956.
 - 3. Conduct pull test with embedded bolt or tab.
 - 4. Repair holes and discontinuities following manufacturer's recommendations.
- F. Grout and Concrete: Test for compressive strength following ASTM C109.

3.7 WARRANTY INSPECTIONS

- A. Conduct visual inspection prior to expiration of warranty to determine integrity of rehabilitation materials and water-tightness.
 - 1. Complete post inspection during first high groundwater period (spring or fall) following acceptance of work.
 - 2. Contractor will accompany Contract Manager on inspections.
 - 3. Inspect 25 percent of manholes rehabilitated at locations selected by Contract Manager.
 - a. Infiltration and Inflow: None

- b. Structural Repair: Sound
- c. If more than one manhole fails warranty inspection, inspect all manholes with similar characteristics.
- d. Repair defects in accordance with Warranty.

****WSSC****