SECTION 02320
SEWER MANHOLE REHABILITATION

PART I: GENERAL

1.1 GENERAL REQUIREMENTS
- A. Requirements for repair and rehabilitation of sanitary sewer manholes.

1.2 MEASUREMENT AND PAYMENT
- A. Unit Prices:
  1. Payment for normal depth manholes, up to eight feet (8 Ft) deep, is on a unit price basis for each manhole rehabilitated. Manhole depth is measured from top of cover to sewer invert.
  2. Payment for shallow depth manholes is on a unit price basis for each manhole rehabilitated. Shallow manholes have a depth of five feet (5 Ft) or less measured from top of cover to sewer invert.
  3. Payment for extra depth manholes is on a unit price basis per vertical foot for each foot of depth greater than eight feet (8 Ft). Sewer manhole depth is measured from top of cover to sewer invert.
  4. Payment for removal and replacement of frames and covers shall be on a unit price basis for each frame and cover replaced. Payment includes removal of existing frame and cover, replacing frame and cover, and disposal of old frame and cover following Section 02315 – Frames, grates, rings and covers; and the Standard Details in the Drawings.
  5. Payment for adjustment materials shall be on a unit price basis by the vertical linear foot of adjustment materials provided. Payment includes providing adjustment materials following the Standard Details, including at least one (1) grade ring, from bottom of frame and cover to top of manhole cone.
  6. Refer to Section 01270 – Measurement and Payment for unit price procedures.
- B. Stipulated Price (Lump Sum):
  1. If Contract is Stipulated Price Contract, payment for Work in this Section is included in Total Stipulated Price.

1.3 REFERENCES
- A. ASTM – American Society for Testing and Materials.
  1. ASTM C109 – Standard Test Method for Compressive Strength of Hydraulic Cement Mortars.
  2. ASTM C157 – Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.
  3. ASTM C307 – Standard Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacings.

4. ASTM C580 – Standard Test Method for Flexural Strength and Modulus of Elasticity of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.
5. ASTM C596 – Standard Method for Drying Shrinkage of Mortar Containing Hydraulic Cement.
6. ASTM C882 – Standard Test Method for Bond Strength of Epoxy-Resin Systems Used With Concrete By Slant Shear.
7. ASTM C923 – Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals.
8. ASTM D638 – Standard Test Method for Tensile Properties of Plastics.
9. ASTM D797 – Test Method for Rubber Property-Young's Modulus at Normal and Subnormal Temperatures.
10. ASTM D4787 – 93(1999) Standard Practice for Continuity Verification of Liquid or Sheet Linings Applied to Concrete Substrates.
11. ASTM D4833 – Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
12. ASTM F2414 – 04 Standard Practice for Sealing Sewer Manholes Using Chemical Grouting.

B. CFTS – City of Friendswood Technical Specifications.

C. FS – Federal Specifications.
   1. Federal Standard Stock Catalogue, Section IV, Pat 5 HH-P-117.

1.4 SUBMITTALS

A. Conform to requirements of Section 01330 – Submittal Procedures.
   1. Grout, Cementitious Reconstruction, Patching Materials, Chimney Seals, Manhole Liners.
      a. Material type and manufacturer to be used, including catalog data showing manufacturer’s clarifications and updates, ASTM references, material composition, specifications, physical properties and chemical resistance, manufacturer’s recommended mix, additives and set time.
      b. Manufacturer’s detailed description of recommended procedures for handling and storing material to include use of strip recorder to monitor temperature at storage location.
      c. Manufacturer’s detailed description of processes to execute the use of material including equipment required.
      d. Detailed description of field testing processes and procedures.
      e. Certification: Backup equipment is available and

deliverable to the Project sites within twenty-four hours (24 Hrs).

f. 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 including MSDS documents.
   11) Received by, and date.
   12) Signature of receiver.

2. Shop drawings and manufacturer's installation requirements for internal rubber sleeve chimney seals.
3. Bypass pumping plan showing:
   a. Intake manhole.
   b. Service over pumping.
   c. Receiving manhole.
   d. Expected flows.
   e. Pump size.
   f. Pipe layout.
   g. Backup equipment.
   h. Procedures to monitor upstream lines for backup impacts.
   i. Procedures for setup and breakdown of pumping operations.
4. Emergency plan detailing procedures to be followed in event of pump failures, sewer overflows, service backups, and sewage spillage. Maintain a copy of emergency plan on site for duration of the Project.

B. Submit following in accordance with Section 01450 – Contractor's Quality Control.
1. Certified statement from manufacturer that the Contractor is an approved installer of the material or system, with manufacturer's certificates of training for each crew member involved in each process.
   a. Documentation for products and installers must be approved by the Project Manager before installation of material.
2. For each manhole rehabilitated, complete and accurate record of the work completed.
   a. Show identifying number and location, quantities of

rehabilitation material used, estimate of infiltration/inflow eliminated, and results of post-rehabilitation inspection.

3. Field test reports.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Protect, store, and handle during transportation and delivery, while stored on-site, and during installation following approved submittals.
   1. Maintain temperature less than one hundred twenty degrees Fahrenheit (120° F) while in storage.
B. Material found to be defective or damaged due to manufacture or shipment:
   1. Repair following manufacturer's recommendations if the Project Manager deems item to be repairable.
   2. Material not deemed repairable: Reject, remove from The Project site, and replace at the Project Manager's direction.

1.5 QUALITY ASSURANCE

A. Follow national standards and as specified herein.
B. The Contractor's personnel involved in installation of materials: Certified by manufacturer that they have successfully completed training in handling, applying and finishing materials used.
C. The Contractor: Inspect pre-rehabilitation work, rehabilitation operations, and post-rehabilitation work.
D. For a product to be considered commercially proven, a minimum of one thousand vertical linear feet (1000 Vlf) of manhole rehabilitation must have been completed over a period of at least three years (3 Yrs) with the material proposed by the Contractor or by other contractors. Submit description of each project including material used, vertical linear feet of manhole rehabilitated and owner's contact information.

PART II: PRODUCTS

2.1 MATERIALS

A. Acrylic or Acrylate Base Grout.
   1. Two (2) part chemical grout mixed at point of injection.
   2. Minimum twenty-five percent (25%) acrylic or acrylate base material by volume.
      a. Use higher concentration of base material, at the Project Manager's direction, to increase strength or offset dilution during injection period.
   3. Controllable Reaction Time: Ten seconds (10 Sec) to one hour (1 Hr).
   4. Viscosity: One and one-half centipoise (1.5 cP) water.
      a. May increase viscosity to no more than two and one-half centipoise (2.5 cP) water, at the Project Manager's direction.

b. Remain constant throughout injection period.

5. Tolerates dilution and reacts in moving water.
6. Final Reaction:
   a. Produces continuous irreversible, impermeable, non-porous still gel in pure form.
   b. Produces stabilized soil in ground that shall not become brittle or rigid.
7. Gel does not bleed water under stress.
8. Dehydrated gel returns to ninety percent (90%) of its original volume and form after a prolonged period of low ground water.
9. Do not use catalyst containing dimethyl amino propionitrile (DMAPM).
10. Use root inhibitor [fifty percent (50%) active dichlobenil] when roots are present in manholes.
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, AV 118 Duriflex.
       2) De Neef, Inc., AC400.
       3) Or Equal.
    b. Root Inhibitor.
       1) Avanti, Norosac AC 50W.
       2) Or Equal.
    c. Latex Additive.
       1) Avanti, AV-257 Icoset
       2) Or Equal.

B. Urethane Base Grout.
1. Ratio: One (1) part urethane prepolymer to one (1) to ten (10) parts water by volume [ten percent (10%) to fifty percent (50%) prepolymer].
2. Liquid Prepolymer:
   a. Solids Content: Seventy-seven percent (77%) to eighty-three percent (83%).
   b. Specific Gravity: 1.04.
   c. Flash Point: Twenty degrees Celsius (20° C).
   d. Viscosity: Two hundred centipoise (200 cP) to one thousand two hundred centipoise (1200 cP) at seventy degrees Fahrenheit (70° F).
3. Water for reacting prepolymer: pH of five (5) to nine (9).
4. Use gel control agent to control cure time as required.
5. Final Reaction:
   a. Produces chemically stable, non-biodegradable, flexible gel, impermeable to water at pressures up to fifteen pounds per square inch (15 psi).

6. Use root inhibitor [fifty percent (50%) active dichlobenil] when roots are present in manholes.
7. Use Latex additive for increased tensile strength.
8. Tinted to allow detection of grout in drill holes or at leakage locations.
9. Approved Manufacturers:
    a. Grout.
        1) 3M Corporation, Scotch-Seal 5610.
        2) De Neef, Inc., Hydroactive Multigel NF.
        3) Avanti International, AV 350.
        4) Or Equal.
    b. Root Inhibitor.
        1) Avanti, Norosac AC 50W.
        2) Or Equal.
    c. Latex Additive.
        1) Avanti, AV-257 Icoset.
        2) Or Equal.

C. Cementitious Reconstruction for Manhole Restoration.
1. Quick-setting, high-strength, corrosion-resistant cementitious material.
2. Suitable for rotary spray application to inside of manhole.
3. Use additives to increase corrosion resistance or bond strength at manufacturer's direction and with the Project Manager's approval.
4. Initial set time per manufacturer's recommendation and per the Project conditions.
5. Density when applied: One hundred thirty-five pounds per cubic foot (135 Lb/Cf) plus or minus five pounds per cubic foot (±5 Lb/Cf).
6. Compressive Strength (ASTM C109) at one day (1 D).
    a. Per manufacturer's recommendation.
    b. Minimum acceptable for "or equal" products: Two thousand eight hundred pounds per square inch (2800 psi).
7. Compressive Strength (ASTM C109) at twenty-eight days (28 D).
    a. Per manufacturer's recommendation.
    b. Minimum acceptable "or equal" products: Five thousand eight hundred pounds per square inch (5800 psi).
8. Bond Strength (ASTM C882) at twenty-eight days (28 D).
    a. Per manufacturer's recommendation.
    b. Minimum acceptable "or equal" products: One thousand six hundred forty pounds per square inch (1640 psi).
9. Flexural Strength (ASTM C78) at twenty-four days (28 D).
    a. Per manufacturer's recommendation.
    b. Minimum acceptable "or equal" products: One thousand

five hundred (1500 psi).

10. Shrinkage (ASTM C596) at twenty-four days (28 D): zero percent (0%).
11. Approved Manufacturers:
    a. IPA Systems, Inc., Octocrete.
    b. The Strong Company, Inc., Strong-Seal.
    c. AP/M Permaform, Permacast MS-10,000 or CR-9,000.
    d. Sauereisen, F-120 Underlayment.
    e. QuadEx Aluminaliner.
    f. Or Equal.

D. Hydraulic Water Plugs:
1. Rapid-setting hydraulic water plug to plug active leaks prior to other rehabilitation work.
2. Initial Set Time at seventy degrees Fahrenheit (70° F): Sixty seconds (60 Sec) to ninety seconds (90 Sec).
3. Final Set Time at seventy degrees Fahrenheit (70° F): One hour (1 Hr).
4. Compressive Strength (ASTM C109) at twenty-eight days (28 D).
    a. Per manufacturer's recommendation.
    b. Minimum acceptable "or equal" products: Four thousand pounds per square inch (4000 psi).
5. Length Change (ASTM C157): Zero percent (0%).
6. Approved Manufacturers:
    a. Sauereisen, Instaplug F-180.
    b. IPA Systems, Inc., Octoplug Plus.
    c. The Strong Company, Inc., Strong-Seal Strong-Plug.
    d. AP/M Permaform, Permacast-Plug.
    e. Or Equal.

E. Oil-free Oakum Water Plugs.
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 (2) part urethane resin.
4. Initial Set Time: Five minutes (5 Min) to ten minutes (10 Min).
    a. Use accelerator to decrease initial set time.
5. Approved Manufacturers:
    a. Avanti International, Oil-free Oakum (AV-219) and Multigrout (AV-202).
    b. DeNeef, Inc., Oil-free Oakum and Hydro Active Sealfoam or Hydro Active Flex LV grout.
    c. Or Equal.

F. Manhole Chimney Seals.
1. Elastomeric hand-applied lining or flexible internal rubber sleeve and appurtenances.
2. Elastomeric liner.

a. Two (2) part urethane-based elastomer.
b. Initial Set Time at seventy degrees Fahrenheit (70° F): One hour (1 Hr).
c. Minimum Thickness: One hundred twenty-five (125) mils.
d. Tensile Strength (ASTM D638): Fifty-four pounds per square inch (54 psi).

3. Internal Rubber Sleeve.
a. Extruded or molded from high grade rubber compound following ASTM C923.
b. Minimum Tensile Strength (ASTM D412): One thousand five hundred pounds per square inch (1500 psi).
c. Maximum Compression set: Eighteen percent (18%).
d. Hardness (durometer): Forty-five (48) plus or minus five (±5).
e. Minimum Thickness: Three-sixteenths inch (3/16 In).
f. Sealing fins for watertight seal against manhole chimney.
g. Top and Bottom Expansion Bands: Sixteen (16) gauge Type 304 stainless steel, minimum width of one and three-quarters inches (1-3/4 In).

4. Approved Manufacturers:
a. Internal Rubber Sleeve.
1) Cretex Specialty Products, Manhole Chimney Sleeve.
2) NPC, FlexRib Manhole Frame-Chimney Seal.
3) Or Equal.
b. Elastomeric Liner.
1) Sauereisen, Manhole Chimney Seal F-88.
2) Or Equal.

G. Manhole Liners:
1. Cured in Place Liners.
a. Multiple structural layers of fiberglass with non-porous membrane layer between fiberglass, or Polyvinyl Chloride/Polyester (PVCP) liner with a fiberglass layer, bonded to manhole under pressure and heat.
b. Liner fabricated to match manhole dimensions for custom fit.
c. Epoxy resin.
1) Polyamide Bisphenol “A” Epichlorodhydrin for use with fiberglass liner.
2) Modified epoxy resin for use with PVCP liner.
d. Approved Manufacturers:
1) Terre-Hill, Multi-Plexx Liner System.
2) Poly-Triplex Technologies, Poly Triplex Liner

System.
3) Or Equal.

2. Spray on Epoxy Liners.
   a. Two (2) or three (3) part epoxy to protect concrete and steel from chemical attack.
   b. Minimum Thickness:
      1) Spray on Epoxy: Sixty (60) mils.
      2) Rotary Spray on Epoxy: One hundred twenty-five (125) mils.
   c. Tensile Strength (ASTM C307): Minimum two thousand five hundred pounds per square inch (2500 psi).
   d. Flexural Strength (ASTM C580): Minimum four thousand six hundred pounds per square inch (4600 psi).
   e. Working Time at seventy degrees Fahrenheit (70° F): Thirty minutes (30 Min).
   f. Initial Set Time at seventy degrees Fahrenheit (70° F): Seventeen hours (17 Hrs).
   g. Approved Manufacturers:
      1) Sauereisen, Sewer Gard No. 210, No. 210S or No. 210RS.
      2) Raven, Raven 400S.
      3) Terre Hill, Hydropoxxy.
      4) AP/M Permaform, Cor+Gard.
      5) SprayRoq, Inc., SprayWall.
      6) Or Equal.
3. Concrete Protective Liners:
   a. High density polyethylene (HDPE) concrete protective liner.
      1) Integrally Extruded with anchoring studs, minimum thirty-nine (39) studs per square foot.
      2) Minimum Thickness of liner sheet with anchoring studs: Two millimeters (2 mm).
      3) Minimum Thickness of flat liner sheet at joint overlaps: Three millimeters (3 mm).
      4) Joints sealed using thermal welding.
      5) Density (ASTM D792): Nine hundred forty-five thousandths gram per cubic meter (0.945 gm/cm$^{3)}$.
      6) Elongation at Break (ASTM D638): Greater than four hundred percent (400%).
      7) Minimum Abrasion Resistance (ASTM D4833): One hundred sixty pounds (160 Lbs).
      8) Steel profiles for mounting liner.
         a) Maintain minimum two and one-half inch (2-1/2 In) annular space when filling with flowable concrete.

b) Maintain minimum one inch (1 In) annular space when filling with grout.
c) Anchor Bolts: Minimum penetration of concrete on manhole wall: One and one-half inches (1-1/2 In).
d) Countersink screws to mount liner to profiles.

9) Cement in annular space.
a) Minimum Compressive Strength: Four thousand pounds per square inch (4000 psi) at twenty-eight days (28 D).
b) Minimum Aggregate size: Eight millimeter (8 mm).
c) Maximum Aggregate size: Thirty-two millimeter (32 mm).

10) Grout in annular space.
a) Minimum Compressive Strength: Six thousand pounds per square inch (4000 psi) at twenty-eight days (28 D).
b) Low-viscosity, high-flowability to fill annular space without voids.
c) Bonds to manhole wall.

11) Approved Manufacturers:
a) AGRU, Sure Grip Concrete Protective Liner.
b) Or Equal.

b. Polyvinyl Chloride (PVC) Sheet Liner.
1) Resin: Minimum ninety-nine percent (99%) PVC by weight.
2) Do not use copolymer resins or recycled materials.
3) Minimum Thickness: One and sixty-five hundredths millimeter (1.65 mm), with integrally extruded anchoring extensions on maximum two inch (2 In) center and minimum one-quarter inch (1/4 In) deep.
4) Joints sealed using thermal welding.
5) Tensile Strength (ASTM C307): Minimum two thousand two hundred pounds per square inch (2200 psi).
6) Elongation at Break (ASTM D638): Two hundred percent (200%) minimum.
7) Mastic primer and two (2) part mastic to seal liner to manhole walls.
8) Approved Manufacturers:
a) Ameron, Arrow-Lock.
b) Or equal.

4. Cast-in-Place Concrete Liner:
a. Formed-in place seamless concrete manhole within the

existing manhole, extending from bench to frame. Liner shall be structurally independent of existing manhole structure.

b. Concrete.
   1) Type I/II Portland cement concrete.
   2) Maximum Aggregate Size: Five-eighths inch (5/8 In).
   3) Fiber reinforcement and plasticizers to produce minimum compressive strength of Four thousand pounds per square inch (4000 psi) at twenty-eight days (28 D).

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 twenty inches (20 In).
   4) Sealed at bench and pipe openings to form water stop.
   5) Removable from within new cast concrete manhole wall.

d. When specified, provide PVC or polyethylene liner on new interior manhole wall surface.
   1) Minimum Thickness: Sixty-five thousandths inch (0.065 In).
   2) Ribbed or studded for embedment into concrete minimum pull out strength of one hundred pounds per linear inch (100 Lbs/Li).
   3) Fit securely to exterior of concrete forms.
   4) Heat fuse or extrusion weld seams.

e. Approved Manufacturers:
   1) AP/M Permaform, Permaform Liner.
   2) Or Equal.

H. Precast Concrete Manholes: See Section 02305 – Precast Concrete Manholes and Section 02315 – Frames, Grates, Rings and Covers.

I. Manhole Frames and Covers: See Section 02315 – Frames, Grates, Rings and Covers.

PART III: EXECUTION

3.1 PUBLIC NOTIFICATION

A. Maintain service usage throughout duration of the Project.
   1. Maximum amount of time of no service: Eight hours (8 Hrs) for any property served by a sanitary sewer. Any service out longer than eight hours (8 Hrs) shall be bypassed to a sanitary sewer.

2. Public Notification Program:
    a. Deliver written notices to each home or business forty-eight hours (48 Hrs) before commencement of the work being conducted on section, including a local telephone number of the Contractor for contact regarding inquiries or complaints.
    b. Provide owner or occupant a summary of the work to be completed, and time and duration of service interruption to building.
    c. Contact any home or business that cannot be reconnected within time stated in written notice.
    d. Fax or email copies of all delivered notices to the Project Manager.

3.2 MANHOLE PREPARATION

A. Sewer Bypass Pumping: Follow Section 02555 – Sanitary Sewer Bypass Pumping and specified herein.
    1. Pumping failure, sewer overflow, service backup or sewage spillage: See Section 02555 – Sanitary Sewer Bypass Pumping for reporting requirements.
B. Clean interior surfaces of manhole of debris, dirt, oil, grease, remains of old coating materials, and any other extraneous materials following approved submittals for rehabilitation products used.
C. Pressure wash manhole walls to remove loose mortar, concrete, debris following approved submittals for rehabilitation products used.
D. Repair irregularities in manhole following approved submittals for rehabilitation products used.
E. Repair leakage in manhole following approved submittals for rehabilitation products used.
F. Trim and grout incoming laterals and pipes following approved submittals for rehabilitation products used.
G. Remove debris from manhole and sewer.
    1. Handle cleaning water in closed discharge hoses to prevent water and residue from causing damage.
    2. Do not discharge debris through sanitary sewer system.
    3. Filter solids-laden water through an approved desilting device.
    4. Dispose of residue from cleaning and other construction operations in a manner satisfactory to the Project Manager and any other authority having jurisdiction over area where the work site is located.

3.3 GROUTING

A. Provide forty-eight hour (48 Hr) notice to the Project Manager for equipment inspection prior to start of the work.
    1. Allow measurements to be taken.
    2. Demonstrate acceptable grout volumetric measuring technique.

B. Adjust chemical mixing ratios required for specific application.
   1. Minimum gel time thirty seconds (30 Sec), or at the Project Manager's direction.
C. Do not block pipes entering/exiting manhole with grout.
   1. Use camera to confirm pipes are not blocked as required in Section 02520 – Television Inspection of Sanitary Sewer Lines.
D. Do not damage manhole structure during operations.
   1. Repair damage at the Project Manager's direction.
E. Protect area of manhole below repair the work.
   1. Do not allow solid material to enter sewage flow.
   2. Remove protective devices as soon as practicable.
F. Manhole Sealing.
   1. Following ASTM F2414 and specified herein.
      a. Do not use curtain grout sealing around brick manholes.
      b. Drill only the amount of holes necessary to stop leakage.
      c. Seal manhole base when specified. Drill holes and inject grout through manhole base.
G. Cementitious Reconstruction.
   1. Mix and handle following approved submittals.
   2. Apply coating materials using rotary spray equipment or spray gun following approved submittals.
   3. Apply beginning at the top of the manhole and the work down to bench.
      a. Seal around pipe connections and steps.
   4. Do not allow solid material to enter sewage flow.
   5. Apply thickness following approved submittals.
      a. Minimum Total Thickness: One-half inch (1/2 In).
   6. Trowel and brush finish following approved submittals.
   7. Cure following approved submittals.
      a. Use curing compound when recommended by manufacturer.
      b. Do not allow flow in manhole or traffic over manhole, until manufacturer's minimum cure times have been achieved.
H. Hydraulic Water Plugs.
   1. Provide mechanical key by undercutting or square cutting the opening and removing loose materials following approved submittals.
   2. Mix, handle, place and cure following approved submittals.
   3. Finish surface following approved submittals and as required for other rehabilitation work.
I. Oil-free Oakum Water Plugs.
   1. Saturate oakum with resin following approved submittals, using additives as required. Place and cure following approved submittals.
J. Manhole Chimney Seals.

1. Provide smooth circular surface for internal rubber sleeve following manufacturer's requirements, and install following Standard Details. Realign manhole frame and cover if required.
2. Mix, handle, apply and cure elastomeric lining following approved submittals.

K. Manhole Liners.
1. Cured in Place Liners.
   a. Custom fabricate liner to individual manhole dimensions when finished, liner forms a monolithic structure from the manhole frame to the bench.
   b. Line bench area with material placed in the bottom of the manhole and extending a minimum of six inches (6 In) up the manhole wall.
   c. Remove manhole steps.
   d. Saturate liner with resin, place into manhole, pressurize with air or water and cure with hot water, steam or hot air following approved submittals.
   e. Finish liner following approved submittals.
2. Epoxy Liners.
   a. Mix and apply following approved submittals.
   b. Sagging of epoxy coating not permitted.
   c. Seal around pipe connections and steps.
   d. Cure following approved submittals.
3. Concrete Protective Liners.
   a. Remove manhole steps.
   b. Liner attached to wall using supports.
      1) Insert liner sheet into manhole and support following approved submittals.
         a) Apply bonding agent compatible with grout or concrete to manhole wall before placing liner.
         b) Provide adequate annular space between liner sheet and manhole wall to allow placement of concrete or grout.
         c) Secure liner supports to manhole walls.
         d) Secure liner to supports.
         e) Form liner seams following approved submittals.
         f) Place concrete or grout with no wrinkling of liner. Vibrate to prevent voids.
         g) After curing, remove internal forms or supports.
         h) Finish seams following approved submittals.
   c. Liner Attached to Wall Using Mastic.
      1) Apply mastic primer to manhole wall and cure following approved submittals.
      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 following approved submittals.

4. Formed in Place Concrete Liner.
   a. Remove manhole steps.
   b. Place pipe extensions in manhole at main line and pipes entering manhole.
   c. Erect internal forms. Place PVC or PE liner with forms when specified, and seal forms at bench to prevent concrete leakage.
   d. Place concrete to prevent segregation of aggregate and cement.
   e. Consolidate concrete to fill pockets, seams and cracks in existing manhole wall.
   f. Remove formwork when concrete is cured.
   g. Finish liner seams following approved submittals.
   h. Seal concrete liner at frame and at pipe penetrations following approved submittals.

3.4 RESET/REPLACE FRAME AND COVER

A. Following Sections 02310 – Adjusting Manholes, Inlets and Valve Boxes to Grade and 02315 – Frames, Grates, Rings and Covers.

3.5 REPLACE MANHOLE

A. Following Sections 02300 – Cast-In-Place Concrete Manholes and 02305 – Precast Concrete Manholes.

3.6 FIELD TESTING

A. Visual inspection to determine integrity of rehabilitation materials and water-tightness.
   1. Provide flow-through plugs for a duration of six hours (6 Hrs).
   2. No infiltration or inflow permitted.
   3. Repair damage and leakage.
B. Test manhole lining for continuity following ASTM D4787 and approved submittals. Repair holes and discontinuities following manufacturer's recommendations.
C. Test grout and concrete for compressive strength following ASTM C109.

3.7 WARRANTY INSPECTIONS

A. Visual inspection to determine integrity of rehabilitation materials and water-tightness shall be conducted within three months (3 Mos) of the expiration of the guarantee period.
B. Accompany the Project Manager on inspections.

C. Inspect twenty-five percent (25%) of manholes rehabilitated at locations selected by the Project Manager.
   1. No infiltration or inflow permitted.
   2. If any manhole fails warranty inspection, inspect all manholes rehabilitated in the Work with the Project Manager.

END OF SECTION