SECTION 02300
CAST-IN-PLACE CONCRETE MANHOLES

PART I: GENERAL

1.1 GENERAL REQUIREMENTS
- A. Cast-in-place concrete manholes for sanitary sewers and storm sewers, including box sewers.
- B. Pile-supported concrete foundation used for unstable subgrade treatment for manhole base.

1.2 MEASUREMENT AND PAYMENT
- A. Unit Prices:
  1. Payment for manholes is on a unit price basis for each manhole installed.
  2. Payment for Type C manhole with BB inlet top is on a unit price basis for each.
  3. Payment for pile-supported concrete foundation used for unstable subgrade treatment for manhole base is on a unit price basis for each foundation installed.
  4. 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. ASME – American Society of Mechanical Engineers.
  1. ASME B16.1 – Cast Iron Pipe Flanges and Flanged Fittings.
- B. ASTM – American Society for Testing and Materials.
  1. ASTM A307 – Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile.
  2. ASTM C270 – Standard Specification for Mortar for Unit Masonry.
  3. ASTM C923 – Standard Specifications for Resilient Connectors Between Reinforced Concrete Manhole Structures and Pipes.
  4. ASTM C1107 – Standard Specification for Packaged Dry, Hydraulic – Cement Grout (Nonshrink).
  5. ASTM D698 – Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft3).
  6. ASTM D2665 – Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste and Vent Pipe and Fittings.
  7. ASTM D2996 – Standard Specification for Filament-wound Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.
  8. ASTM D2997 – Standard Specification for Centrifugally Cast

Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.

C. AWWA – American Water Works Association.
   1. AWWA C213 – Standard for Fusion Bonded Epoxy Coating for Interior and Exterior of Steel Water Pipelines.

D. CFTS – City of Friendswood Technical Specifications.

1.4 SUBMITTALS

A. Conform to requirements of Section 01330 – Submittal Procedures.

B. Submit proposed design mix and test data for each type and strength of concrete.

C. Submit manufacturer's data and details of following items for approval:
   1. Frames, grates, rings and covers.
   2. Materials to be used in fabricating drop connections.
   3. Materials to be used for pipe connections at manhole walls.
   4. Materials to be used for stubs and stub plugs.
   5. Plugs to be used for sanitary sewer hydrostatic testing.
   6. Installation instructions for forms.

D. Seal submittal drawings by a Professional Engineer licensed by the State of Texas.

PART II: PRODUCTS

2.1 CONCRETE

A. Conform to requirements of Section 03300 – Structural Concrete.

B. Provide Class A concrete with minimum compressive strength of four thousand pounds per square inch (4000 psi) unless otherwise indicated on the Drawings.

2.2 REINFORCING STEEL

A. Conform to requirements of Section 03200 – Reinforcing Steel.

2.3 MORTAR

A. Conform to requirements of Section 03100 – Mortar.

2.4 MISCELLANEOUS METALS

A. Provide cast-iron frames, grates, rings and covers conforming to requirements of Section 02315 – Frames, Grates, Rings and Covers.

2.5 DROP CONNECTIONS AND STUBS

A. Provide drop connections and stubs conforming to same pipe material requirements used in main pipe, unless otherwise indicated on the Drawings.

2.6 PIPE CONNECTIONS

A. Sanitary Sewers.
   1. Provide resilient connectors conforming to requirements of

ASTM C923. Use the following materials for metallic mechanical devices as defined in ASTM C923:

a. External clamps: Type 304 stainless steel.
b. Internal, expandable clamps on standard manholes: Type 304 stainless steel, eleven (11) gauge minimum.
c. Internal, expandable clamps on corrosion-resistant manholes:
   1) Type 316 stainless steel, eleven (11) gauge minimum.
   2) Type 304 stainless steel, eleven (11) gauge minimum, coated with minimum sixteen (16) mil fusion bonded epoxy conforming to AWWA C213.

2. Where rigid joints between pipe and cast-in-place manhole base are specified or shown on the Drawings, provide polyethylene-isoprene waterstop meeting physical property requirements of ASTM C923, such as Pres-Seal WS Series or approved equal.

B. Storm Sewers.
1. Use non-shrink grout for storm sewer pipe connections to concrete manholes, unless otherwise shown on the Drawings. Pipe shall be flush with the inside wall of manhole. Grout pipe penetration in place on both inside and outside of manhole.

2.7 SEALANT MATERIALS
A. Provide sealing materials between precast concrete adjustment ring and manhole cover frame, such as Adeka Ultraseal P201 or approved equal.
B. Provide external sealing material from Canusa Wrapid Seal manhole encapsulation system or approved equal.
C. Butyl Sealant: Provide Press-Seal EZ Stick or equal, for HDPE rings.

2.8 CORROSION-RESISTANT MANHOLE MATERIALS
A. Where corrosion-resistant manholes or PVC-lined manholes are indicated on the Drawings, provide the following:
1. PVC liner for precast cylindrical manhole section, base sections and cone sections.

2.9 BACKFILL MATERIALS
A. Conform to the requirements of Section 02125 – Excavation and Backfill for Utilities.

2.10 NON-SHRINK GROUT
A. Provide prepackaged, inorganic, flowable, non-gas-liberating, non-metallic, cement-based non-shrink grout requiring only addition of water.
B. Provide grout meeting requirements of ASTM C1107 and having minimum twenty-eight day (28 D) compressive strength of seven thousand pounds per square inch (7000 psi).

2.11 VENT PIPES

A. Provide external vent pipes for manholes where indicated on the Drawings.
B. Buried Vent Pipes: Provide three inch (3 In) or four inch (4 In) PVC Drain, Waste and Vent (DWV) pipe conforming to ASTM D2665. Alternatively, provide Fiberglas Reinforced Plastic (FRP) pipe as specified for vent outlet assembly.
C. Vent Outlet Assembly: Provide vent outlet assembly as shown on the Drawings, constructed of following specified materials:
    1. FRP Pipe: Provide filament-wound FRP conforming to ASTM D2996 or centrifugally cast FRP conforming to ASTM D2997. Seal cut ends in accordance with manufacturer's recommendations.
    2. Joints and Fittings: Provide epoxy- bodied fittings and join pipe to fittings with epoxy adhesive, according to pipe manufacturer's instructions.
    3. Flanges: Provide socket-flange fittings for epoxy adhesive bonding to pipe ends where shown on the Drawings. Meet bolt pattern and dimensions for ASME B16.1, one hundred twenty-five pound (125 Lb) flanges. Use Type 304 stainless steel or hot-dip zinc coated, conforming to ASTM A 307, Class A or B flange bolts.
    4. Coating: Provide two (2) component, aliphatic polyurethane coating, using primer or tie coat recommended by manufacturer. Provide two (2) or more coats to yield dry film thickness of at least three (3) mils. Provide Amershield, Tnemec 74 or approved equal. The Project Manager selects color from manufacturer's standard colors.

PART III: EXECUTION

3.1 EXAMINATION

A. Verify lines and grades are correct.
B. Determine if subgrade, when scarified and recompacted, can be compacted to ninety-five percent (95%) of maximum Standard Proctor Density according to ASTM D698 prior to placement of foundation material and base section. When proper density cannot be reached, condition subgrade until that density is reached or treat as an unstable subgrade.
C. Do not build manholes in ditches, swales or drainage paths unless approved by the Project Manager.

3.2 MANHOLES

A. Construct manholes to dimensions shown on the Drawings. Commence construction as soon as possible after pipes are laid. On monolithic sewers, construct manholes at same time sewer is being constructed.

B. Unstable Subgrade Treatment: When unstable subgrade is encountered, notify the Project Manager for examination of subgrade to determine if subgrade has heaved upwards after being excavated. When heaving has not occurred, over-excavate subgrade to allow for twenty-four inch (24 In) thick layer of crushed stone wrapped in filter fabric as foundation material under manhole base. When there is evidence of heaving, provide pile-supported concrete foundation under manhole base, as detailed on the Drawings.

C. Cast manhole foundations and walls monolithically. Use cold joint with approved waterstop when manhole flow line depth exceeds twelve feet (12 Ft). No other joints shall be allowed unless shown on the Drawings. Wrap cold joints with external sealing material, minimum six inch (6 In) width.

D. For concrete containing micro silica admixtures, place, finish and cure concrete for manholes following procedures in Section 03300 –Structural Concrete.

E. Top of manhole elevations shown on the Drawings are approximate, based on current pavement and natural ground conditions as determined from elevations measured on fifty foot (50 Ft) spacing. No additional payment shall be made if final elevation of manhole ring and cover is higher or lower due to requirements of finished grade or replaced pavement surface.

3.3 PIPE CONNECTIONS

A. Install approved resilient connectors at each pipe entering and exiting sanitary sewer manholes in accordance with manufacturer's instructions.

B. Grout storm sewer connections to manhole unless otherwise shown on the Drawings. Grout pipe penetrations both inside and outside of manhole. Pipes shall be flush with interior of the manhole.

C. Ensure no concrete, cement-stabilized sand, fill or other solid material is allowed to enter space between pipe and edge of wall opening at and around resilient connector on interior or exterior of manhole. When necessary, fill space with compressible material to ensure resilient connector shall maintain full flexibility where evidence of reduced flexibility is encountered.

D. Where new manhole is to be constructed on existing sewer, a rigid joint pipe may be used. Install waterstop gasket around existing pipe at center of cast-in-place wall. Join ends of split waterstop material at pipe spring line using adhesive recommended and supplied by waterstop manufacturer.

1. Field verify the elevations of all manholes to be constructed on existing sewer before the start of any related work.
2. Failure to field verify existing conditions before start of work shall be the responsibility of the Contractor should the elevations not match and the work shall be completed with no additional cost to the City.

E. Do not construct joints on sanitary sewer pipe within wall sections of manholes. Use approved connection material.
F. Construct pipe stubs with resilient connectors for future connections at locations and with material indicated on the Drawings. Install approved stub plugs at interior of manhole.
G. Test connection for watertight seal before backfilling.

3.4 INVERTS FOR SANITARY SEWERS

A. Construct invert channels to provide smooth flow transition waterway with no disruption of flow at pipe-manhole connections. Conform to following criteria:
   1. Slope of invert bench: one inch per foot (1 In/Ft) minimum; one and one-half inch per foot (1-1/2 In/Ft) maximum.
   2. Depth of bench to invert:
      a. Pipes smaller than fifteen inches (15 In): one-half (1/2) of largest pipe diameter.
      b. Pipes fifteen inches (15 In) to twenty-four inches (24 In): three-quarters (3/4) of largest pipe diameter.
      c. Pipes larger than twenty-four inches (24 In): equal to largest pipe diameter.
   3. Invert slope through manhole: one-tenth foot (0.1 Ft) drop across manhole with smooth transition of invert through manhole, unless otherwise indicated on the Drawings.
B. Form invert channels with Class A concrete if not integral with manhole base. For direction changes of mains, construct channels tangent to mains with maximum possible radius of curvature. Provide curves for side inlets and smooth invert fillets for flow transition between pipe inverts.

3.5 DROP CONNECTIONS FOR SANITARY SEWERS

A. Backfill drop assembly with crushed stone wrapped in filter fabric, cement-stabilized sand or Class A concrete to form solid mass. Extend cement-stabilized sand or concrete encasement minimum of four inches (4 In) outside bells.
B. Install connection when sewer line enters manhole higher than twenty-four inches (24 In) above invert of manhole.

3.6 STUBS FOR FUTURE CONNECTIONS

A. In manholes where future connections are indicated on the Drawings, install resilient connectors and pipe stubs with approved watertight plugs.

3.7 ADJUSTMENT RINGS AND FRAME

A. Combine precast concrete or HDPE adjustment rings so elevation of installed casting cover matches pavement surface. Seal between concrete adjustment ring and precast top section with non-shrink grout; do not use mortar between adjustment rings. Apply latex-based bonding

agent to precast concrete surfaces to be joined with non-shrink grout. Set cast iron frame on adjustment ring in a bed of approved sealant material. Install a sealant bed consisting of two (2) beads of sealant, each bead having minimum dimensions of one-half inch (1/2 In) and one-half inch (1/2 In) wide.

B. Wrap manhole frame and adjustment rings with external sealing material, minimum three inches (3 In) beyond joint between ring and frame and ring and precast section.

C. For manholes in unpaved areas, set top of frame a minimum of six inches (6 In) above existing ground line unless otherwise indicated on the Drawings. Encase manhole frame in mortar or non-shrink grout placed flush with face of manhole ring and top edge of frame. Provide rounded corner around perimeter.

D. For Manholes in paved areas, set manhole cover is flush with surrounding pavement. Form a six foot by six foot (6 Ft x 6 Ft) area, full depth to subgrade and parallel to the roadway centerline, centered on the manhole. Install expansion joint material on the perimeter of the form. Install reinforcing bar and concrete typical of road paving. Ensure that manhole is flush with surrounding pavement before applying final finish and curing compound.

3.8 BACKFILL

A. After concrete obtains adequate strength, place and compact backfill materials in area of excavation surrounding manholes in accordance with requirements of Section 02125 – Excavation and Backfill for Utilities. Use embedment zone backfill material for adjacent utilities, as shown in City of Friendswood Standard Details over each pipe connected to manhole. Provide trench zone backfill, as specified for adjacent utilities, above embedment zone backfill.

B. Where rigid joints are used for connecting existing sewers to manhole, backfill under existing sewer up to spring line of pipe with Class A concrete or flowable fill.

C. In unpaved areas, provide positive drainage away from manhole frame to natural grade. Provide minimum of four inches (4 In) of topsoil conforming to requirements of Section 02905 – Topsoil. Seed in accordance with Section 02910 – Hydromulch Seeding or sod disturbed areas in accordance with Section 02915 – Sodding.

3.9 FIELD QUALITY CONTROL

A. Conduct leakage testing of Sanitary Sewer manholes in accordance with requirements of Section 02525 – Acceptance Testing of Gravity Sanitary Sewer Lines.

3.10 PROTECTION

A. Protect manholes from damage until subsequent Work has been accepted. Repair or replace damaged elements of manholes at no

additional cost to City.

B. Damaged manholes that have been repaired or replaced shall be retested at no additional cost to the City.

END OF SECTION

SECTION 02305
PRECAST CONCRETE MANHOLES

PART I: GENERAL

1.1 GENERAL REQUIREMENTS

A. Precast concrete manholes for sanitary sewers and storm sewers.

B. Precast concrete sanitary sewer manholes with PVC liner where corrosion resistant manholes are specifically indicated in the Drawings.

C. Pile-supported concrete foundation used for unstable subgrade treatment for manhole base.

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 installed. Manhole depth is measured from top of cover to sewer invert. Air release manhole depth is measured from top of cover to inside base for air release or vacuum release manholes.
2. Payment for shallow depth manholes is on a unit price basis for each manhole installed. 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. Air release manhole depth is measured from top of cover to inside base for air release or vacuum release manholes.
4. Payment for normal depth corrosion resistant manholes is on a unit price basis for each manhole installed.
5. Payment for standard manhole drops is on a unit price basis for each drop installed. Standard manhole drops include both internal and external drops.
6. Payment for watertight manholes, including external vent pipe is on a unit price basis for each.
7. Payment for air-release manhole with valves and fittings installed is on a unit price basis for each manhole with air-release valves and fittings installed.
8. Payment for pile-supported concrete foundation used for unstable subgrade treatment for manhole base is on a unit price basis for each foundation installed.
9. Payment for sanitary sewer manholes shall be authorized when manhole has been tested as specified in Section 02525 – Acceptance Testing of Gravity Sanitary Sewer Lines.
10. 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. AASHTO – American Association of State Highway and Transportation Officials.
B. ASME – American Society of Mechanical Engineers.
   1. ASME B16.1 – Cast Iron Pipe Flanges and Flanged Fittings.
C. ASTM – American Society for Testing and Materials.
   1. ASTM A307 – Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile.
   2. ASTM A615 – Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
   3. ASTM C270 – Standard Specification for Mortar for Unit Masonry.
   4. ASTM C443 – Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
   5. ASTM C478 – Standard Specification for Precast Reinforced Concrete Manhole Sections.
   6. ASTM C923 – Standard Specifications for Resilient Connectors Between Reinforced Concrete Manhole Structures and Pipes.
   7. ASTM C1107 – Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
   8. ASTM D698 – Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft3).
   9. ASTM D2665 – Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste and Vent Pipe and Fittings.
   10. ASTM D2996 – Standard Specification for Filament-Wound “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.
   11. ASTM D2997 – Standard Specification for Centrifugally Cast “Fiberglass” (Glass-Fiber-Reinforced Thermosetting Resin) Pipe.
D. AWWA – American Water Works Association.
   1. AWWA C213 – Standard for Fusion Bonded Epoxy Coating for Interior and Exterior of Steel Water Pipelines.
E. CFTS – City of Friendswood Technical Specifications.

1.4 SUBMITTALS
A. Conform to requirements of Section 01330 – Submittal Procedures.
B. Submit manufacturer's data and details of following items for approval:
   1. Shop drawings of manhole sections, base units and construction details, including reinforcement, jointing methods, materials and dimensions.

2. Summary of criteria used in manhole design including as a minimum; material properties, loadings, load combinations and dimensions assumed. Include certification from manufacturer that precast manhole design is in full accordance with ASTM C478 and design criteria as established in Paragraph 2.1.E of this Specification.
3. Frames, grates, rings and covers.
4. Materials to be used in fabricating drop connections.
5. Materials to be used for pipe connections at manhole walls.
6. Materials to be used for stubs and stub plugs, if required.
7. Materials and procedures for corrosion-resistant liner and coatings, if required.
8. Plugs to be used for sanitary sewer hydrostatic testing.
9. Manufacturer's data for pre-mix (bag) concrete, if used for channel inverts and benches.

C. Seal submittal drawings by a Professional Engineer licensed by the State of Texas.

PART II: PRODUCTS

2.1 PRECAST CONCRETE MANHOLES

A. Provide manhole sections, base sections and related components conforming to ASTM C478. Provide base riser section with integral floors, unless shown otherwise. Provide adjustment rings which are standard components of manufacturer of manhole sections. Mark date of manufacture and name or trademark of manufacturer on inside of barrel.

B. Construct barrels for precast manholes from standard reinforced concrete manhole sections of diameter indicated on the Drawings. Use various lengths of manhole sections in combination to provide correct height with fewest joints. Design wall sections for depth and loading conditions in Paragraph 2.1.E, with minimum thickness of five inches (5 In). Base section shall have minimum thickness of twelve inches (12 In) under invert.

C. Provide tops to support HS-20 vehicle loading and receive cast iron frame covers, as indicated on the Drawings.

D. Where manholes larger than forty-eight inch (48 In) diameter are indicated on the Drawings, provide precast base sections with flat slab top precast sections used to transition to forty-eight inch (48 In) diameter manhole access riser sections. Transition can be concentric or eccentric unless otherwise shown on the Drawings. Locate transition to provide minimum of seven foot (7 Ft) head clearance from base to underside of transition unless otherwise approved by the Project Manager.

E. Design Loading Criteria: Manhole walls, transition slabs, cone tops and manhole base slab shall be designed, by manufacturer, to requirements

of ASTM C478 for depth as shown on the Drawings and to resist following loads.

1. AASHTO HS-20 vehicle loading applied to manhole cover and transmitted down to transition and base slabs.
2. Unit soil weight of one hundred twenty pounds per cubic foot (120 pcf) located above portions of manhole, including base slab projections.
3. Lateral soil pressure based on saturated soil conditions producing an at-rest equivalent fluid pressure of one hundred pounds per cubic foot (100 pcf).
4. Internal liquid pressure based on unit weight of sixty-three pounds per cubic foot (63 pcf).
5. Dead load of manhole sections fully supported by transition and base slabs.

F. Design: Manhole walls, transition slabs, cone tops and manhole base slab shall be designed according to requirements of ASTM C478 and following:
   1. Design additional reinforcing steel to transfer stresses at openings. Area of steel to be no less than shown on the Drawings.
   2. Wall loading conditions:
      a. Saturated soil pressure acting on empty manhole.
      b. Manhole filled with liquid to a halfway depth as measured from invert to cover, with no balancing external soil pressure.
   3. Minimum clear distance between two (2) wall penetrations shall be twelve inches (12 In) or half diameter of smaller penetration, whichever is greater.

G. Provide joints between sections with O-ring gaskets conforming to ASTM C443.

H. When base is cast monolithic with portion of vertical section, extend reinforcing in vertical section into base.

I. Precast Concrete Base: Suitable cutouts or holes to receive pipe and connections.

2.2 CONCRETE

A. Conform to requirements of Section 03300 – Structural Concrete.

B. Channel Inverts: Use five (5) sack premix (bag) concrete or Class A concrete for inverts not integrally formed with manhole base, with minimum compressive strength of four thousand pounds per square inch (4000 psi).

C. Cement-Stabilized Sand Foundation: Provide cement-stabilized sand foundation under base section in lieu of foundation slab, as shown on the Drawings, conforming to requirements of Section 02145 – Cement-Stabilized Sand.

D. Concrete Foundation: Provide Class A concrete with minimum compressive strength of four thousand pounds per square inch (4000 psi) for concrete foundation slab under manhole base section where indicated on the Drawings.

2.3 REINFORCING STEEL

A. Conform to requirements of Section 03200 – Reinforcing Steel.

2.4 MORTAR

A. Conform to requirements of Section 03100 – Mortar.

2.5 MISCELLANEOUS METALS

A. Provide cast-iron frames, rings and covers conforming to requirements of Section 02315 – Frames, Grates, Rings and Covers.

2.6 DROP CONNECTIONS AND STUBS

A. Provide drop connections and stubs conforming to same pipe material requirements used in main pipe, unless otherwise indicated on the Drawings.

2.7 PIPE CONNECTIONS TO MANHOLE

A. Sanitary Sewers.
   1. Provide resilient connectors conforming to requirements of ASTM C923. Use the following materials for metallic mechanical devices as defined in ASTM C923:
      a. External clamps: Type 304 stainless steel.
      b. Internal, expandable clamps on standard manholes: Type 304 stainless steel, eleven (11) gauge minimum.
      c. Internal, expandable clamps on corrosion-resistant manholes:
         1) Type 316 stainless steel, eleven (11) gauge minimum.
         2) Type 304 stainless steel, eleven (11) gauge minimum, coated with minimum sixteen (16) mil fusion-bonded epoxy conforming to AWWA C213.
   2. Where rigid joints between pipe and cast-in-place manhole base are specified or shown on the Drawings, provide polyethylene-isoprene water-stop meeting physical property requirements of ASTM C923, such as Press-Seal WS Series or approved equal.

B. Storm Sewer Connections:
   1. Provide watertight connections in accordance with ASTM C923.

2.8 SEALANT MATERIALS

A. Approved products in accordance with Section 01630 – Product Substitution.

B. Provide sealing materials between precast concrete adjustment ring and manhole cover frame, Adeka Ultraseal P201 or approved equal.
C. Provide approved external sealing material from Canusa Wrapid Seal manhole encapsulation system or approved equal.
D. Provide Butyl Sealant: Provide Press-Seal EZ Stick or equal, for HDPE rings.

2.9 CORROSION RESISTANT MANHOLE MATERIALS
A. Where corrosion-resistant manholes or PVC-lined manholes are indicated on the Drawings, provide one of following:
1. PVC liner for precast cylindrical manhole section, base sections and cone sections.

2.10 BACKFILL MATERIALS
A. Conform to requirements of Section 02125 – Excavation and Backfill for Utilities.

2.11 NON-SHRINK GROUT
A. Provide prepackaged, inorganic, flowable, non-gas-liberating, non-metallic, cement-based grout requiring only addition of water.
B. Meet requirements of ASTM C1107 and have minimum twenty-eight day (28 D) compressive strength of seven thousand pounds per square inch (7000 psi).

2.12 VENT PIPES
A. Provide external vent pipes for manholes where indicated on the Drawings.
B. Buried Vent Pipes: Provide three inch (3 In) or four inch (4 In) PVC Drain, waste and Vent (DWV) pipe conforming to ASTM D2665. Alternatively, provide Fiberglass Reinforced Plastic (FRP) pipe as specified for vent outlet assembly.
C. Vent Outlet Assembly: Provide vent outlet assembly as shown on the Drawings, constructed of following specified materials:
1. FRP Pipe: Provide filament wound FRP conforming to ASTM D2996 or centrifugally cast FRP conforming to ASTM D2997. Seal cut ends in accordance with manufacturer's recommendations.
2. Joints and Fittings: Provide epoxy bodied fittings and join pipe to fittings with epoxy adhesive.
3. Flanges: Provide socket-flange fittings for epoxy adhesive bonding to pipe ends where shown on the Drawings. Meet bolt pattern and dimensions for ASME B16.l, one hundred twenty-five pound (125 Lb) flanges. Flange bolts shall be Type 304 stainless steel or hot-dip zinc coated, conforming to ASTM A307, Class A or B.

4. Coating: Provide approved two (2) component, aliphatic polyurethane coating using primer or tie coat recommended by manufacturer. Provide two (2) or more coats to yield dry film thickness of at least three (3) mils. Color shall be selected by the Project Manager from manufacturer's standard colors.

2.13 PROHIBITED MATERIALS

A. Do not use brick masonry for construction of sanitary sewer manholes or storm sewer manholes, including adjustment of manholes to grade. Use only specified materials listed above.

PART III: E X E C U T I O N

3.1 EXAMINATION

A. Verify that lines and grades are correct.

B. Determine if subgrade, when scarified and recompacted, can be compacted to ninety-five percent (95%) of maximum Standard Proctor Density according to ASTM D698 prior to placement of foundation material and base section. When proper density is not reached, moisture condition subgrade until that density is reached or treat as unstable subgrade.

C. Do not build manholes in ditches, swales or drainage paths unless approved by the Project Manager.

3.2 PLACEMENT

A. Install precast manholes to conform to locations and dimensions shown on the Drawings.

B. Place sanitary and storm manholes at points of change in alignment, grade, size, pipe intersections and end of sewer unless otherwise shown on the Drawings.

3.3 MANHOLE BASE SECTIONS AND FOUNDATIONS

A. Place precast base on twelve inch (12 In) thick (minimum) foundation of crushed stone wrapped in filter fabric, cement-stabilized sand or concrete foundation slab. Compact cement-stabilized sand in accordance with requirements of Section 02145 – Cement-Stabilized Sand.

B. Unstable Subgrade Treatment: When unstable subgrade is encountered, notify the Project Manager for examination of subgrade to determine if subgrade has heaved upwards after being excavated. When heaving has not occurred, over-excavate subgrade to allow for twenty-four inch (24 In) thick layer of crushed stone wrapped in filter fabric as foundation material under manhole base. When there is evidence of heaving, provide pile-supported concrete foundation, as detailed on the Drawings, under manhole base.

3.4 PRECAST MANHOLE SECTIONS

A. Install sections, joints and gaskets in accordance with manufacturer's printed recommendations.

B. Install precast adjustment rings above tops of cones or flat-top sections as required to adjust finished elevation and to support manhole frame.

C. Seal any lifting holes with non-shrink grout.

D. Where PVC liners are required, seal joints between sections in accordance with manufacturer's recommendations.

E. Place at least two (2) precast concrete grade rings with thickness of twelve inches (12 In) or less, under casting.

3.5 PIPE CONNECTIONS AT MANHOLES

A. Install approved resilient connectors at each pipe entering and exiting manholes in accordance with manufacturer's instructions.

1. Where smooth exterior pipes, i.e. steel, ductile iron or PVC pipes are connected to manhole base or barrel, space between pipe and manhole wall shall be sealed with an assembly consisting of rubber gaskets or links mechanically compressed to form watertight barrier. Assemblies: "Press-Wedge," "Res-Seal," "Thunderline Link-Seals," or approved equal. See the Drawings for placement of assembly in manhole sections.
2. When connecting concrete or cement mortar coated steel pipes or as an option for connecting smooth exterior pipes to manhole base or barrel, space between pipe and manhole wall may be sealed with an assembly consisting of stainless steel power sleeve, stainless steel take-up clamp and rubber gasket. Take-up clamp: Minimum of nine-sixteenths inch (9/16 In) wide. Provide PSX positive seal gasket system by Press-Seal Gasket Corporation or approved equal.

B. Grout storm sewer connections to manhole unless otherwise shown on the Drawings. Grout pipe penetration in place on both inside and outside of manhole. Pipes are to be flush with interior of the manhole.

C. Ensure no concrete, cement-stabilized sand, fill or other rigid material is allowed to enter space between pipe and edge of wall opening at and around resilient connector on either interior or exterior of manhole. If necessary, fill space with compressible material to ensure full flexibility provided by resilient connector.

D. Where new manhole is constructed on existing sewer, rigid joint pipe may be used. Install waterstop gasket around existing pipe at center of cast-in-place wall. Join ends of split waterstop material at pipe springline using an adhesive recommended and supplied by waterstop manufacturer.

1. Field verify the elevations of all manholes to be constructed on existing sewer before the start of any related work.
2. Failure to field verify existing conditions before start of work shall be the responsibility of the Contractor should elevations not

match and the work shall be completed with no additional cost to the City.

E. Test connection for watertight seal before backfilling.

F. All connection to existing manholes shall be core drilled. Making openings to existing manholes by any other means shall not be accepted.

3.6 INVERTS FOR SANITARY SEWERS

A. Construct invert channels to provide smooth flow transition waterway with no disruption of flow at pipe-manhole connections. Conform to following criteria:

1. Slope of invert bench: one inch per foot (1 In/Ft) minimum; one and one-half inches per foot (1-1/2 In/Ft) maximum.
2. Depth of bench to invert:
   a. Pipes smaller than fifteen inches (15 In): one-half (1/2) of largest pipe diameter.
   b. Pipes fifteen inches (15 In) to twenty-four inches (24 In): three-quarters (3/4) of largest pipe diameter.
   c. Pipes larger than twenty-four inches (24 In): equal to largest pipe diameter.
3. Invert slope through manhole: one-tenth foot (0.1 Ft) drop across manhole with smooth transition of invert through manhole, unless otherwise indicated on the Drawings.

B. Form invert channels with concrete if not integral with manhole base section. For direction changes of mains, construct channels tangent to mains with maximum possible radius of curvature. Provide curves for side inlets and smooth invert fillets for flow transition between pipe inverts.

3.7. DROP CONNECTIONS FOR SANITARY SEWERS

A. Backfill drop assembly with crushed stone wrapped in filter fabric, cement-stabilized sand or Class A concrete to form solid mass. Extend cement-stabilized sand or concrete encasement minimum of four inches (4 In) outside bells.

B. Install drop connection when sewer line enters manhole higher than twenty-four inches (24 In) above invert of manhole.

3.8 STUBS FOR FUTURE CONNECTIONS

A. In manholes, where future connections are indicated on the Drawings, install resilient connectors and pipe stubs with approved watertight plugs.

3.9 MANHOLE FRAME AND ADJUSTMENT RINGS

A. Combine precast concrete or HDPE adjustment rings so elevation of installed casting cover matches pavement surface. Seal between concrete adjustment ring and precast top section with non-shrink grout; do not use mortar between adjustment rings. Apply latex-based bonding agent to precast concrete surfaces joined with non-shrink grout. Set cast

iron frame on adjustment ring in bed of approved sealant material. Install sealant bed consisting of two (2) beads of sealant, each bead having minimum dimensions of one-half inch (1/2 In) and one-half inch (1/2 In) wide.

B. Wrap manhole frame and adjustment rings with external sealing material, minimum three inches (3 In) beyond joint between ring and frame and adjustment rings and precast section.

C. For manholes in unpaved areas, set top of frame a minimum of six inches (6 In) above existing ground line unless otherwise indicated on the Drawings. In unpaved areas, encase manhole frame in mortar or non-shrink grout placed flush with face of manhole ring and top edge of frame. Provide rounded corner around perimeter.

3.10 BACKFILL

A. Place and compact backfill materials in area of excavation surrounding manholes in accordance with requirements of Section 02125 – Excavation and Backfill for Utilities. Provide embedment zone backfill material, as specified for adjacent utilities, from manhole foundation up to an elevation twelve inches (12 In) over each pipe connected to manhole. Provide trench zone backfill, as specified for adjacent utilities, above embedment zone backfill.

B. Where rigid joints are used for connecting existing sewers to manhole, backfill under existing sewer up to springline of pipe with Class B concrete or flowable fill.

C. In unpaved areas, provide positive drainage away from manhole frame to natural grade. Provide minimum of four inches (4 In) of topsoil conforming to requirements of Section 02905 – Topsoil. Seed in accordance with Section 02910 – Hydromulch Seeding. When shown on the Drawings, sod disturbed areas in accordance with Section 02915 – Sodding.

D. For Manholes in paved areas, set manhole cover is flush with surrounding pavement. Form a six foot by six foot (6 Ft x 6 Ft) area, full depth to subgrade and parallel to the roadway centerline, centered on the manhole. Install expansion joint material on the perimeter of the form. Install reinforcing bar and concrete typical of road paving. Ensure that manhole is flush with surrounding pavement before applying final finish and curing compound.

3.11 FIELD QUALITY CONTROL

A. Conduct leakage testing of sanitary sewer manholes in accordance with requirements of Section 02525 – Acceptance Testing of Gravity Sanitary Sewer Lines.

3.12 PROTECTION

A. Protect manholes from damage until work has been accepted. Repair damage to manholes at no additional cost to the City.

B. Damaged manholes that have been repaired or replaced shall be retested at no additional cost to the City.

END OF SECTION

SECTION 02310
ADJUSTING MANHOLES, INLETS AND VALVE BOXES TO GRADE

PART I: GENERAL

1.1 GENERAL REQUIREMENTS
- A. Adjusting elevation of manholes, inlets and valve boxes to new grades.

1.2 MEASUREMENT AND PAYMENT
- A. Unit Prices:
  1. No separate payment shall be made for adjusting inlets and valve boxes to grade for new construction under this Section. Include payment in the unit price for related item.
  2. Payment for adjusting existing manhole and frame and cover to new grade is on a unit price basis for each manhole and frame and cover.
  3. Payment for adjusting existing utility structures to grade is on unit price basis for each:
     - a. Inlet adjusted.
     - b. Valve box adjusted.
     - c. 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. CFTS – City of Friendswood Technical Specifications.

PART II: PRODUCTS

2.1 CONCRETE MATERIALS
- A. Provide concrete, conforming to requirements of Section 03300 – Structural Concrete.
- B. Provide precast concrete manhole sections and adjustment rings conforming to requirements of Section 02305 – Precast Concrete Manholes.
- C. Provide mortar conforming to requirements of Section 03100 – Mortar.

2.2 CAST-IRON MATERIALS
- A. Provide cast-iron materials conforming to requirements of Section 02315 – Frames, Grates, Rings and Covers.

2.3 PIPING MATERIALS

A. For riser pipes and fittings, refer to all Sections from Section 02200 to Section 02280.

2.4 MASONRY MATERIALS FOR STORM SEWER MANHOLES AND INLETS

A. Provide concrete brick masonry units.

PART III: EXECUTION

3.1 EXAMINATION

A. Examine existing structure, valve box, frame and cover or inlet box, frame and cover or inlet, piping and connections for damage or defects affecting adjustment to grade. Report damage or defects to the Project Manager.

3.2 ESTABLISHING GRADE

A. Coordinate grade-related items with existing grade and finished grade or paving and relate to established bench mark or reference line.

3.3 ADJUSTING MANHOLES AND INLETS

A. Curb and Gutter Streets.
   1. Manholes and inlets in the paving shall have top of ring matching top of surrounding pavement.
   2. Manholes and inlets within five feet (5 Ft) of the back of curb shall have top of ring a minimum of three inches (3 In) above the top of the nearest adjacent curb.
   3. All other manholes and inlets shall be three inches (3 In) above finished grade. In new development where finish grade has not been established, manhole shall be six inches (6 In) above rough grade.

B. Open Ditch Streets.
   1. Manholes and inlets in the paving shall have top of ring matching top of surrounding pavement.
   2. Manholes and inlets between edge of pavement and top of ditch bank shall be one inch (1 In) above adjacent finished grade.
   3. Manholes and inlets at any location in ditch shall be a minimum of three inches (3 In) above the highest top of ditch bank.
   4. All other manholes and inlets shall be three inches above finished grade. In new development where finish grade has not been established, manhole shall be six inches (6 In) above rough grade.

C. Manholes in ditches shall be a minimum of three inches above the elevation at the center of the road.

D. Rebuild adjustment portion of manhole or inlet by adding or removing Adjustments. Follow procedures for the type of structure being adjusted detailed in the following Sections:
   1. Section 02300 – Cast-In-Place Concrete Manholes.
   2. Section 02305 – Precast Concrete Manholes.
   3. Section 02605 – Cast-In-Place Inlets, Headwalls and Wingwalls.
   4. Section 02610 – Precast Concrete, Inlets, Headwalls and Wingwalls.
   5. Section 02615 – Concrete Brick Manholes for Storm Sewers.

E. Salvage and reuse cast-iron frame and cover or grate.

F. Protect or block off manhole or inlet bottom using wood forms shaped to fit so that no debris or soil falls to bottom during adjustment.

G. Verify that manholes and inlets are free of visible leaks as result of reconstruction. Repair leaks in manner subject to the Project Manager's approval.

3.4 ADJUSTING VALVE BOXES

A. Salvage and reuse valve box and surrounding concrete block as approved by the Project Manager. No separate pay.

B. Remove and replace six inch (6 In) ductile iron riser pipe with suitable length for depth of cover required to establish adjusted elevation to accommodate actual finish grade.

C. Reinstall valve box and riser piping plumbed in vertical position. Provide minimum six inches (6 In) telescoping freeboard space between riser pipe top butt end and interior contact flange of valve box for vertical movement damping.

D. After valve box has been set, aligned and adjusted so that top lid is level with final grade.

3.5 BACKFILL AND GRADING

A. Backfill area of excavation surrounding each adjusted manhole, inlet and valve box and compact according to requirements of Section 02120 – Excavation and Backfill for Structures.

B. Grade ground surface to drain away from each manhole and valve box. Place earth fill around manholes to level of upper rim of manhole frame. Place earth fill around valve box concrete slab.

C. In unpaved areas, grade surface at uniform slope of one to five (1:5) from manhole frame to natural grade. Provide minimum of four inches (4 In) of topsoil conforming to requirements of Section 02905 – Topsoil. Provide seeding in accordance with Section 02910 – Hydromulch Seeding or if sodding in accordance with Section 02915 – Sodding.

END OF SECTION

SECTION 02315
FRAMES, GRATES, RINGS and COVERS

PART I: GENERAL

1.1 GENERAL REQUIREMENTS
- A. Iron castings for manhole frames and covers.
- B. Inlet frames and grates.
- C. Catch basin frames and grates.
- D. Meter vault frames and covers.
- E. Adjustment of rings and extensions.
- F. Ring grates.

1.2 MEASUREMENT AND PAYMENT
- A. Unit Prices:
  1. No payment shall be made for frames, grates, rings, covers and seals under this Section. Include payment in the unit price for related item.
  2. Payment to rack over existing manhole is on a unit price basis for each manhole.
  3. 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. AASHTO – American Association of State Highway Officials.
  1. AASHTO Standard Specification for Highway Bridges.
- B. ASTM – American Society for Testing and Materials.
  1. ASTM A48 – Standard Specification for Gray Iron Castings.
  2. ASTM A615 – Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
- C. AWS – American Welding Society.
  1. AWS – D12.1 Welding Reinforcing Steel.
- D. CFTS – City of Friendswood Technical Specifications.

1.4 SUBMITTALS
- A. Conform to requirements of Section 01330 – Submittal Procedures.
- B. Submit copies of manufacturer's specifications, load tables, dimension diagrams, anchor details and installation instructions.
- C. Submit shop drawings for fabrication and installation of casting assemblies that are not included in the Drawings or City of Friendswood Standard Details. Include plans, elevations, sections and connection details. Show anchorage and accessory items. Include setting drawings

for location and installation of castings and anchorage devices.

PART II: PRODUCTS

2.1 CASTINGS

A. Use castings for frames, grates, rings and covers conforming to ASTM A48, Class 35B. Provide locking covers if indicated on the Drawings.

B. Use clean castings capable of withstanding application of AASHTO M306- forty thousand pound (40000 Lb) proof loading without detrimental permanent deformation.

C. Fabricate castings to conform to shapes, dimensions and with wording or logos shown on the Drawings. Standard dimensions for manhole covers are thirty-two inches (32 In) in diameter. Twenty-four inch (24 In) diameter is acceptable for curb inlets only.

D. Use clean castings, free from blowholes and other surface imperfections. Use clean and symmetrical cast holes in covers, free of plugs.

2.2 BEARING SURFACES

A. Machine bearing surfaces between covers or grates and their respective frames so that even bearing is provided for position in which casting may be seated in frame.

2.3 SPECIAL FRAMES AND COVERS

A. Where indicated on the Drawings, provide watertight manhole frames and covers with minimum of four (4) bolts and gasket designed to seal cover to frame. Supply approved watertight manhole covers and frames.

B. Where shown on the Drawing, provide manhole frames and covers with forty-eight inch (48 In) diameter clear opening, with inner cover for twenty-two inch (22 In) diameter clear opening. Provide approved inner cover with pattern shown on the Drawings.

2.4 FINISH

A. Unless otherwise specified, use uncoated coat iron.

2.5 FABRICATED RING GRATES

A. Fabricate ring grates from reinforcing steel conforming to ASTM A615.

B. Conform to welds connecting bars to AWS D12.1.

2.6 ADJUSTMENT RINGS FOR ASPHALT OVERLAYS

A. Use castings conforming to Paragraph 2.1.

B. One (1) piece casting with dimensions to fit frame and cover.

PART III: EXECUTION

3.1 INSTALLATION

A. Install castings according to approved shop drawings, instructions in related specifications and applicable directions from manufacturer's printed materials.

B. Set castings accurately at required locations to proper alignment and elevation. Keep castings plumb, level, true and free of rack. Measure location accurately from established lines and grades. Brace or anchor frames temporarily in form work until permanently set.

C. Fabricate ring grates in accordance with City of Friendswood Standard Detail, “Ring Grate for Open End of eighteen inch (18 In) to seventy-two inch (72 In) Stubs to Ditch”. Set in mortar in mouth of pipe bell.

D. Install adjustment rings in existing frames with clean bearing surfaces that are free from rocking.

END OF SECTION

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