SECTION 02050

SOILS AND AGGREGATES FOR EARTHWORK

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Aggregate base course.
   2. Structural fiil.
   3. Drain rock.
   4. Gravel.
   5. Native material.
   6. Sand.
   7. Select material.
   8. Stabilization material.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. C117 - Standard Test Method for Materials Finer than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing.
   2. C131 - Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
   3. C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
   4. D2419 - Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate.
   5. D2844 - Standard Test Method for Resistance R-Value and Expansion Pressure of Compacted Soils.
   6. D4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
   7. D4829 - Standard Test Method for Expansion Index of Soils.
   8. D5821 - Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate.

B. Manual of Standard Specification adopted by local, county, and state governmental agencies.

1.03 SUBMITTALS

A. Product data:
   1. Material source.
   2. Gradation.
   3. Testing data.

B. Quality control for aggregate base course:
   1. Test reports: Reports for tests required by Sections of Manual of Standard Specifications.

2. Certificates of Compliance: Certificates as required by Sections of Manual of Standard Specifications.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Storage and protection: Protect from segregation and excessive moisture during delivery, storage, and handling.

PART 2 PRODUCTS

2.01 MATERIALS

A. General:
   1. Provide material having maximum particle size not exceeding 4 inches and that is free of trash, lumber, debris, leaves, grass, roots, stumps, and other organic matter.
   2. Materials derived from processing demolished or removed asphalt concrete are not acceptable.

B. Aggregate base course (untreated base course):
   1. Crushed gravel.
   2. Consists of hard durable particles of fragments of stone or gravel; screened or crushed to required size and grading; and free from organic matter, lumps or balls or clay, alkali, or other deleterious matter.
   3. Materials derived from processing demolished or removed asphalt concrete can be blended with approved base course material and used only as base course under asphaltic concrete paving. It cannot be used as structural backfill under or around any buried facilities.
   4. When sampled and tested in accordance with specified test methods, material shall comply with following requirements:
      a. Percentage of wear: Not to exceed 40 percent after 500 revolutions when tested in accordance with ASTM C131.
      b. Plasticity index: Not be more than 5 when tested in accordance with ASTM D4318.
   5. Aggregate base course for structures:
      a. Consists of crushed or fragmented particles.
      b. Grade within the following limits when tested in accordance with ASTM C117 and ASTM C136:

Sieve Sizes (Square Openings)	Percent by Weight Passing Sieve
1 inch	100
1/2 inch	79 - 91
Number 4	49 - 61
Number 16	27 - 35
Number 200	7 - 11

C. Structural Fill:
   1. Imported materials composed of crushed or processed gravel.
   2. Consists of hard, durable particles of stone or gravel; screened or crushed to the specified size and gradation; and free from organic matter, lumps or balls of clay, and other deleterious matter.
   3. When sampled and tested in accordance with specified test methods, material shall comply with the following requirements:
      a. Percentage of wear: Not to exceed 40 percent after 500 revolutions when tested in accordance with ASTM C 131.
      b. Plasticity index: Not be more than 5 when tested in accordance with ASTM D 4318.
   4. Well graded materials with a coefficient of uniformity greater than 4 and a coefficient of curvature between 1 and 3 inclusively. See ASTM D 2487.
   5. Conforms to size and grade within the following limits when tested in accordance with ASTM C 117 and C 136:

Sieve Size (Square Openings)	**Percent by Weight Passing Sieve**
2"	100
1 1/2"	90 - 100
1"	80 - 92
3/4"	70 - 85
3/8"	55 - 75
No. 4	40 - 65
No. 16	25 - 40
No. 200	7 - 11

D. Drain rock:
   1. Durability: Percentage of wear not greater than 40 percent when tested in accordance with ASTM C131.
   2. Consists of hard, durable particles of stone or gravel; screened or crushed to specified size and gradation; and free from organic matter, lumps or balls of clay, or other deleterious matter.
   3. Crush or waste coarse material and waste fine material as required to meet gradation requirements.
   4. Conforms to size and grade within the following limits when tested in accordance with ASTM C117 and C136:

Sieve Size (Square Openings)	**Percent By Weight Passing Sieve**
2 inch	100
1-1/2 inch	95 - 100
3/4 inch	50 - 100
3/8 inch	15 - 55
Number 200	0 - 2

E. Gravel:
   1. Consists of hard, durable particles or fragments of stone or gravel; screened or crushed to specified sizes and gradations; and free from organic matter, lumps or balls of clay, alkali, adobe, or other deleterious matter.
   2. When sampled and tested in accordance with specified test methods, material shall comply with following requirements:
      a. Durability: Percentage of wear not greater than 40 percent when tested in accordance with ASTM C131.
      b. Plasticity index: Not greater than 5 when tested in accordance with ASTM D4318.
      c. Liquid limit: Not greater than 25 percent when tested in accordance with ASTM D4318.
   3. Conforms to sizes and grade within the following limits when tested in accordance with ASTM C117 and C136:

Sieve Size (Square Openings)	Percent By Weight Passing Sieve	
	Type A	Type B
3 inch	100	--
1-1/2 inch	--	100
Number 4	30 - 75	30 - 70
Number 8	20 - 60	20 - 60
Number 30	10 - 40	10 - 40
Number 200	0 - 12	0 - 12

   4. Durability: Percentage of wear not greater than 40 percent when tested in accordance with ASTM C131.

F. Native material:
   1. Sound, earthen material passing 3/4-inch sieve.
   2. Percent of material by weight passing Number 200 sieve shall not exceed 30 when tested in accordance with ASTM C136.
   3. Expansion index less than 35 when tested in accordance with ASTM D4829.

G. Sand:
   1. Clean, coarse, natural sand.
   2. Non-plastic when tested in accordance with ASTM D4318.
   3. 100 percent shall pass a 1/2-inch screen.
   4. No more than 20 percent shall pass a Number 200 sieve.

H. Select material:
   1. Sound earthen material for which the sum of plasticity index when tested in accordance with ASTM D4318 and the percent of material by weight passing a Number 200 sieve shall not exceed 23 when tested in accordance with ASTM C136.
   2. Organic content shall not be greater than 3 percent by volume.

I. Stabilization material:
   1. Durability: Percentage of wear not greater than 40 percent when tested in accordance with ASTM C131.
   2. Consists of clean, hard, durable particles of crushed rock or gravel; screened or crushed to the specified sizes and gradations; and free of any detrimental quantity of soft, friable, thin, elongated, or laminated pieces, disintegrated material, organic matter, oil, alkali, or other deleterious substance.
   3. Shall be free of slaking or decomposition under the action of alternate wetting and drying.
   4. The portion of material retained on the 3/8-inch sieve shall contain at least 50 percent of particles having 3 or more fractured faces. Not over 5 percent shall be pieces that show no such faces resulting from crushing. Of that portion which passes the 3/8-inch sieve but is retained on the Number 4 sieve, not more than 10 percent shall be pieces that show no faces resulting from crushing.
   5. Conforms to size and grade when tested in accordance with ASTM C117 and ASTM C136.

Sieve Size (Square Openings)	**Percent by Weight Passing Sieve**
1 inch	100
3/4 inch	90 - 100
Number 4	0 - 10
Number 200	0 - 2

2.02 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 02084

PRECAST DRAINAGE STRUCTURES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Onsite utility structures:
   1. Precast concrete manholes.
   2. Precast drainage inlets.
   3. Standpipes for irrigation or drainage pipes.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. C361 - Standard Specification for Reinforced Concrete Low-Head Pressure Pipe.
   2. C478 - Standard Specification for Precast Reinforced Concrete Manhole Sections.
   3. C857 - Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
   4. C858 - Standard Specification for Underground Precast Concrete Utility Structures.

1.03 SYSTEM DESCRIPTION

A. Performance requirements:
   1. Manholes and appurtenances: Manholes and appurtenances shall be watertight and free from infiltration or exfiltration.

1.04 SUBMITTALS

A. Shop drawings: Submit shop drawings for precast structures.

B. Shop drawings:
   1. Show dimensions, locations, lifting inserts, reinforcement, and joints.
   2. Structural design calculations for vaults, signed by a licensed registered Civil or Structural Engineer licensed in the State where project is located.

PART 2 PRODUCTS

2.01 MANUFACTURED UNITS

A. Precast concrete manholes:
   1. Construct precast concrete manholes in accordance with design, size, shape, form, details, and at locations indicated on the Drawings and specified.
   2. Construct manholes of precast eccentric or concentric manhole units in accordance with the requirements indicated on the Drawings and specified.

3. Provide precast, cylinder units, taper sections, and eccentric flat top sections meeting strength requirements in accordance with ASTM C478.
4. Base design and manufacture to A-16 (HS 20-44) loading in accordance with ASTM C857.
5. Construct precast manhole sections of Class D concrete as specified in Section 03300 - Cast-in-Place Concrete to form and dimensions indicated on the Drawings.

B. Precast drainage inlets:
1. Construct precast concrete drainage inlets in accordance with the size, shape, form, details, and at locations indicated on the Drawings and specified.
2. Base design and manufacture to A-16 (HS 20-44) loading in accordance with ASTM C857.
3. In accordance with ASTM C858.
4. Construct precast drainage inlets of Class D concrete as specified in Section 03300 - Cast-in-Place Concrete to form and dimensions indicated on the Drawings.

2.02 ACCESSORIES

A. Precast concrete manholes:
1. Joint sealant: Use precast concrete joint sealant as specified in Section 07900 - Joint Sealants.
2. Manhole frames and cover sets: Type, size, and quality as specified in Section 05500 - Metal Fabrications or as indicated on the Drawings.
3. Drop manhole fittings:
   a. Drop tee and other fittings: Vitrified clay pipe or as otherwise specified or indicated on the Drawings.
4. Piping penetrations through cylinder units:
   a. Install K or-N-Seal, or equivalent, rubber gasket boots with steel clamps.
   b. Piping connections to the manhole bases shall be as indicated on the Drawings.

B. Precast drainage inlets:
1. Covers: As indicated on the Drawings.

PART 3 EXECUTION

3.01 INSTALLATION

A. Concrete manholes:
1. Excavation and backfill: As specified in Section 02330 - Trenching and Backfilling.
2. Precast concrete manholes:
   a. Manhole bases:
      1) Form and place concrete on undisturbed soil and/or on aggregate base course compacted to 95 percent of maximum density.
      2) Form that portion of base above invert elevation of sewer pipe to provide smooth channel section as indicated on the Drawings.
      3) Check forms for accuracy of dimensions and relative smoothness prior to placing concrete for base. Channels shall vary uniformly in size and shape from inlet to outlet if required.

4) Construct of Class A concrete as specified in Section 03300 - Cast-in-Place Concrete to form and dimensions indicated on the Drawings.
5) Place base concrete as monolith.

b. Manhole sections:
1) Set each manhole section plumb.
2) Use sections of various heights and adjustment rings to bring top of manhole ring and cover to required elevation.

c. Joints:
1) Seal joints with precast concrete joint sealant as specified in Section 07900 - Joint Sealants unless otherwise indicated on the Drawings.
2) Clean joints with brush and prime.
3) Apply precast concrete joint sealant as follows, except where instructions differ from manufacturer's printed instructions. Where these instructions differ from manufacturer's instructions, install precast concrete joint sealant in accordance with manufacturer's written instructions:
a) Remove silicon treated protective paper from one side of preformed rope and lay preformed rope, paper side up, on cleaned joint surface. Press surface firmly end-to-end around entire joint, making minimum 1-inch laps where necessary.
b) Remove protective paper from preformed rope and lower next section into place.
4) Seal joints watertight.

d. Manhole frame and cover sets:
1) Install manhole frames and cover sets at locations indicated on the Drawings.
2) Setting:
a) Set manhole frames and covers at elevations and requirements indicated on the Drawings.
(1) Set manhole covers flush with paving.
(2) Where no paving exists, set manhole cover 6 inches above surrounding grade.
b) Where structure is outside limits of traveled shoulder but not in roadside ditch, place structure 1/10 foot or more above existing ground surface.
c) Where cover is in existing pavement or in traveled way of existing road shoulder, place cover flush with existing surface.
d) Where manhole cover falls in existing roadside ditch or right of way, place manhole cover approximately 1-1/2 feet above existing ground surface.
e) Set manhole frames at required grade and securely attach to top of precast manhole shaft unit or on adjustment rings, using cement mortar.
f) Setting covers:
(1) After frames are securely set in place in accordance with requirements specified, install covers and perform necessary cleaning and scraping of foreign materials from frames and covers as required to accomplish and to ensure proper fit.

(2) Any frame and cover which creates noise when passed over by traffic shall be replaced.

B. Precast drainage inlets:
   1. Excavation and backfill: As specified in Section 02330 - Trenching and Backfilling.

3.02 FIELD QUALITY CONTROL

A. Tests:
   1. Sanitary sewer manholes: Vacuum test all sanitary sewer manholes. Use following vacuum test procedures and requirements:
      a. After completion of the manhole barrels but prior to backfilling and grade ring installation, seal all openings in the manhole with plugs and a rubber ring "donut" type plug inserted inside the opening of the cone.
      b. Attach a small vacuum pump to a hose connected to the plug and apply 4 pounds per square inch of vacuum.
         1) Allow vacuum to stabilize at 3.5 pounds per square inch for 1 minute, then begin the test.
         2) The manhole must maintain vacuum such that no greater than 0.5 pounds per square inch of vacuum is lost during the specified test period.
      c. The specified test period is as follows:

Manhole Depth (Feet)	Minimum Test Period (Minutes)
0-5	4.5
5-10	5.5
10-15	6.0
Greater than 15	6.5

      d. Patch as required and retest manholes that fail the test.
      e. Provide a vacuum regulator on the vacuum pump such that no greater than 4 pounds per square inch can be applied to the manhole during the test.
      f. Repair all manholes that do not meet the leakage test, or are unsatisfactory from visual inspection.
         1) Retest after repair is completed.

END OF SECTION

SECTION 02085

PRECAST CONCRETE VAULTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Precast concrete vaults.

1.02 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO).
   1. LRFD Bridge Design Specifications.

B. American Concrete Institute (ACI):
   1. 318 - Building Code Requirements for Structural Concrete and Commentary.

C. ASTM International (ASTM):
   1. C150 - Standard Specification for Portland Cement.
   2. C857 - Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete utility Structures.
   3. C858 - Standard Specification for Underground Precast Concrete utility Structures.

D. Occupational Safety and Health Administration (OSHA).

1.03 SUBMITTALS

A. General:
   1. Furnish submittals as specified in Section 01330 - Submittal Procedures.

B. Shop drawings:
   1. Show dimensions, locations, lifting inserts, reinforcement, and joints.
   2. Structural design calculations for vaults, signed by a licensed registered Civil or Structural Engineer licensed in the State where project is located.

C. Manufacturer’s Certification for Vaults: Written certification that the vault complies with the requirements of this Section.

1.04 QUALITY ASSURANCE

A. Inspection:
   1. After installation, the Contractor shall demonstrate that vaults have been properly installed, level, with tight joints, at the correct elevations and orientations, and that the backfilling has been carried out in accordance with the Contract Documents.

PART 2 PRODUCTS

2.01 VAULTS

A. Manufacturers: One of the following or equal:
   1. Utility Vault Co.
   2. Oldcastle Precast.

B. Provide precast vaults for the size indicated on the Drawings.

C. The minimum structural member thickness for vaults shall be 5 inches.
   1. Cement shall be Type V portland cement in accordance with ASTM C150.
   2. The minimum 28-day concrete compressive strength shall be 4,000 pounds per square inch.
   3. All reinforcing steel shall be embedded in the concrete with a minimum clear cover as recommended by ACI 318.

D. Design requirements: Loads on structures:
   1. In accordance with ASTM C857, except as modified in this Section.
   2. Loads at the ground surface:
      a. ”Roadway”: Load from heavy, frequently repeated vehicle traffic:
         1) ASTM C857, Table 1, Designation A-16 (AASHTO HS20-44).
   3. Loads against walls. Include effects of groundwater and seismic accelerations on earth pressures.
      a. Equivalent lateral pressure:
         1) Triangular distribution: 65 pounds per square foot per foot of depth (triangular distribution).
         2) Rectangular distribution backfill-induced live load surcharge: 240 pounds per square foot.
      b. Surface surcharge load: In accordance with ASTM C857 A-16 wheel load if such surcharge exceeds backfill loads described in the preceding paragraph.
      c. Groundwater effects: Include groundwater effects on lateral earth pressure loads using design elevation of 4385.
         1) Use equivalent lateral pressure of 118 pounds per square foot per foot of depth (triangular distribution) for soil below the design groundwater elevation.
      d. Seismic acceleration effects:
         1) As specified in Section 01612 - Seismic Design Criteria.
         2) Rectangular distribution: 20 pounds per square foot per foot of structure depth.
         3) Adding lateral force for soil accelerating toward structure:
            a) Direct uniform pressure distribution toward the wall, effectively increasing the static lateral soil pressure.
         4) Reducing lateral force for soil accelerating away from structure:
            a) Direct inverted pressure distribution away from the wall, effectively reducing the static lateral soil pressure.
   4. Groundwater and flood loads, and buoyancy effects:
      a. As specified in Geotechnical Report for design groundwater and design flood elevations.
      b. Lateral pressure effects: Determine based on groundwater and flood elevations specified.

c. Buoyancy: For groundwater and flood conditions, provide factor of safety against flotation of at least 1.67.
    1) If the weight of soil overlying footing projections on the structure is considered to resist flotation, use a buoyant unit weight of soil equal to not more than 48 pounds per cubic foot.
    2) Concrete fill may be provided in the bottom section of precast portland cement concrete structures to add weight. Submit proposed details.

5. Soil bearing pressure at base:
    a. Maximum 3,500 pounds per square foot total pressure on prepared subgrade soils.
6. Lifting and handling loads:
    a. Make provision in the design for the effects of loads or stresses that may be imposed on structures during fabrication, transportation, or erection.
7. Load combinations:
    a. Design structures to sustain the specified loads individually or in combination.

E. Design requirements: Structural analysis, design and detailing:
1. Analyze and design structures including the effects of 2-way action (“plate action”) and of load transfer around current and future openings.
2. Where structures include panels designed for future removal (“knockout panels”), design structures for loads and stresses with any combination of any or all such panels in place or removed.
3. Design structures in accordance with the requirements of ACI 318 and this Section.
4. Provide reinforcement at all areas subject to tensile stress when loaded with the specified loads and combinations thereof.
5. Provide temperature and shrinkage reinforcement to equal or exceed ACI 318 requirements in all concrete sections.
6. Provide minimum clear concrete cover over reinforcement at both interior and exterior faces of all members in accordance with the following:
    a. Vaults: 2 inches.
7. Reinforcement details:
    a. Walls: For structures with wall thickness of 8 inches or less, locate a single mat of reinforcement at the center of the wall.
    b. Slabs: For structures with slab thickness of 7 inches or less, locate a single mat of reinforcement at the center of the slab.
    c. Structures with wall or slab thicknesses exceeding these limits shall have a reinforcement at each face of the member.
8. Joints:
    a. Provide structures with watertight joints between sections, and detailed to minimize water infiltration at duct bank and conduit penetrations.
    b. Provide structures with non-skid, shiplap, or tongue and groove joints between sections.

F. Design requirements: Materials:
1. Portland cement concrete vaults:
    a. In accordance with ASTM C858, except as modified in this Section.
    b. Proportion concrete mixes to resist damage from freezing and thawing in a moist environment, and for exposure to deicing chemicals. In

accordance with ACI 318 requirements for minimum specified compressive strength and air entrainment.

2. Seal joints watertight with precast concrete joint sealant as specified in Section 07900 - Joint Sealants.

G. Where joints are designed in pre-cast concrete vaults, such joints shall be interlocking to secure proper alignment between members and prevent migration of soil through the joint. Structural sections at joints shall be sized sufficiently to reinforce the section against localized distress during transportation and handling and against excess contact bearing pressures through the joint.

H. Vault shall be solid walled construction.
   1. Where penetration of the pre-cast concrete vault is required for piping, conduit, or ducts, such penetrations shall be accommodated through pre-cast openings or core-drilled sections.
   2. Openings for penetrations shall be smooth and free of surface irregularities and without exposed steel reinforcing.
   3. Vaults need not be designed to resist thrust from piping passing through the vault.
   4. Coordinate pipe penetration locations with piping arrangement as indicated on the Drawings.

I. Slope bottom of vault to Drainage Sump as indicated on the Drawings.

J. Drainage Sump: Dimensions as indicated on the Drawings.
   1. Drainage Sump shall consist of an open knockout in the bottom of the vault. Provide additional reinforcing as required to accommodate knockout.
   2. Provide FRP grating with rebate as indicated on the Drawings.
      a. Grating shall be designed for 300 pounds per square foot load with L/200 maximum deflection.
      b. Provide removable grating sections to facilitate grating removal without disconnecting Automatic Sump Drain Ejector Assembly indicated on the Drawings.

K. Ladders:
   1. General:
      a. Type:
         1) Safety type conforming to local, State, and OSHA standards as minimum.
         2) Furnish guards for ladder wells.
      b. Size: 18 inches wide between side rails of length, size, shape, detail, and location indicated on the Drawings.
   2. Aluminum ladders:
      a. Materials: 6063-T5 aluminum alloy.
      b. Rungs:
         1) 1-inch minimum solid square bar with 1/8-inch grooves in top and deeply serrated on all sides.
         2) Capable of withstanding 1,000 pound load without failure.
      c. Side rails: Minimum 4-inch by 1/2-inch flat bars.
      d. Fabrication:
         1) Welded construction, of size, shape, location, and details indicated on the Drawings.

2.02 ACCESS HATCH

A. Where openings for access to the vault are required, the full clear space opening indicated shall be provided, without obstructions from brackets or supports. For large openings where brackets or supports are designed to protrude into the opening for support of required covers, such brackets or supports shall be designed to be easily removed and replaced with a minimum of effort and without cutting or welding.

B. Access hatch as specified in Section 08320 - Floor Access Doors for access floor requirements.

2.03 COATINGS

A. Coat interior and exterior of valve vault in accordance with Section 09960 - High-Performance Coatings or as indicated on the Drawings.

PART 3 EXECUTION

3.01 INSTALLATION

A. Pre-cast concrete sections shall be transported and handled with care in accordance with the manufacturer's written recommendations.
   1. Where lifting devices are provided in pre-cast sections, such lifting devices shall be used as intended.
   2. Where no lifting devices are provided, the Contractor shall follow the manufacturer's recommendations for lifting procedures to provide proper support during lifting.

B. Buried pre-cast concrete vaults shall be assembled and placed in excavations on properly compacted soil foundations as indicated. Pre-cast concrete vaults shall be set to grade and oriented to provide the required dimensions and clearances from pipes and other structures.

C. Apply coatings in accordance with manufacturer's instructions.

D. Ladders:
   1. Secure to supporting surface with bent plate clips providing minimum 8 inches between supporting surface and center of rungs.
   2. Anchorage by manufacturer.
   3. Where exit from ladder is forward over top rung, extend side rails 3 feet 3 inches minimum above landing, and return the rails with a radius bend to the landing.
   4. Where exit from ladder is to side, extend ladder 5 feet 6 inches minimum above landing and rigidly secure at top.
   5. Erect rail straight, level, plumb, and true to position indicated on the Drawings. Correct deviations from true line or grade which are visible to the eye.

END OF SECTION

SECTION 02200

SITE CLEARING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: stripping project site.

1.02 DEFINITIONS

A. Stripping: Includes the removal and disposal of all organic sod, topsoil, grass and grass roots, and other objectionable material remaining after clearing and grubbing from the areas designated to be stripped. The depth of stripping is estimated to be 8 inches, but the required depth of stripping will be determined by the Engineer.

1.03 QUALITY ASSURANCE

A. Regulatory requirements: Verify and comply with applicable regulations regarding those governing noise, dust, nuisance, drainage and runoff, fire protection, and disposal.

B. Pre-construction conference: Meet with Engineer to discuss order and method of work.

1.04 PROJECT CONDITIONS

A. Environmental requirements:
   1. For suspected hazardous materials found: As specified in Section 01354 - Hazardous Material Procedures.

1.05 SEQUENCING AND SCHEDULING

A. Clearing and grubbing: Perform clearing and grubbing in advance of grading operations.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of conditions: Examine site and verify existing conditions for beginning work.

3.02 PREPARATION

A. Protect existing improvements from damage by site preparation work.

3.03 INSTALLATION

A. Stripping:
   1. Remove soil material containing sod, grass, or other vegetation to depth of 8 inches from areas to receive fill or pavement and from area within 5 feet outside foundation walls.
   2. Deposit stripped material in accordance with following requirements:
      a. At locations acceptable to the Owner.

END OF SECTION

SECTION 02240

DEWATERING FOR STRUCTURES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Installation and maintenance of dewatering systems.
   2. Disposal of water entering excavation or other parts of the work.

1.02 SYSTEM DESCRIPTION

A. Design requirements:
   1. Keep excavations reasonably free from water. Draw down static groundwater level to minimum of 3 feet below anticipated bottom of excavations before the excavation reaches bottom elevation.
   2. Dewatering design analysis. Include the following:
      a. Evaluation of anticipated subsurface conditions.
      b. Required well spacing.
      c. Diameter of wells.
      d. Depth to screen, screen height, and mesh size.
      e. Backfill and filter pack.
      f. Pump size.
      g. Drawdown duration.
      h. Drawdown and steady state flow rates.
      i. Plans for de-silting of groundwater before discharge.
      j. Expected settlements.
   3. Include water drawdown curves in dewatering calculations.
   4. Coordinate dewatering design with excavation and shoring design. Excavation and shoring design shall consider changes in groundwater conditions and associated earth pressures.
   5. Do not place concrete or masonry foundations or concrete slabs in water. Do not allow water to rise over these elements until concrete or mortar has set for at least 24 hours.
   6. Maintain operation of dewatering system until complete structure -- including walls, slabs, beams, struts, and other structural elements -- has been constructed; concrete has attained its specified compressive strength; and backfill has been completed to 3 feet above normal static groundwater level at the site .
   7. Provide standby power to ensure continuous dewatering in case of power failure.

B. Dewatering shored excavations:
   1. Dewater from within shoring.
   2. Use impermeable shoring system to minimize lowering of groundwater outside shoring.
   3. Extend impermeable shoring below bottom of excavation sufficient amount to:
      a. Minimize lowering of groundwater outside shoring.
      b. Prevent unstable excavation due to piping and heave.

4. To minimize settlement outside shoring due to dewatering, do not lower groundwater outside shoring more than 1 foot. Provide groundwater recharge if required to maintain this groundwater elevation outside of shoring.
5. Provide monitoring wells located outside shoring for monitoring groundwater elevation.

C. Obtain written permission from Engineer before locating wells, well points, or drain lines for dewatering within the limits of a structure's foundation.

D. Locate dewatering facilities where they will not interfere with utilities and construction work to be performed by others.

E. Discharge:
1. Discharge water to sewer interceptor manholes or storm drain inlets as they run into the headworks.

1.03 SUBMITTALS

A. Dewatering plan:
1. Dewatering design analysis.
2. Required permits.
3. Arrangement, location, and depths of dewatering system components.
4. Type and sizes of filters.
5. Identify proposed alignment, support, and protection for discharge pipe. Identify location of discharge and provide details for that location**.** For pipes discharging to manholes, provide details of pipe entry at manhole.

B. Well construction logs. Include:
1. Descriptions of actual materials encountered, categorized in accordance with Unified Soil Classification System.
2. Construction details.
3. Well development procedures and results.
4. Deviations from original design.

C. Qualifications:
1. Dewatering contractor.
2. Dewatering design engineer.
3. Testing laboratory.

1.04 QUALITY ASSURANCE

A. Dewatering plan and dewatering system analysis:
1. Prepared by a qualified Civil Engineer, licensed in the state where the Project is located.
a. The dewatering design engineer shall have at least 5 years of experience in designing similar systems.

B. Dewatering Contractor shall have at least 5 years of experience in installing similar systems.

C. Testing laboratory shall meet discharge permit testing laboratory qualifications.

D. Regulatory requirements:
   1. Obtain required water discharge permits.

PART 2 EXECUTION

2.01 INSTALLATION

A. During construction, provide and maintain ample means and devices to promptly remove and properly dispose of water entering excavation or other parts of the work, whether water is surface water or underground water.

B. Keep excavations reasonably free of water.

C. Make provisions to maintain continuous dewatering:
   1. Provide standby power to maintain dewatering during power outages and interruptions.
   2. Provide 24-hour monitoring by personnel skilled in operation and maintenance of the system, and capable of providing or obtaining work required to maintain system operation.

D. Intercept and divert precipitation and surface water away from excavations. Use dikes, curb walls, ditches, pipes, sumps, or other means acceptable to Engineer.

E. Disposal of water:
   1. Dispose of water from the work in suitable manner without damage to adjacent property.
   2. Do not drain water into work built or under construction.
   3. Dispose of water in such manner that it will not be a menace to public health or safety.

F. Wells, well points, and drain lines for dewatering:
   1. Provide after receiving Engineer's written acceptance.
   2. Fill dewatering wells, pipes, and french drains to be left in place within structure foundation limits with Class “C” concrete as specified in Section 03300 - Cast-in-Place Concrete or grout as specified in Section 03600 - Grouting.

2.02 CONSTRUCTION

A. Prior to release of groundwater to its static level: Confirm that:
   1. All groundwater pressure relief devices for structure are fully operational.
   2. Construction of structure is complete and concrete has reached its specified compressive strength.
   3. Backfill of structure is complete.

B. Control release of groundwater to its static level to prevent disturbance of natural foundation soils or compacted backfills and fills and to prevent flotation or movement of structures, pipelines, or other facilities.

END OF SECTION

SECTION 02260

EXCAVATION SUPPORT AND PROTECTION

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Requirements for designing, providing, maintaining, and removing excavation support and protection.

1.02 REFERENCES

A. American Society of Civil Engineers (ASCE):
   1. Guidelines of Engineering Practice for Braced and Tied-Back Excavations.

B. Department of the Navy Naval Facilities Engineering Command (NAVFAC):
   1. Design Manual 7.2 - Foundations and Earth Structures.
   2. Design Manual 7.3 - Soil Dynamics and Special Design Aspects.

C. State of California Department of Transportation (Caltrans):
   1. Caltrans California Trenching and Shoring Manual.

D. United States Steel Corporation (USS):
   1. Steel Sheet Piling Design Manual.

1.03 DEFINITIONS

A. General Engineering Design Practice: General engineering design practice in area of the Project, performed in accordance with recent engineering literature on subject of shoring and stability of excavations.

B. Shoring: A temporary structural system designed to support vertical faces, or nearly vertical faces, of soil or rock for purposes of excavation. Shoring includes cantilevered sheet piling, internally braced sheet piling, slurry walls, soldier piles and lagging, and other similar shoring systems. Sloping of the soil is not shoring.

C. Support levels: Level of tiebacks, wales, rackers, bottom of excavation, and other types of support.

1.04 SYSTEM DESCRIPTION

A. Where General Engineering Design Practice is specified, provide drawings and calculations that are performed and signed by civil or structural engineer registered in State where Project is located:
   1. Clearly disclose assumptions made, criteria followed, and stress values used for materials being used in design calculations.
   2. Submit list of references acceptable to Engineer that substantiating appropriateness of design assumptions, criteria, and stress values.

B. Design requirements:
   1. General:
      a. For trench excavations 5 feet or more in depth and for trenches less than 5 feet in depth when there is potential for cave-in.
         1) Perform design pursuant to general engineering design practice.
         2)
      b. Dewatering:
         1) Dewater soil inside shoring as specified in Section 02240 - Dewatering for Structures.
         2) Do not lower groundwater outside of shoring more than 1 foot.
         3) Recharge groundwater outside shoring to limit groundwater draw down outside of shoring to amount specified above.
      c. When electing to design with material stresses for temporary construction higher than allowable stresses prescribed in building code as specified in Section 01410 - Regulatory Requirements, increase in such stresses shall not exceed 10 percent of value of prescribed stresses.
      d. Minimum safety factor used for design shall not be less than 1.5.
      e. The calculated minimum depth of penetration of shoring below bottom of excavation shall be increased not less than 30 percent if full value of allowable passive pressure is used in design.
      f. Maximum height of cantilever shoring above bottom of excavation shall not exceed 15 feet. Use braced shoring when height of shoring above bottom of excavation exceeds 15 feet.
      g. The location of point of fixity for shoring shall not be less than half calculated minimum embedment depth below bottom of excavation.
      h. Generally acceptable references for design of shoring and excavations are as follows:
         1) ASCE Guidelines of Engineering Practice for Braced and Tied-Back Excavations.
         2) Caltrans California Trenching and Shoring Manual.
         3) NAVFAC Design Manual 7.2.
         4) NAVFAC Design Manual 7.3.
         5) USS Steel Sheet Piling Design Manual.

   2. Soldier piles and lagging:
      a. Provide lagging over full face of excavation. Joints between pieces of lagging shall be tight to prevent loss of soil.
      b. Provide full face lagging all around penetrations through lagging.
      c. If the soldier piles are installed in predrilled holes and are not concrete encased, fill predrilled holes with controlled low strength material as specified in Section 02312 - Controlled Low Strength Material (CLSM) after soldier piles are installed.
      d. Assumed effective width for passive soil resistance:
         1) Effective width of driven soldier piles shall not exceed 2 times width of pile.
         2) Effective width of CLSM encased soldier piles in drilled holes shall not exceed 2 times width of pile.
         3) Effective width of concrete encased soldier piles shall not exceed 2 times width of concrete encasement.
      e. Fill voids behind lagging with gravel or other material acceptable to Engineer.

f. Apply loads from tie back soil, rock, or deadman anchors concentrically to soldier piles or wales spanning between soldier piles:
   1) Wales shall be back-to-back double channels or other members acceptable to Engineer.
   2) Do not eccentrically load structural section of soldier piles or wales.
g. Design soldier piles for downward loads including vertical loads from tieback anchors.

3. Soil anchors, rock anchors, and deadman anchors:
   a. Design tieback anchors for a safety factor of not less than 2 times calculated load from shoring.
   b. Proof load all production anchors to 150 percent of calculated load from shoring.
   c. Lock off production anchors at calculated load from shoring.
   d. Length of soil anchors used to calculate resistance to load from shoring shall not include any length within potential active pressure soil failure zone behind face of shoring.
   e. Design tie rods for tieback anchors for 130 percent of calculated load from shoring.
   f. Design tie rods for tieback anchors for 150 percent of the calculated load from shoring when tie rod couplers are used and for other conditions where stress concentrations can develop.
4. Set inside face of shoring back from structure not less than greater of following:
   a. 5 feet from face of wall.
   b. 2 foot 6 inches from edge of foundation.
   c. Depth of excavation below bottom of foundation.

C. Performance requirements:
1. General:
   a. Support faces of excavations and protect structures and improvements in vicinity of excavations from damage and loss of function due to settlement or movement of soils, alterations in ground water level caused by such excavations, and related operations.
   b. Specified provisions:
      1) Complement, but do not substitute or diminish, obligations of Contractor for furnishing of safe place of work pursuant to provisions of the Occupational Safety and Health Act of 1970 and its subsequent amendments and regulations and for protection of Work, structures, and other improvements.
      2) Represent minimum requirement for:
         a) Number and types of means needed to maintain soil stability.
         b) Strength of such required means.
         c) Methods and frequency of maintenance and observation of means used for maintaining soil stability.
2. Provide safe and stable excavations by means of sheeting, shoring, bracing, sloping, and other means and procedures, such as draining and recharging groundwater and routing and disposing of surface runoff, required to maintain stability of soils and rock.
3. Provide support for trench excavations for protection of workers from hazard of caving ground.

4. Provide shoring:
    a. Where, as result of excavation work and analysis performed pursuant to general engineering design practice, as defined in this Section:
        1) Excavated face or surrounding soil mass may be subject to slides, caving, or other types of failures.
        2) Stability and integrity of structures and other improvements may be compromised by settlement or movement of soils, or changes in soil load on structures and other improvements.
    b. For trenches 5 feet and deeper.
    c. For trenches less than 5 feet in depth, when there is potential for cave-in.
    d. Where indicated on the Drawings.
5. For safe and stable excavations, use appropriate design, construction, and maintenance procedures to minimize settlement of supported ground and to prevent damage to structures and other improvements, including:
    a. Using stiff shoring systems.
    b. Following appropriate construction sequence.
    c. Using shoring system that is tight enough to prevent soil loss through the shoring.
    d. Using shoring system that extends far enough below bottom of excavation to prevent piping, heave, or flow of soil under shoring.
    e. Design for safety factor of not less than 1.50.
    f. Providing surface runoff routing and discharge away from excavations.
    g. Where dewatering inside shoring is necessary, recharge groundwater outside shoring as necessary to prevent settlement in area surrounding shored excavation.
    h. Where sheet piling is used, use interlocking type sheets:
        1) Sheet piles shall be continuous and driven in interlock.
        2) If bottom of the excavation is located below the water table, use “ball and socket” or "thumb and finger" type interlock.
    i. Not applying shoring loads to existing structures and other improvements.
    j. Not changing existing soil loading on existing structures and other improvements.
    k. Provide welded steel packing between soil retaining members such as sheet piles and wales and similar members when gap exceeds 1/2 inch before wales are loaded.

1.05 SUBMITTALS

A. Shop drawings and calculations:
    1. Calculations for different load, support, and other conditions that occur during the sequence of installation of shoring, construction of facilities protected by shoring, and sequence of removal of shoring.
    2. Sketches showing the condition at various stages of installation and removal of shoring.
    3. Show on plan shoring, structures, pipelines, and other improvements located near shoring.
    4. When utilities penetrate shoring, show location of penetrations on elevation of all sides of shoring.
    5. Show details for ground support and sealing around utility penetrations.
    6. Indicate method used for installing driven shoring.

B. Control points and schedule of measurements:
   1. Submit location and details of control points and method and schedule of measurements.
   2. Survey data.

C. Detailed sequence of installation and removal of shoring:
   1. Consider effects of ground settlement in sequence of installation and removal of shoring.
   2. Provide sketches showing conditions at various stages in sequence of installation and removal of shoring.

D. Vibrator monitoring:
   1. Vibration monitoring program.
   2. Manufacturer's literature on vibration monitoring instrumentation.
   3. Vibration monitoring data.

E. Submit submittals for excavation support and protection as complete package and include all items required in this Section:
   1. Incomplete submittals will not be reviewed and will be returned for resubmittal as complete package.

F. Submit dewatering submittals as specified in Section 02240 - Dewatering for Structures with submittals for excavation support and protection.

1.06 SEQUENCING

A. Do not begin construction of any shoring or excavation operations until:
   1. Submittals for shoring and dewatering have been accepted.
   2. Control points as specified in this Section and on existing structures and other improvements as indicated on the Drawings have been established and surveyed to document initial elevations and locations.
   3. Materials necessary for installation are on site.

B. Submit submittals minimum of 60 days prior to scheduled date to begin excavation work.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 CONSTRUCTION

A. Installation of shoring:
   1. Install means for providing safe and stable excavations as indicated in submittals.

B. Removal of shoring:
   1. Except for concrete encased soldier piles, slurry walls, and similar shoring systems, remove shoring by completion of Work.

2. Select shoring system and method of removal, which will minimize soil that sticks to shoring from creating voids and causing settlement.
3. To prevent settlement caused by pulling shoring, fill voids with pressure injected grout:
    a. Inject grout starting at bottom of void and progressively fill void to grade.
    b. Minimize length of shoring removed ahead of grouting operation and limit time void is left ungrouted to prevent void from closing up before being grouted.
4. Pressure preservative treated wood lagging may be left in place if acceptable to Engineer.

C. Control points:
1. Establish control points on shoring and on structures and other improvements in vicinity of excavation for measurement of horizontal and vertical movement:
    a. Set control points on shoring support system:
        1) Set points at distances not exceeding 25 feet at each support level.
2. Promptly upon completion of construction of control points survey control points. Submit copy of field notes with measurement.
3. Perform horizontal and vertical survey and measurement of control points at least once every week.
    a. Field notes shall show current measurement and change in measurement from first measurement taken.
4. Set control points on corners of existing structures and on curbs, manholes, and other improvements at the locations indicated on the Drawings.
5. Provide plumb bobs with horizontal targets indicating original position of plumb bobs in relation to shoring at control points.

D. Vibration monitoring:
1. Measure vibration due to installation and removal of shoring.
2. Perform vibration monitoring continuously during installation and removal of shoring.
3. Submit vibration monitoring program including information on vibration monitoring instrumentation.
4. Submit vibration monitoring data weekly.

E. Maintenance:
1. Where loss of soil occurs, plug gap in shoring and replace lost soil with fill material acceptable to Engineer.
2. Where measurements and observations indicate possibility of failure or excessive movement of excavation support, determined in accordance with general engineering design practice, take appropriate action immediately.

END OF SECTION

SECTION 02300

EARTHWORK

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Loosening, excavating, filling, grading, hauling, preparing subgrade, compacting in final location, wetting and drying, and operations pertaining to site grading for buildings, basins, reservoirs, boxes, roads, and other facilities.
   2. Backfilling and compacting under and around structures.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. D1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand Cone Method.
   2. D1557 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN m/m^3)).
   3. D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.03 DEFINITIONS

A. Backfill adjacent to structure: Backfill within volume bounded by the exterior surfaces of structure, the surface of undisturbed soil in the excavation around structure, and finish grade around structure.

B. Embankments: Dikes, levees, berms, and similar facilities.

C. Excavation: Consists of loosening, removing, loading, transporting, depositing, and compacting in final location, wet and dry materials, necessary to be removed for purposes of construction of structures, ditches, grading, roads, and such other purposes as are indicated on the Drawings.

1.04 SYSTEM DESCRIPTION

A. Performance requirements:
   1. Where mud or other soft or unstable material is encountered, remove such material and refill space with stabilization material. Wrap stabilization material with stabilization fabric.
   2. Obtain acceptable import material from other sources if surplus or borrow materials obtained within Project site does not conform to specified requirements or are not sufficient in quantity.
   3. No extra compensation will be made for hauling of fill materials nor for water required for compaction.

1.05 SUBMITTALS

A. Copy of Property Owner’s Agreement allowing placement of surplus soil material on their property.

B. Excavation plan.

C. Testing lab: Submit Contractor's proposed testing laboratory capabilities and equipment.

D. Test reports:
   1. Submit certified test reports of all tests specified to be performed by the Contractor.
   2. Sign and seal test reports by a registered Engineer who practices geotechnical engineering registered in Utah.

1.06 QUALITY ASSURANCE

A. Initial compaction demonstration:
   1. Adequacy of compaction equipment and procedures: Demonstrate adequacy of compaction equipment and procedures before exceeding any of following amounts of earthwork quantities:
      a. 50 cubic yards of backfill adjacent to structures.
      b. 100 cubic yards of embankment work.
      c. 100 cubic yards of fill.
      d. 50 cubic yards of roadway base material.
      e. 100 cubic yards of road fill.
   2. Compaction sequence requirements: Until specified degree of compaction on previously specified amounts of earthwork is achieved, do not perform additional earthwork of the same kind.
   3. After satisfactory conclusion of initial compaction demonstration and at any time during construction, provide confirmation tests as specified under "FIELD QUALITY CONTROL."

B. Contractor shall perform all work related to this Section in accordance with the approved Stormwater Pollution Prevention Plan (SWPPP).

1.07 SEQUENCING AND SCHEDULING

A. Schedule earthwork operations to meet requirements specified in this Section for excavation and uses of excavated material.

B. If necessary, stockpile excavated material in order to use it at specified locations.

C. Excavation, backfilling, and filling: Perform excavation, backfilling, and filling during construction in manner and sequence that provides drainage at all times.

PART 2 PRODUCTS

2.01 MATERIALS

A. Water for compacting: Use water from source acceptable to Engineer.

B. Soil and rock materials:
   1. General:
      a. Provide aggregate base course, Class 2 permeable, controlled low-strength material, drain rock, gravel, native material, sand, select material, and stabilization material where specified or indicated on the Drawings.
      b. If suitable surplus materials are available, obtain native material and select material from cut sections or excavations or imported materials.
   2. Aggregate base course materials: As specified in Section 02050 - Soils and Aggregates for Earthwork.
   3. Class 2 permeable: As specified in Section 02050 - Soils and Aggregates for Earthwork.
   4. Drain rock: As specified in Section 02050 - Soils and Aggregates for Earthwork.
   5. Gravel: As specified in Section 02050 - Soils and Aggregates for Earthwork.
   6. Native material: As specified in Section 02050 - Soils and Aggregates for Earthwork.
   7. Sand: As specified in Section 02050 - Soils and Aggregates for Earthwork.
   8. Select material: As specified in Section 02050 - Soils and Aggregates for Earthwork.
   9. Stabilization material: As specified in Section 02050 - Soils and Aggregates for Earthwork.

C. Controlled low-strength material: As specified in Section 02312 - Controlled Low Strength Materials (CLSM).

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of conditions:
   1. Confirm compaction of existing material underneath the Grit Removal Building:
      a. Perform 6 compactions tests: 95 percent.
      b. Contractor to coordinate with field engineer for locations of tests.
      c. Excavate 24 inches below existing grade for test pits.
      d. If tests fall below compaction limits, Contractor to coordinate with Engineer and Owner.
   2. Character and quantity of material:
      a. Verify character and quantity of rock, gravel, sand, silt, water, and other inorganic or organic materials to be encountered in work to be performed.
      b. Determine gradation, shrinkage, and swelling of soil, and suitability of material for use intended in work to be performed.
      c. Determine quantity of material, and cost thereof, required for construction of backfills, cuts, embankments, excavations, fills, and roadway fills, whether from onsite excavations or imported materials. Include in cost of work to be performed.
      d. Include wasting of excess material, if required, in cost of work to be performed.

3.02 PREPARATION

A. Backfills:
   1. After clearing and excavation are completed, scarify entire areas that underlie backfills or structures to a depth of 6 inches and until surface is free of ruts, hummocks, and other features that would prevent uniform compaction by equipment to be used.
   2. Recompact scarified areas to density specified before placing backfill material or concrete.
   3. Do not place backfill against walls until:
      a. Walls have been cast full height of structure and concrete has reached the specified strength.
      b. Connecting slabs and beams have been cast, and concrete has reached the specified strength.
      c. Water bearing walls have been water tested for leakage.
   4. Do not place backfill on top of buried structures until:
      a. Concrete has reached full strength.
   5. Prior to backfilling:
      a. Remove all forms.
      b. Clean all trash and debris from the excavation site.
   6. After inspection of foundation, walls, and pipes, place backfill symmetrically around structures to prevent eccentric loading of structures.
   7. Place material on top of structure to prevent excessive point loading that exceeds the loading capacity of the structure.
      a. Contractor is responsible for damage to structures due to improper backfilling and compaction.

B. Embankments:
   1. After clearing is completed, scarify entire areas that underlie embankments to a depth of 6 inches and until surface is free of ruts, hummocks, and other features that would prevent uniform compaction by equipment to be used.
   2. Recompact scarified areas to density specified for embankments before placing of embankment material.
   3. If embankment areas have cemented rock, cobbles, or boulders, do not scarify the top 6 inches prior to compaction. Moisten the native soil and compact the coarse fill as specified in this Section.

C. Fills:
   1. After clearing is completed, scarify entire areas that underlie fill sections or structures to a depth of 6 inches and until surface is free of ruts, hummocks, and other features that would prevent uniform compaction by equipment to be used.
   2. Recompact scarified areas to density specified for compacted fills before placing of fill material or concrete.
   3. If fill areas have cemented rock, cobbles, or boulders, do not scarify the top 6 inches prior to compaction. Moisten the native soil and compact the coarse fill as specified in this Section.

D. Roadway fills:
   1. After clearing is completed, scarify entire areas that underlie roadway fills to a depth of 6 inches and until surface is free of ruts, hummocks, and other features that would prevent uniform compaction by equipment to be used.

2. Recompact scarified areas to density specified for roadway fills before placing of roadway fill material.
3. If roadway fill areas have cemented rock, cobbles, or boulders, do not scarify the top 6 inches prior to compaction. Moisten the native soil and compact the coarse fill as specified in this Section.

E. Sloped surfaces for fill or foundations:
1. Foundations for fill having slopes in excess of 1 vertical to 4 horizontal:
a. Bench or terrace to adequately key existing ground and fill built thereon.
2. Slopes of original hillsides and old fills: Bench minimum of 10 feet horizontally as fill is placed.
3. Provision of new benches:
a. Start new bench wherever vertical cut of next lower bench intersects existing grade.
b. Recompact material thus cut out along with new embankment material at no additional cost to the Owner.

3.03 INSTALLATION

A. General:
1. Dispose of excavated materials that are not required or are unsuitable for fill and backfill in lawful manner.
2. Dispose of surplus material on private property only when written permission agreement is furnished by owner of property. Submit copies of such agreements.
3. Rocks, broken concrete, or other solid materials larger than 4 inches in greatest dimension: Remove from project site at no additional cost to the Owner.
4. Stabilization of subgrade: Provide materials used, or perform work required, to stabilize subgrade so it can withstand loads that may be placed upon it by Contractor's equipment.

B. Compaction:
1. Provide specified compaction for backfills, cuts, embankments, fills, roadway fills, and other earthwork.
2. Perform confirmation tests to verify and confirm that work has complied, and is complying at all times, with compaction requirements specified in this Section for initial compaction demonstration and field quality control testing.
3. In-place density of compacted backfills, cuts, embankments, fills, and roadway fills determined in accordance with ASTM D1556, or with ASTM D6938.
4. Maximum density obtained in laboratory when tested in accordance with ASTM D1557.
5. To prevent damage to structures due to backfilling operations, place backfill with equipment that does not exceed H-20 loading, within a distance from the face of the structure of not less than 1/2 the depth of backfill. The depth of backfill is the distance between the level being compacted and the bottom of the excavation. Outside this distance, heavier compaction equipment may be used.
6. Compact to percentage of maximum density as follows:
a. Backfill adjacent to structures: 95 percent.
b. Backfilling voids: 95 percent.
c. Embankments: 95 percent.

d. Demolition areas: As indicated on the Drawings.
e. Loose fill:
    1) No compaction other than by hauling vehicles will be required.
    2) Uniformly distribute travel of vehicles over fill area as required to provide uniformly compacted surface.
f. Other areas: 85 percent.
g. Spoil areas indicated on the Drawings: No minimum required.
h. Under present and future structures: 95 percent.
i. Under roadways, parking and storage areas, curbs, and sidewalks: 95 percent.
j. Upper 6 inches of cuts: 95 percent.
k. Fills: 95 percent.

C. Dewatering: As specified in Section 02240 - Dewatering for Structures.

D. Excavation:
1. Blasting: Not permitted.
2. Excavations for structures:
    a. Provide excavations conforming to dimensions and elevations indicated on the Drawings for each structure, including trenching for piping and all work incidental thereto.
    b. After clearing is complete, excavate for the structure, down to the elevation indicated on the Drawings. Unless directed by Engineer, do not carry excavations below elevation indicated on the Drawings.
    c. Where soil is encountered having unsuitable bearing value, Engineer may direct in writing that excavation be carried to elevations below those indicated on the Drawings.
    d. Where excavations are made below elevations indicated on the Drawings, adjust elevations of excavations in accordance with the following requirements:
        1) Under slabs: Restore to proper elevation in accordance with procedure specified for backfill in this Section.
        2) Under footings: Restore to the proper elevation using one of the following:
            a) Aggregate base course.
    e. Excavation width:
        1) Extend excavations at least 2 feet clear from walls and foundations of structures to allow for placing and removal of forms, installation of services, and inspection.
        2) Do not undercut slopes.
    f. Difficulty of excavation: No extra compensation will be made for removal of rock or any other material due to difficulty of excavation.
3. Excavation of ditches and gutters:
    a. Cut ditches and gutters accurately to cross sections and grades indicated on the Drawings.
    b. Take care not to excavate ditches and gutters below grades indicated on the Drawings.
    c. Backfill excessive ditch and gutter excavations to grade with suitable material acceptable to the Engineer.
    d. Do not deposit any material within 3 feet of edge of ditch unless otherwise indicated on the Drawings.

4. Necessary over-excavation:
    a. Where it becomes necessary to excavate beyond normal lines of excavation in order to remove boulders or other interfering objects, backfill voids remaining after removal as specified in backfilling of voids below, or as acceptable to the Engineer.
    b. Backfill voids with material acceptable to the Engineer:
        1) With acceptance of the Engineer, backfill with one of the following:
            a) Aggregate base course.
            b) Controlled low-strength material.

E. Materials for backfills, embankments, fills, and roadway fills:
1. General:
    a. Obtain import material from other sources if surplus materials from cuts and excavations obtained from within Project site do not conform to specified requirements or are not sufficient in quantity for construction of Project.
2. Backfills:
    a. Backfill adjacent to structures, slabs, or walls: Native material or imported material meeting the requirements of native material, unless otherwise specified or indicated on the Drawings.
    b. Backfill material under concrete structures: Aggregate base course material, except in areas where controlled low-strength material or concrete encasement are indicated on the Drawings.
    c. Extend backfill in any area under concrete structures from undisturbed soil or rock to the bottom aggregate base course material layer.
3. Embankments:
    a. Native material or imported material meeting the requirements of native material, unless otherwise specified or indicated on the Drawings.
4. Fills:
    a. Native material or imported material meeting the requirements of native material, unless otherwise specified or indicated on the Drawings.
    b. Extend fill in any area under concrete structures from undisturbed soil or rock to the bottom aggregate base course material layer.
5. Roadway fills: One of the following, unless otherwise specified or indicated on the Drawings:
    a. Aggregate base course material.
    b. Native material or imported material meeting the requirements of native material.

F. Placement:
1. General:
    a. Lines and grades:
        1) Construct backfills, embankments, fills, and road fills, at locations and to lines and grades indicated on the Drawings.
        2) Overbuild all permanent fill slopes by at least 1 foot and then cut to final grade to provide adequate compaction of the remaining fill.
2. Backfills:
    a. Place loose material in successive layers that do not exceed 12 inches in depth after compaction.
    b. Bring each layer to a moisture content between optimum moisture content and 3 percent above optimum moisture content before compacting.
    c. Defective compacted backfills: Remove and recompact.

3. Fills:
    a. Place loose material in successive layers that do not exceed 12 inches in depth after compaction.
    b. Bring each layer to a moisture content between optimum moisture content and 3 percent above optimum moisture content before compacting.
    c. Defective compacted fills: Remove and recompact.
4. Embankments:
    a. Place loose material in successive layers that do not exceed 8 inches in depth after compaction.
    b. Bring each layer to a moisture content between optimum moisture content and 3 percent above optimum moisture content before compacting.
    c. Defective compacted embankments: Remove and recompact.
5. Roadway fills:
    a. Place loose material in successive layers that do not exceed 8 inches in depth after compaction.
    b. Bring each layer to a moisture content between optimum moisture content and 3 percent above optimum moisture content before compacting.
    c. Defective compacted roadway fills: Remove and recompact.

3.04 FIELD QUALITY CONTROL

A. Tests:
1. Confirmation tests:
    a. Contractor's responsibilities:
        1) Accomplish specified compaction for backfills, fills, and other earthwork.
        2) Control operations by confirmation tests to verify that compaction work complies, and is complying at all times, with requirements specified in this Section concerning compaction, control, and testing.
        3) Cost of confirmation tests: Paid for by the Contractor.
        4) Qualifications of Contractor's testing laboratory: Perform confirmation testing by soils testing laboratory acceptable to the Engineer.
        5) Copies of confirmation test reports: Submit promptly to the Engineer.
    b. Frequency of confirmation testing:
        1) Perform testing not less than the following:
            a) In-place density:
                (1) Backfill: 1 per every 20 cubic yards.
                (2) Cuts: 1 per every 500 square feet.
                (3) Embankments: 1 per every 100 cubic yards.
                (4) Fills: 1 per every 100 cubic yards.
                (5) Roadway fills: 1 per every 100 cubic yards.
            b) Maximum dry density versus moisture:
                (1) 1 for every material type.
                (2) If at any time during placement and compaction the material appears to have changed, Engineer may request a new maximum dry density versus moisture test for that material.
2. Compliance tests:
    a. Periodic compliance tests will be made by the Engineer to verify that compaction is meeting requirements previously specified.
    b. Remove overburden above level at which the Engineer wishes to test. Backfill and recompact excavation after testing is completed.

c. If compaction fails to meet specified requirements, perform remedial work by one of the following methods:
    1) Remove and replace materials at proper density.
    2) Bring density up to specified level by other means acceptable to the Engineer.
d. Retesting:
    1) Contractor bears the costs of retesting required to confirm and verify that remedial work has brought compaction within specified requirements.
    2) Contractor's confirmation tests during performance of remedial work: Double the normal rate specified.

B. Tolerances:
1. Finish grading of backfills, cuts, embankments, fills, and roadway fills:
    a. Perform fine grading under concrete structures such that finish surfaces are never above the grade or cross section indicated on the Drawings and are never more than 0.10 feet below.
    b. Provide finish surface for areas outside of structures that are within 0.10 feet of grade or cross section indicated on the Drawings.
2. Areas which are not under structures, concrete, asphalt, roads, pavements, sidewalks, dikes, and similar facilities:
    a. Provide finish graded surfaces of either undisturbed soil, or cohesive material not less than 6 inches deep.
    b. Intent of proceeding is to avoid sandy or gravelly areas.
3. Finish grading of surfaces:
    a. Reasonably smooth, compacted, and free from irregular surface changes.
    b. Provide degree of finish that is ordinarily obtainable from blade grader operations, except as otherwise specified.
    c. Uniformly grade areas that are not under concrete.
    d. Finish ditches and gutters so that they drain readily.

3.05 ADJUSTING

A. Finish grades of excavations, backfills, and fills:
1. Repair and reestablish grades to required elevations and slopes due to any settlement or erosion that may occur from action of the elements or any other cause prior to final acceptance.

3.06 PROTECTION

A. Finish grades of backfills, cuts, excavations, and fills:
1. Protect newly graded areas from erosion and deterioration by action of the elements.

B. Ditches and gutters:
1. Maintain ditches and gutters free from detrimental quantities of debris that might inhibit drainage until final acceptance.

END OF SECTION

SECTION 02312

CONTROLLED LOW STRENGTH MATERIAL (CLSM)

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Controlled low strength material (CLSM), also known as “flowable fill.”

1.02 REFERENCES

A. American Concrete Institute (ACI):
   1. 229R - Report on Controlled Low-Strength Materials.
   2. 301 - Specifications for Structural Concrete.

B. ASTM International (ASTM):
   1. C94 - Standard Specification for Ready Mix Concrete.
   2. C143 - Standard Test Method for Slump of Hydraulic Cement Concrete.
   3. C150 - Standard Specification for Portland Cement.
   4. C260 - Standard Specification for Air-Entraining Admixtures for Concrete.
   5. C494 - Standard Specification for Chemical Admixtures for Concrete.
   6. C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
   7. D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3(600 kN-m/m3).
   8. D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3(2,700 kN-m/m^3)).
   9. D4832 - Standard Test Method of Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders.
   10. D5971 - Standard Practice for Sampling Freshly Mixed Controlled Low Strength Material.
   11. D6023 - Standard Test Method for Density (Unit Weight), Yield, Cement Content, and Air Content (Gravimetric) of Controlled Low-Strength Material.
   12. D6103 - Standard Test Method for Flow Consistency of Controlled Low Strength Material.

1.03 SYSTEM DESCRIPTION

A. Mixture of portland cement, water, pozzolan, fine aggregate and admixtures, proportioned in accordance with the recommendations of ACI 229 to produce a homogeneous mixture that is flowable, that will readily work into corners and angles; that will not segregate in the plastic state; and that is self-compacting at the time of placement without the use of mechanical vibration.

B. Performance requirements:
   1. Air content, total calculated in accordance with ASTM D6023: Not less than 8.0 percent, nor greater than 12.0 percent.

2. Compressive strength, measured in accordance with ASTM D4832 at 28 days: Not less than 50 pounds per square inch, nor greater than 150 pounds per square inch.
3. Wet density: Not greater than 132 pounds per cubic foot.
4. Slump, measured in accordance with ASTM C143 at the point of placement: Greater than 9 inches and that allows CLSM to flow freely and to be self-compacting during placement.

1.04 SUBMITTALS

A. Product data: Submit data completely describing materials in the mix and demonstrating compliance with the requirements of this Section.
   1. Cement: Mill tests. Indicate alkali content representative of each shipment.
   2. Fly ash: Identify source and type of fly ash.
   3. Water: Identify source and quality if not from a municipal treatment source.
   4. Admixtures: Manufacturer's product data indicating suitability for use in CLSM mixes and recommended dosage rates.
   5. Aggregate:
      a. Submit source, type, and sieve analyses.
      b. Resubmit at any time there is a significant change in grading of materials.

B. Mix design:
   1. Submit full details, including mix design calculations for mix proposed for use.
   2. Trial batch test data:
      a. Submit data for each test cylinder.
      b. Submit data that identifies mix and slump for each test cylinder.

1.05 DELIVERY, STORAGE AND HANDLING

A. Store or stockpile cement, fly ash, and aggregate in accordance with ACI 301.

B. Store admixtures in accordance with the manufacturer's recommendations.

PART 2 PRODUCTS

2.01 MATERIALS

A. Cement:
   1. Portland cement in accordance with ASTM C150, Type I or Type II.
   2. Having total alkali content not more than 0.60 percent.

B. Fly ash: Class C or Class F fly ash in accordance with ASTM C618.

C. Water:
   1. Potable water: Clean and free from oil and deleterious amounts of alkali, acid, organic matter, or other substances.

D. Admixtures: Products of a single manufacturer, specifically manufactured or recommended by that manufacturer for use in CLSM.
   1. Air entraining admixture: In accordance with ASTM C260.
   2. Water reducing admixture: In accordance with ASTM C494, Type A.

E. Aggregate:
   1. Non-expansive, non-reactive, inert natural sand conforming to the following requirements:
      a. Not more than 12 percent passing a No. 200 sieve.
      b. No plastic fines present.
      c. Including pea gravel no larger than 3/8 inch.

2.02 MIXES

A. See System Description for performance requirements of the plastic and hardened mix.

2.03 SOURCE QUALITY CONTROL

A. Trial batch:
   1. After mix design has been accepted by Engineer, have trial batch of the accepted mix design prepared by testing laboratory acceptable to Engineer.
   2. Prepare trial batches using the specific cement, fly ash, admixtures, aggregates, and water proposed for the Work.
   3. Prepare trial batch with quantity sufficient to determine slump, workability, and consistency; and to provide test cylinders as indicated in the this Section.

B. Trial batch testing:
   1. Determine slump in accordance with ASTM C143, with the following modifications:
      a. Do not rod the concrete material.
      b. Place material in slump cone in one semi-continuous filling operation, slightly overfill, tap lightly, strike off, and then measure and record slump.
   2. Prepare and test trial batch specimens in accordance with ASTM D4832, with the following modifications:
      a. Provide cylindrical test specimens, each 6 inches in diameter by 12 inches high.
      b. Provide a minimum of 8 cylinders for testing of each trial batch.
      c. Fill the molds to overflowing and tap sides lightly to settle the mix.
      d. Do not rod the mix for consolidation in the cylinder.
      e. Strike off the excess material.
   3. Place test cylinders in a moist curing room. Exercise caution in moving and transporting the cylinders since they are fragile and will withstand only minimal bumping, banging, or jolting without damage.
   4. Do not remove the test cylinder from mold until that cylinder is to be capped and tested.
      a. Perform the capping carefully to prevent premature fractures.
      b. Do not perform initial compression test until the cylinders reach a minimum age of 3 days.
   5. Provide compressive strength tests:
      a. Test 4 test cylinders at 7 days after casting, and another 4 cylinders at 28 days after casting.
      b. The compression strength of the 4 test cylinders tested at 28 days shall be equal to or greater than the minimum required compression strength, but shall not exceed maximum compression strength.

C. If the trial batch tests do not meet the Specifications for strength or density, revise and re-submit the mix design, prepare additional trial batch(es), and complete additional trial batch tests. Repeat until an acceptable trial batch is that conforms to the Specifications is produced.
   1. All the trial batches and acceptability of materials shall be paid by the Contractor.
   2. After acceptance, do not change the mix design without submitting a new mix design, trail batches, and test information.

PART 3 EXECUTION

3.01 PREPARATION

A. Do not place CLSM until preparation and condition of surfaces receiving the fill have been observed and accepted by the Engineer.

B. Remove debris foreign matter, and standing or running water from excavations and areas receiving CLSM before placement.

3.02 INSTALLATION

A. Pipes and trenches.
   1. Install cellular concrete as indicated on the Drawings and specified.
   2. Where CLSM is placed around and over pipes, secure pipes in place, or place CLSM in lifts to prevent pipe flotation.
   3. Where CLSM is placed in long, open trenches, confine material using bulkheads of sandbags, earth dams, or stiffer concrete at open ends of placement.

B. Soil preparation:
   1. Prior to placement of CLSM, prepare underlying soils as follows:
      a. Scarify surface to a depth of 8 inches.
      b. Adjust moisture content to or slightly above the optimum in accordance with ASTM D1557.
      c. Re-compact scarified surface to a minimum of 95 percent relative density in accordance with ASTM D1557.

3.03 MEASURING, BATCHING, MIXING AND TRANSPORTING

A. Measure, batch, mix and transport CLSM in accordance with the requirements of ASTM C94 and this Section.

B. Mix until there is uniform distribution of materials.

C. Discharge mixer completely prior to recharging.

D. After trial batch testing and mix acceptance, maintain slump during construction within plus or minus 1 inch of the design slump.

3.04 PLACING

A. Place controlled low strength material by method that preserves the quality of the material in terms of compressive strength and density.

B. Maintain fluid properties of the mix during placement.
   1. At point of placement, provide material that flows easily around, beneath, or through walls, pipes, conduits, or other structures.
   2. Do not place CLSM that has partially hardened or that has been contaminated by foreign materials.
   3. Handle and place CLSM using methods that minimize segregation of the mix.
   4. Deposit mix as near its final position as possible to avoid segregation due to rehandling or flowing.
   5. Contain and confine mix while it is fluid. Design containment structures and bracing at walls and forms to withstand lateral pressures of wet mix.

C. Lifts:
   1. Limit lift heights of CLSM placed against structures and other facilities that could be damaged due to the pressure from the CLSM, to the lesser of 3 feet or the lift height indicated on the Drawings.
   2. Do not place another lift of CLSM until the last lift of CLSM has set and gained sufficient strength to prevent additional lateral load against the forms or structure due to the weight of the next lift of CLSM.

D. Water conditions:
   1. Do not place CLSM in standing or flowing water.
   2. Do not permit water to flow over the surface of freshly placed or un-hardened CLSM.
   3. Do not submerge CLSM in water within 24 hours after placement.

E. Manage CLSM bleed water.
   1. Grade top surface of CLSM to drain away from the fill.
   2. Provide side containment that permits bleed water to drain to a contained management area away from the fill.

3.05 CURING AND PROTECTION

A. Curing:
   1. Prior to and during curing, install barriers to prevent equipment or personnel from falling into or becoming entrapped in CLSM.

B. Protect CLSM from:
   1. Damage from the elements.
   2. Damage of any nature during surrounding construction operations.
   3. Freezing: Do not use salt, manure, or other chemicals to protect from the cold.

3.06 FIELD QUALITY CONTROL

A. Provide quality control over the Work of this Section as specified in Section 01450 - Quality Control and 01460 - Contractor Quality Control Plan and as specified in this Section.

B. General:
   1. Engineer inspection and acceptance required prior to placement.
   2. Make provisions for and furnish all material for the test specimens, and provide manual assistance to assist the Owner's Testing Laboratory in preparing said specimens.

3.07 FIELD QUALITY ASSURANCE

A. Provide quality control over the work of this Section as specified in Section 01450 - Quality Control and 01460 - Contractor Quality Control Plan.

B. Field inspections:
   1. Engineer shall provide on-site inspection for the Work of this Section.
   2. Advise Engineer of readiness to proceed at least 24 hours prior to each placement of CLSM.
   3. Required inspections:
      a. Engineer will observe the prepared areas. Do not place CLSM until Engineer has observed and accepted preparations.
   4. Record of inspections.

C. Field sampling and testing:
   1. During construction, Owner shall provide sampling and testing to determine whether the CLSM, as produced and placed, complies with the requirements specified.
      a. Make provisions for and furnish material for test specimens. Cooperate by allowing free access for Owner's independent testing firm to sample and test materials. Provide assistance in obtaining and preparing said specimens.
   2. Sample CLSM for testing in accordance with ASTM D5971.
   3. Required tests:
      a. Air content: Prepare sample and test in accordance with ASTM D6023
      b. Compressive strength: Prepare and test cylinder specimens in accordance with ASTM D4832.
         1) Prepare 6-inch diameter by 12-inch high specimens for testing.
            a) Provide one set of specimens for each 150 cubic yards of CLSM placed, but not less than 1 set for each half day's placement.
            b) Prepare and test not less than 3 cylinders for each set.
            c) Place CLSM in the molds in accordance with ASTM D4832. Do not rod or otherwise consolidate the material in the mold.
            d) In accordance with ASTM D4832 recommendations for displacing bleed water at the top of the molds and refilling the molds before covering with a lid. Do not use air-tight lids.
         2) Place the cylinders in a safe location away from construction activities.
            a) Protect cylinders from bumping and impact.
            b) Maintain temperature surrounding cylinders between 60 and 80 degrees Fahrenheit until delivery to the laboratory for testing.
            c) After the first day, surround molds with a high humidity environment by covering with wet burlap, or equivalent highly absorptive material. Maintain saturation of the cover. Do not sprinkle water directly on the cylinders.

3) After 4 days, place the cylinders in a protective container for transport to the laboratory for testing.
    a) Exercise caution in moving and transporting the cylinders since they are fragile and will withstand only minimal bumping, banging, or jolting without damage.
    b) Transport container may be a box with a Styrofoam or similar lining that will limit jarring and bumping of the cylinders.
4) Upon receipt at the testing laboratory, place test cylinders in a moist curing room until dates for testing.
5) Do not remove test cylinders from molds until the day that cylinders is to be capped and tested.
6) Cap and test for compressive strength in accordance with ASTM D4832.
    a) Do not perform initial compression test until the cylinders reach an age of at least 4 days.
    b) Test 1 cylinder at 7 days and 2 at 28 days.
7) Compressive strength of the cylinders tested at 28 days shall be equal to or greater than the minimum required compression strength, but shall not exceed maximum compression strength specified.

3.08 NON-CONFORMING WORK

A. When testing or observation indicates CLSM with properties outside the specified and accepted range, Engineer will issue instructions regarding disposition of nonconforming materials.

B. Engineer may:
    1. Reject CLSM represented by those test specimens and require its removal and replacement.
    2. Require modification of the mix design to provide CLSM with the properties specified.

C. Make such modifications at no additional expense to the Owner and with no adjustment to the schedule.

END OF SECTION

SECTION 02330

TRENCHING AND BACKFILLING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Trench excavation and backfilling for pipelines including appurtenant structures such as manholes, junction boxes, valve vaults, etc.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. C117 - Standard Test Method for Materials Finer than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing.
   2. C131 - Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
   3. C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
   4. D422 - Standard Test Method for Particle-Size Analysis of Soils.
   5. D1557 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft lbf/ft^3 (2,700 kN m/m^3)).
   6. D2844 - Standard Test Method for Resistance R-Value and Expansion Pressure of Compacted Soil.
   7. D4253 - Standard Test Method for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
   8. D4254 - Standard Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
   9. D4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

1.03 SUBMITTALS

A. As specified in Section 01330 - Submittal Procedures.

B. Product data for backfill materials:
   1. Test reports.

C. Qualifications of Safety Officer.
   1. Include description of previous experience as a Safety Officer on similar projects with a list of references including phone numbers for review and Owner approval.

D. Protection System Design Certificate(s):
   1. A separate certificate shall be submitted for each unique Protection System design.

E. Confirmation testing:
   1. Qualifications of Contractor's testing laboratory:
      a. Include lab certification.

2. Field compliance test reports.

1.04 DESIGN REQUIREMENTS

A. Dewatering requirements as specified in Section 02240 - Dewatering for Structures.

B. Shored excavation dewatering.
   1. Excavation and shoring design shall consider changes in groundwater conditions and associated earth pressures.
   2. Use impermeable shoring system to minimize lowering of groundwater outside shoring.
   3. Dewater from within shoring.
   4. Extend impermeable shoring below bottom of excavation sufficient amount to:
      a. Minimize lowering of groundwater outside shoring.
      b. To minimize settlement outside shoring due to dewatering, do not lower groundwater outside shoring more than 1 foot.
         1) Provide groundwater recharge if required to maintain this groundwater elevation outside of shoring.
      c. Provide monitoring wells located outside shoring for monitoring groundwater elevation.
      d. The shoring design calculations shall consider the groundwater elevation during construction (i.e. dewatered groundwater elevation).

PART 2 PRODUCTS

2.01 GENERAL

A. Material shall be free of trash, debris, and organic material.

B. The maximum particle size for backfill material and trench bottom preparation as follows:

Nominal Pipe Size (inches)	Maximum Particle Size (inches)
6 to 8	3/4
10 to 16	1
18 and larger	1-1/2

2.02 AGGREGATE BASE COURSE

A. Hard, durable particles or fragments of stone or gravel; crushed to required size and gradation as specified in Section 02050 - Soils and Aggregates for Earthwork.

B. Section 02050 - Soils and Aggregates for Earthwork:
   1. Percentage of wear not greater than 40 percent after 500 revolutions in accordance with ASTM C131.
   2. Plasticity index not more than 5 in accordance with ASTM D4318.
   3. Liquid limit not more than 25 percent in accordance with ASTM D4318.

4. Size and gradation in accordance with ASTM C117 and ASTM C136:

Sieve Sizes (Square Openings)	Percent by Weight Passing Sieve
1-1/8 inch	100
Number 4	38 - 65
Number 8	25 - 60
Number 30	10 - 40
Number 200	3 - 12

2.03 DRAIN ROCK

A. Hard, durable particles of stone or gravel; screened or crushed to specified size and gradation:
   1. No lumps or balls of clay.
   2. Percentage of wear not greater than 40 percent in accordance with ASTM C131.
   3. Size and gradation in accordance with ASTM C117 and C136:

Sieve Size (Square Openings)	33
2 inch	100
1-1/2 inch	95 - 100
3/4 inch	50 - 100
3/8 inch	15 - 55
Number 200	0 - 2

2.04 SELECT MATERIAL

A. Materials can be imported or excavated from the trench.

B. The sum of plasticity index in accordance with ASTM D4318 and the percent of material by weight passing a Number 200 sieve in accordance with ASTM D422 shall not exceed 23.

C. Organic content shall not be greater than 3 percent by volume.

D. Corrosion resistance requirements:

Resistivity (wet aggregates)	5,000 ohm-cm (min)
pH	5.0 to 12.0
Chlorides	100 PPM (max)
Sulfates	200 PPM (max)

2.05 SAND

A. Clean, coarse, natural sand.

B. Non-plastic in accordance with ASTM D4318.

C. Sieve analysis requirements in accordance with ASTM D422:
   1. 100 percent shall pass a 1/2-inch screen.
   2. No more than 20 percent shall pass a Number 200 sieve.

2.06 STABILIZATION MATERIAL.

A. Clean, hard, durable particles of crushed rock or gravel; screened or crushed to the specified size and gradation; and free of any detrimental quantity of soft, friable, thin, elongated, or laminated pieces, disintegrated material, organic matter, oil, alkali, or other deleterious substance.

B. Shall be free of slaking or decomposition under the action of alternate wetting and drying.

C. The portion of material retained on the 3/8-inch sieve shall contain at least 50 percent of particles having 3 or more fractured faces.
   1. Not over 5 percent shall be pieces that show no such faces resulting from crushing.
   2. Of that portion which passes the 3/8-inch sieve but is retained on the Number 4 sieve, not more than 10 percent shall be pieces that show no faces resulting from crushing.

D. Percentage of wear not greater than 40 percent in accordance with ASTM C131.

E. Conforms to size and gradation in accordance with ASTM C117 and ASTM C136.

Sieve Size (Square Openings)	**Percent by Weight Passing Sieve**
1 inch	100
3/4 inch	90 - 100
Number 4	0 - 10
Number 200	0 - 2

2.07 CONTROLLED LOW-STRENGTH MATERIAL (CLSM)

A. As specified in Section 02312 - Controlled Low Strength Material (CLSM).

PART 3 EXECUTION

3.01 TRENCH EXCAVATION

A. Preparation:
   1. Dewatering:
      a. As specified in Section 02240 - Dewatering for Structures.

b. Excavations shall be kept dry during trench bottom preparation and continually until the pipe has been installed to the extent that no damage from hydrostatic pressure, flotation, or other cause will result.
c. Surface water shall be diverted or otherwise prevented from entering excavations without causing damage to property.
d. Contractor shall be responsible for the condition of any pipe or conduit used for drainage purposes.
1) Return such pipe or conduit to clean condition and free of sediment.

2. Clearing:
a. Perform clearing to allow access, stringing of pipeline materials, and construction of the pipeline and appurtenances.

3. Cutting concrete:
a. Limit cuts in concrete pavement and concrete base pavements to no larger than necessary to provide adequate working space for installation of pipe and appurtenances as recommended by the manufacturer.
1) No undercutting during trench excavation will be allowed.
b. Start cutting with a concrete saw providing a clean groove at least 1 1/2 inches deep along each side of the trench and as needed along the perimeter of cuts for appurtenant structures.
c. Make cuts to and between straight or accurately marked curved lines which, unless otherwise required, shall be parallel to the center line of the trench.
d. Pavement removal for connections to existing lines or structures shall not exceed that necessary for the installation.
e. Where the trench parallels the length of concrete walks, and the trench location is all or partially under the walk, the entire walk shall be removed and replaced.
f. Where the trench crosses driveways, walks, curbs, or other concrete surfaces, the concrete shall be removed.

B. Excavation support and protection:
1. As specified in Section 02260 - Excavation Support and Protection.
a. Performance monitoring of the Protection System from the beginning of installation until it is abandoned in-place or removed.
b. Each design shall address the actions to be taken if measurement threshold limits are reached or exceeded.
2. At least 30 days before starting construction of the Protection System submit the Protection System Design Certificate(s).
3. Contractor shall be responsible for the stability and adequacy of the Protection System's design, installation, and monitoring as well as all costs and damages resulting from any failure.

C. Excavation:
1. Mechanical equipment will not be permitted in locations where its operation would cause damage to trees, buildings, culverts, utilities, or structures. In all such locations, hand excavating methods shall be used.
2. The rough trench bottom elevation and trench alignment shall allow the pipe, when accurately installed to the specified alignment, to be centered in the trench.
a. Undercutting the trench sidewall to obtain sidewall clearance is not permitted.

3. Excavations shall provide adequate working space and clearances to install the Protection System, prepare the trench subgrade, install the pipe, and place and compact the backfill. Native subgrade surfaces shall be clean and free of loose material before placing subgrade material.
4. Trench shall be considered open until backfilled to final grade.
    a. The maximum amount of open trench permitted in any one location shall be 500 feet, unless otherwise approved by the Engineer.
    b. If the Contractor is not expected to fully complete the work within any excavated area in a reasonable length of time, as determined by the Engineer, the Contractor shall backfill the excavation and re-excavate when the work can be completed.
5. Excavation and trenching work shall include the removal and subsequent handling of all materials excavated or otherwise removed in performance of the work, regardless of their type, character, composition, or condition.
6. Blasting or any use of explosives for excavation is not permitted.
7. Rocks, broken concrete, or other solid materials larger than 4 inches in greatest dimension shall be removed from the project site and disposed legally off site.
8. Excavate to the trench bottom elevation indicated on the Drawings.
    a. Holes shall provide adequate clearance for bells, couplings, tools, grouting, banding, welding, and other methods used to install the pipe. During pipe jointing, no part of any bell or coupling shall be in contact with the trench bottom, trench walls, or granular embedment.
    b. Where the bottom of the trench is excavated below the depth indicated on the Drawings, restore the trench bottom to the proper grade by back filling with aggregate base course material compacted to 95 percent of the density determined by Method C of ASTM D1557.
    c. Minimum trench widths to be the pipe's outside diameter plus 24 inches. Trenches shall be excavated to a width which will provide adequate working space and sidewall clearances for proper shoring system, pipe installation, jointing, and embedment.
        1) Where width of trench exceeds limits specified.
            a) Before installing pipes, backfill and compact, in maximum 8 inch lifts, the trench to at least 2 feet above the proposed elevation of the top of pipe.
                (1) Compact backfill to 95 percent of the density determined by Method C of ASTM D1557.
                (2) Re-excavate pipe trench through compacted backfill.
9. For appurtenant structures:
    a. Provide excavations sufficient to leave at least 12 inches clear between their outer surfaces and the sides of trench or shoring.
    b. Fill any unauthorized excess excavation below elevation indicated on the Drawings with aggregate base course material, compacted to 95 percent of the density determined by Method C of ASTM D1557.
10. Trench bottoms shall be firm, dense, thoroughly compacted and consolidated, free from mud and muck, and sufficiently stable to remain firm and intact under the feet of the workers.
    a. Whenever the trench bottom is unsuitable or unstable, as determined by the Engineer, trenches shall be over-excavated and backfilled to the trench bottom elevation as indicated on the Drawings. Backfill with stabilization material compacted to 90 percent of maximum density.

1) If the groundwater elevation is above trench bottom, then drain rock shall be used.
b. Place Geogrid as indicated on the Drawings.
c. Place Stabilization Fabric as indicated on the Drawings.

3.02 BACKFILL AND COMPACTION

A. Determine maximum dry density and relative density for each source or quality of material:
1. In accordance with ASTM D1557, Method C.
2. Material gradation with 10 percent or more passing a No. 4 sieve: In accordance with ASTM D4253.
3. Material gradation with less than 10 percent passing a No. 4 sieve: In accordance with ASTM D4254.

B. Field density requirements:

TABLE A

Location or Use of Fill or Backfill	Percentage of Maximum Dry Density	Percentage of Relative Density
Pipe zone backfill	95	70
Final backfill, beneath paved areas or structures.	95	70
Final backfill, not beneath paved areas or structures.	90	70
Trench zone backfill, beneath paved areas and structures, including trench plugs.	90	70
Trench zone backfill, not beneath paved areas or structures, including trench plugs.	90	70

C. Pipe Zone:
1. Bedding:
a. Bedding material shall be CLSM as specified above for all pipe 16 inches and large. Fill pipe zone to springline of pipe with CLSM.
b. For pipes smaller than 16 inches nominal diameter and under.
1) Place 6 inches of uniform bedding material below bottom of pipe.
2) Conform to the density requirements specified in Table A.
2. Bell or coupling holes:
1) Dig holes after placement of bedding material.
2) Provide holes of sufficient width and depth to provide ample room for grouting, banding, or welding.
3) Excavate holes only as necessary for making joints and to ensure that pipe rests upon prepared bedding and not supported by any portion of the joint.
b. Depressions for joints, other than bell-and-spigot:
1) In accordance with joint manufacturer recommendations.
3. For appurtenant structures:
a. Bedding under with aggregate base course material.
b. Backfilling of manhole excavation: Backfilling requirements as specified in this Section.

c. Fill any unauthorized excess excavation below elevation indicated on the Drawings for foundation of any structure with aggregate base course at no additional cost to the Owner.

4. Pipe installation:
   a. Fix and determine alignment and grade or elevation of each pipeline from offset stakes.
   b. Vertical and horizontal alignment of pipes: As specified in pipe specifications.
   c. Maximum joint deflection: As specified in pipe specifications.
   d. Alignment and grade of the final pipe installation as indicated on the Drawings.
   e. Close the open end of the pipe with a tight-fitting cap or plug to prevent the entrance of foreign matter any time pipe installation is not in progress.
5. Pipe bedding:
   a. Pipe bedding material as specified in this Section and as indicated on the Drawings.
   b. After pipe installation:
      1) Place bedding material around pipe in 8 inch maximum lifts, to 12 inches above the top of the pipe.
      2) Conform to the density requirements specified in Table A.
   c. Pipe displacement:
      1) Prevent displacement of piping to no more than allowed as specified in pipe specification.
      2) If displacement is more than allowed, re-excavate, re-lay, and re-backfill.

D. Trench Zone:
1. Trench Zone materials as specified in this Section and as indicated on the Drawings.
2. Place Trench Zone backfill material in 12 inch maximum lifts. Conform to the following:
   a. Under structures:
      1) Backfill to the underside of structures with aggregate base course material conforming to the density requirements specified in Table A
   b. Trenches across roadways and paved streets:
      1) Backfill to the underside of the pavement with aggregate base course material conforming to the density requirements specified in Table A.
   c. Trenches under and parallel to roadways, paved areas:
      1) Backfill to within 2 feet of finish grade with select material conforming to the density requirements specified in Table A.
      2) Backfill from 2 feet below finish grade to finish grade, or underside of aggregate base course or pavement as indicated on the Drawings with aggregate base course material conforming to the density requirements specified in Table A.
   d. Areas outside the improved section of roadways or in open country:
      1) Finish grade backfill shall be native material, compacted to the density in accordance with Table A.
   e. Under existing intersecting pipes or conduits larger than 3 inches in diameter:
      1) Backfill from bottom of new pipe trench to spring line of intersecting pipe or conduit with aggregate base course material conforming to the density requirements specified in Table A.

2) Extend CLSM 2 feet on either side of intersecting pipe or conduit to ensure that material remains in place while other backfill is being placed.
3) Backfill remainder of trench conforming to the density requirements specified in Table A.

E. Compaction:
1. Water settling methods such as flooding, poling, jetting, etc. are not allowed.
2. Confirmation testing:
a. Confirm adequacy of compaction equipment and procedures before exceeding any of 200 linear feet of trench backfill.
b. Do not perform additional backfill and compaction until specified degree of compaction on backfill is confirmed.
c. Confirmation testing is required for each unique compaction operation and each unique material used for backfill.
d. Contractor shall employ and pay an approved independent testing laboratory to provide testing.

F. Excess material:
1. Remove excess excavated material from the Project site and legally dispose off-site.

3.03 FIELD QUALITY CONTROL

A. Compliance testing:
1. Contractor to pay for compliance testing using the same testing laboratory used for confirmation testing.
2. Perform testing not less than as follows:
a. For trenches: At each test location include tests for each type or class of backfill from bedding to finish grade:
1) In open fields: 2 every 1,000 linear feet.
2) In unpaved roads or off traveled right-of-way: 2 every 500 linear feet.
3) Crossing paved roads: 2 locations along each crossing.
4) Under pavement or within 2 feet of pavement edges: 1 location every 400 linear feet.
b. If density fails to meet specified requirements: Perform remedial work by removing and replacing backfill compacted to the proper density.
1) Retest for compliance with twice the number of tests as required for initial compliance testing.

3.04 SETTLEMENT

A. Contractor shall be responsible for settlement of trench backfill which may occur within the correction period stipulated in the General Conditions.

B. Contractor shall make, or cause to be made, repairs, or replacements made necessary by settlement within 30 days after notice from Engineer.

END OF SECTION

SECTION 02553

TEMPORARY BYPASS PUMPING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Requirements for temporary bypass pumping of wastewater flows on plant sites as needed to complete the Work.

1.02 REFERENCES

A. National Fire Protection Association (NFPA):
   1. 820 - Standard for Fire Protection in Wastewater Treatment and Collection Facilities.

1.03 GENERAL REQUIREMENTS

A. Provide all necessary labor, tools, materials, and supervision to provide temporary bypass pumping and flow control in accordance with the requirements of this Section.

B. Operate and maintain bypass pumping facilities including, but not limited to, pumps, piping, valves, controls, and monitoring until the involved portion(s) of the Work have been completed to the satisfaction of the Engineer.

C. Bypassing wastewater in a way that ensures that no wastewater is allowed to leak outside of the bypass system or plant facilities. If leakage does occur, pay all fines and reimburse the Owner for all costs associated with the cleanup of the leakage, as wells as costs associated with legal actions.

D. Accept responsibility for any release of wastewater and for penalties associated with bypass pumping activities, including commissioning, operating, and decommissioning of bypass pumping facilities.

E. Coordinate the placement of the bypass piping and pumping equipment with the Owner.

F. The means and methods of accomplishing and maintaining the temporary bypass pumping and associated facilities shall be the sole responsibility of the Contractor.

G. Except as otherwise specified or authorized in writing, no interruption of wastewater flow shall be permitted throughout the duration of the project. Contractor is responsible for all wastewater overflows during construction of this work and bypass operations.

H. Take precautions to prevent any potential spillage of wastewater from entering the stormwater system.

I. Temporary bypass pumping operation:
   1. Limited to the months, times, or seasons indicated, unless approved in writing by the Engineer.
   2. Continuous operation for 24 hours per day and 7 days per week is anticipated during the period of Work.

J. Continuously monitor temporary bypass pumping.

K. Provide qualified operators continuously during operation of the bypass systems.

1.04 SUBMITTALS

A. Prepare and submit a project-specific wastewater bypass pumping plan with completed wastewater bypass pumping checklist.
   1. Be advised that the bypass plan must provide accessibility for pedestrians and vehicular traffic in accordance with Owner requirements.

B. Wastewater bypass pumping plan: Include the following at a minimum:
   1. Capacities and sizes of pumps, standby equipment, and power requirements, if applicable.
   2. Design calculations of the system and selected equipment, including flow, TDH with static head including all friction and minor losses, pump curves showing operating range of flow and TDH at minimum, average, and peak flow.
   3. Standby power generator size and location for electrically-driven bypass pumps.
   4. Downstream discharge plan.
   5. Pipe thrust and restraint types, sizes, and locations.
   6. Temporary pipe supports and anchoring required.
   7. Plans for access to bypass pumping locations.
   8. Schedule that shows duration of temporary bypass pumping including milestones for installation, maintenance, and removal of equipment and accessories.
   9. Means and methods of installing, operating, monitoring, and maintaining the temporary bypass pumping.
   10. Plan indicating bypass pumping line locations.
      a. Include details showing methods used to protect and identify the bypass pumping lines through the length of the bypass route.
   11. Detailed plans of a backup system.
   12. Address access for pedestrians and vehicular traffic.
   13. Mechanical plan showing equipment, valves, pipe sizes and locations, pipe materials, dimensions, vehicle access (where applicable), pedestrian access (where applicable).
   14. Schematic drawings and written description of the control system and its' operating sequence.
   15. Proposed type and location of collection system plugs.
   16. Catalog cut sheets for pumping equipment, pipe and fittings, valves.
   17. Emergency response plan.
   18. Staffing plan.
   19. Spill prevention and cleanup plan.
   20. Noise control system.
   21. Health and safety plan.

22. Surge or water hammer calculations and attenuation means.
23. Maintenance history of pumps.
24. Operating permits from jurisdictional air quality agency for each engine.

1.05 QUALITY ASSURANCE

A. Contractor's qualifications:
   1. Minimum 5 years' experience in performing substantially similar temporary bypass operations.
   2. Submit evidence of satisfactory operation of temporary bypass facilities similar to those specified in at least 5 separate projects in accordance with the specifications, including references.

B. Fulfillment of the specified experience requirements shall be a condition of acceptance.

PART 2 PRODUCTS

2.01 CAPACITY

A. Pumps, piping and accessories: Of adequate capacity and size to handle the range of wastewater flows from minimum flow to peak flow.

B. Piping, fittings, and all accessories shall withstand 1.5 times the maximum pressure including surge.

C. Maintain on site sufficient equipment and materials to ensure continuous and successful operation of the bypass system.
   1. Have standby pump(s) on site to provide 100 percent redundancy of the bypass system design Peak Flow.
      a. The redundant pump(s) shall be plumbed, fueled, and ready for operation at all times.
   2. Provide sufficient bypass lines to provide 100 percent redundancy of the bypass system design Peak Flow.
      a. The bypass lines and separate redundant lines shall be connected via a combined header that enables the shutdown and isolation of each individual line should a leak or rupture occurs.
   3. Maintain on site a sufficient number of valves, tees, elbows, connections, tools, pipe plugs, piping, and other parts or system hardware to ensure immediate repair or modification of any part of the bypass system as necessary.

2.02 BYPASS PUMPS

A. Provide a minimum of 2 pumps: 1 duty and 1 standby.

B. Pump capacity: Sufficient to pump the anticipated peak hour flow with the largest pump out of service.

C. Pumps: Packaged units with a skid base or trailer.

D. Pumps: Fully automatic, self-priming, close-coupled centrifugal units that do not require use of foot valves or vacuum pumps for priming.

E. Pumps shall use oil-lubricated mechanical seal.

F. Pumps shall be capable of passing 4-inch diameter solids, rags, rocks, hair and other debris encountered in municipal wastewater.

G. Pump driver: Diesel engine or 480-V electric engine and include the following:
   1. Minimum 24-hour capacity diesel fuel tank as defined by fuel consumption during peak pumping rate.
   2. Fuel gauge with red warning light when tank approaches empty.

H. Pumps shall be capable of dry operation for up to 3 hours to accommodate large fluctuations in flow.

I. Maximum pump speed: Not exceeding 2,200 revolutions per minute.

J. The system shall include the following features:
   1. START/STOP operation.
   2. Variable flow based on water level in suction structure.
   3. Instrumentation and controls for operation and monitoring for each pump.

K. Electrical equipment, instrumentation and accessories: Suitable for Class 1 Division 1 service as defined by NFPA 820.

L. Comply with applicable air quality regulations.

2.03 BYPASS PIPING

A. Use HDPE**,** ductile iron**,** or steel piping for the temporary bypass pumping system.

B. Piping integrity: 0 leakage:
   1. Include spill containment vessels or ‘spillguards’ in areas indicated on the Drawings.

C. Provide sewage type air release valve at high point in piping and containment spills from valves.

D. Provide temporary ramps constructed over pipelines 6 inches in diameter or less to allow access to driveways.
   1. Bury pipelines larger than 6 inches in diameter crossing driveways, a minimum of 6 inches below the existing ground or pavement surface and backfilled with temporary asphalt concrete.
   2. No driveway access shall be blocked without the written authorization of the Owner.

2.04 PIPE PLUGS IN EXISTING PIPE

A. Pipe diameters 24 inches and smaller: Mechanical plugs with EPDM gaskets.

B. Pipe diameters larger than 24 inches: Inflatable bag stoppers with 2 or more pieces. Provide 2 plugs in series.

2.05 NOISE CONTROL

A. Pumping equipment: Equipped with devices or enclosures for noise attenuation including but not limited to mufflers and/or acceptable noise panels or enclosures.

B. The noise level: At or below 75 decibels on the A-scale at 50 feet from the pumping equipment.

PART 3 EXECUTION

3.01 GENERAL

A. Notify the Owner a minimum of 14 days prior to the Work and notify the Engineer at least 72 hours prior to bypassing or diverting flow in any of the pipelines or laterals.

B. Place pumps, generators, and other equipment on a plastic tarp to protect against spills of petroleum products used by the equipment.

C. Before taking plant pipeline out of service, verify that bypass system is fully operational and acceptable to Engineer.

3.02 PROTECTION

A. Be responsible for all bypass flows:
   1. Inspect the entire bypass pumping and piping system for leaks or spills at a frequency of not less than 2 times per shift.
   2. Do not shut down the temporary bypass system between shifts, on holidays or weekends, or during work stoppages without written permission from the Engineer.

B. Provide trained and qualified attendants 24 hours per day 7 days per week until the bypassing is no longer required. The attendants shall:
   1. Be capable of performing pump and piping maintenance required.
   2. Have cellular phones for communication with the Contractor and the Owner in the event of emergencies.

C. No bypassing to the ground surface, receiving waters, storm drains, or bypassing which results in soil or groundwater contamination or any potential health hazards shall be permitted.
   1. In the event of any wastewater spill, be responsible for the prompt cleanup and disinfecting of the spill as called for in the wastewater bypass pumping plan.
   2. Compensate the Owner for the cost of any fines levied as the result of a spill or unauthorized discharge.

D. Implement measures to prevent interference between plant staff and the bypass pumping equipment, pipelines and wastewater.

E. Take precautions to protect all bypass lines from damage.
   1. Clearly identify above ground portions of the bypass lines by flashers, fencing, or other means to warn of their presence.

3.03 FIELD QUALITY CONTROL

A. Hydrostatic pressure test:
   1. Prior to operation, test each section of discharge piping with maximum pressure equal to 1.5 times the maximum operating pressure.
   2. Conduct test for a duration of 4 hours.
   3. Test using utility water.
   4. The line in service after test if the pressure has been maintained and there are no observable leaks.
   5. Notify Engineer at least 48 hours prior to testing.

B. Inspection:
   1. Inspect temporary bypass piping system at a minimum of every hour 24 hours per day.
   2. An attendant/operator shall be present to monitor the operation of the bypass pumps at all times 24 hours per day.
   3. Inspection log: Keep at each pumping location.

3.04 CLEAN-UP

A. The temporary bypass pumping system: Flush, clean and drain prior to dismantling.

B. Dispose of flushing water in approved manner.

C. Disturbed areas: Upon completion of bypass pumping operation, clean disturbed areas, restoring to original condition, including pavement restoration, at least equal to that which existed prior to start of Work.

3.05 SYSTEM CONDITIONS

A. Refer to Table below.

Bypass		Route		Flows (gpm)					
No	**Description**	**From**	**To**	**Max**	**Avg**	**Min**	**Time**	**Conditions**	**Service**
1.	Bypass pump around Existing 60" MH (coordinate point 510) to connect 12" SS pipe.	Existing MH upstream of Existing 60" MH (coordinate point 510)	Existing MH (coordinate point 561)	8300	5500	3200	12 Hrs	Raw Wastewater	PI
2.	Manhole 2 Bypass	US MH	DS MH						SS
3.	Ex. Manhole Bypass	US MH	DS MH						SS
4.	Manhole 4 Bypass	US MH	DS MH						PD
	Manhole 5 Bypass	US MH	DS MH						PD
	Manhole 7 Bypass	US MH	DS MH						PD

END OF SECTION

SECTION 02581

PRECAST ELECTRICAL HANDHOLES AND ELECTRICAL MANHOLES

PART 1 GENERAL

1.01 SUMMARY

A. Design, fabricate, and install precast electrical handholes and precast electrical manholes of the size and type indicated on the Drawings and specified.
   1. Construction of cast-in-place concrete electrical structures, including handholes and manholes, are specified in other sections.

B. Section includes:
   1. Precast portland cement concrete handholes and accessories.

C. Alternates:
   1. Contractor may propose to construct cast-in-place structures in lieu of the precast structures specified.
      a. Obtain Engineer's acceptance of this alternative before submitting, providing, or installing.
      b. Submit full information on design and detailing of proposed alternatives including design details and drawings of the same types required by this Section for precast structures.

1.02 REFERENCES

A. American Association of State Highway Transportation Officials (AASHTO):
   1. Standard Specifications for Highway Bridges.

B. American Concrete Institute (ACI):
   1. 318 - Building Code Requirements for Structural Concrete and Commentary.

C. ASTM International (ASTM):
   1. A48 - Standard Specification for Gray Iron Castings.
   2. C857 - Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
   3. C858 - Standard Specification for Underground Precast Concrete Utility Structures.
   4. C891 - Standard Practice for Installation of Underground Precast Concrete Utility Structures.
   5. C1028 - Standard Test Method for Determining the Static Coefficient of Friction of Ceramic Tile and Other Like Surfaces by the Horizontal Dynamometer Pull-Meter Method.
   6. C1037 - Standard Practice for Inspection of Underground Precast Concrete Utility Structures.

D. National Fire Protection Association (NFPA):
   1. National Electrical Safety Code (NEC).

E. National Precast Concrete Association (NPCA).

F. Society of Cable Telecommunications Engineers (SCTE):
   1. 77 - Specification for Underground Enclosure Integrity.

G. Underwriters Laboratories (UL).

1.03 DEFINITIONS

A. Handhole: An enclosure for use in underground systems that has been sized and detailed to allow personnel to reach into, but not enter, the enclosure to install, operate, or maintain equipment or wiring or both. (Reference: NEC, Article 100)
   1. As used in this Section, “handhole” will refer to a precast electrical handhole.

B. Manhole: An enclosure for use in underground systems that has been sized and detailed to allow personnel to enter the enclosure to install, operate, or maintain equipment or wiring or both.
   1. As used in this Section, “manhole” will refer to a precast electrical manhole.

C. Polymer concrete: A composite material consisting of an organic polymer binder mixed with embedded aggregate particles. Also known as “resin concrete.”
   1. Abbreviated “PC” as in “PC HANDHOLE.”

D. Portland cement concrete: A composite material consisting of a portland cement binder, water, admixtures, and a combination of fine and coarse mineral aggregates.
   1. Abbreviated “PCC” as in “PCC HANDHOLE” or “PCC MANHOLE.”

E. Precast concrete: A concrete fabrication designed by a qualified engineer and subsequently fabricated at a qualified fabrication site, which is usually located some distance from the site where the fabrication will be installed.

1.04 SYSTEM DESCRIPTION

A. General requirements for handholes and manholes:
   1. As specified in Section 16050 - Common Work Results for Electrical for general requirements for electrical work.
   2. Provide structures of the sizes and shapes indicated on the Drawings, with layouts, dimensions, and details as indicated on the Drawings and as specified.
   3. Conform to the requirements of:
      a. NEC.
      b. Project regulatory requirements as specified in Section 01410 - Regulatory Requirements.

B. Polymer concrete handholes:
   1. Load resistance of boxes and covers.
      a. Conform to all provisions of SCTE 77 for Tier 5, 8, 15, or 22 applications as specified in this Section.
         1) Where multiple “Tiers” are specified, handholes shall adequately support compatible covers while providing the highest Tier rating specified.
         2) Load rating of cover for an assembly shall not exceed the load capability of the box below.

3) Coefficient of friction between cover and box: Not less than 0.50 when measured in accordance with ASTM C1028.

2. Testing and certification.
   a. Each handhole to be installed shall have a report certifying that the design and construction of the unit has successfully passed all tests for materials and product performance required by SCTE 77.
      1) Testing and report shall be by a qualified testing agency, independent of the manufacturer. Test report shall bear the seal of a licensed professional engineer.
      2) Provide evidence of UL listing as required by NEC for products to be provided.

C. Portland cement concrete handholes and manholes:
   1. Load resistance of boxes and covers.
   2. Design requirements: Loads on structures:
      a. In accordance with ASTM C857, except as modified in this Section.
      b. Loads at the ground surface:
         1) See “Electrical Handhole and Manhole Schedule” indicated on the Drawings for minimum surface loading requirements at each structure. Loads are designated as “sidewalk,” or ”roadway”.
         2) The vehicle and pedestrian loadings in the following paragraphs need not be additive; however, structures designated for “roadway” loading shall also support “sidewalk” loads.
         3) “Sidewalk”: Load from regular pedestrian traffic with considerations for occasional non-deliberate vehicular traffic:
            a) Designation "A-0.3" in ASTM C857 Table 1 (300-psf uniform load).
         4) ”Roadway”: Load from heavy, frequently repeated vehicle traffic:
            a) Designation "as specified in Table 1.
      c. Lateral earth pressure loads:
         1) Determine in accordance with the following requirements. Include effects of groundwater and seismic accelerations on lateral earth pressures.
            a) Equivalent lateral pressure: 65 pounds per square foot per foot of depth (triangular distribution).
            b) Surface surcharge load:
               (1) Backfill-induced live load surcharge of 130 pounds per square foot (rectangular distribution).
               (2) In accordance with ASTM C857 Vehicle Load Designation "A-16" for "Roadway" or "A-0.3" for "Sidewalk" where such surcharge exceeds backfill loads described in the preceding paragraph.
            c) Groundwater effects:
               (1) Include effects from groundwater and soils saturated by flooding using design elevations specified in Section 01610 - Project Design Criteria.
               (2) Use equivalent lateral pressure of 93 pounds per square foot per foot of depth (triangular distribution) for soil below the design groundwater elevation.
            d) Seismic acceleration effects:
               (1) As specified in Section 01612 - Seismic Design Criteria.

(2) On opposite sides of the structure that are perpendicular to the direction of acceleration, include equivalent lateral pressure (inverted fluid pressure distribution), beginning with a pressure of 0 at the base of the structure, and increasing at a rate of 35 pounds per square foot per foot of rise toward the ground surface.
(3) Apply seismic effects as additive force on side where the soil mass is being accelerated toward the structure, and as subtractive force on the opposite side where the soil mass is being accelerated away from the structure.

d. Groundwater and flood loads - buoyancy effects:
1) As specified in Section 01610 - Project Design Criteria for design groundwater and design flood elevations.
2) Buoyancy: For groundwater and flood conditions, provide factor of safety against flotation of at least 1.20.
a) If the weight of soil overlying footing projections on the structure is considered to resist flotation, use a buoyant unit weight of soil equal to not more than 30 pounds per cubic foot.
b) Concrete fill may be provided in the bottom section of precast portland cement concrete structures to add weight. Submit proposed details.

e. Soil-bearing pressure at base:
1) Maximum 3,500 pounds per square foot total pressure on prepared subgrade soils or pressure not greater than the weight of the vertical column of soil removed (assuming a soil unit weight of 110 pounds per cubic foot).

f. Lifting and handling loads:
1) Make provision in the design for the effects of loads or stresses that may be imposed on structures during fabrication, transportation, or erection.

g. Load combinations:
1) Design structures to sustain the specified loads individually or in combination.

3. Design requirements: Structural analysis, design, and detailing:
a. General:
1) Analyze and design structures including the effects of 2-way action (“plate action”) and of load transfer around current and future openings.
2) Where structures include panels designed for future removal (“knockout panels”), design structures for loads and stresses with any combination of any or all such panels in place or removed.

b. Precast portland cement concrete handholes and manholes:
1) Design structures in accordance with the requirements of ACI 318 and this Section.
2) Provide reinforcement at all areas subject to tensile stress when loaded with the specified loads and combinations thereof.
3) Provide temperature and shrinkage reinforcement to equal or exceed ACI 318 requirements in all concrete sections.
4) Provide minimum clear concrete cover over reinforcement at both interior and exterior faces of all members in accordance with the following:
a) Handholes: 1.25 inches.

b) Manholes: 2 inches.

5) Reinforcement details:
   a) Walls: For structures with wall thickness of 8 inches or less, locate a single mat of reinforcement at the center of the wall.
   b) Slabs: For structures with slab thickness of 7 inches or less, locate a single mat of reinforcement at the center of the slab.
   c) Structures with wall or slab thicknesses exceeding these limits shall have a reinforcement at each face of the member.

6) Joints:
   a) Provide structures with watertight joints between sections, and detailed to minimize water infiltration at duct bank and conduit penetrations.
   b) Provide structures with non-skid, shiplap or tongue and groove joints between sections.

4. Design requirements: Materials:
   a. Portland cement concrete handholes and manholes:
      1) In accordance with ASTM C858 except as modified in this Section.
      2) Proportion concrete mixes to resist damage from freezing and thawing in a moist environment, and for exposure to deicing chemicals. Conform to ACI 318 requirements for minimum specified compressive strength and air entrainment.

1.05 SUBMITTALS

A. Product data: Manufacturer's catalog data, details, and warranties for the following items.
   1. Portland cement concrete handholes and manholes:
      a. Materials of construction.
      b. Joint details and joint-sealing materials.
      c. Data for hatches or covers and rings.
      d. Preformed channels and accessories for cable racking.
      e. Drain and sump details, including removable covers.
      f. Pulling iron details.

B. Shop drawings:
   1. Portland cement concrete handholes and manholes:
      a. Shop drawings for each structure shall bear the seal and signature of a professional civil or structural engineer licensed in the state of Utah.
      b. Dimensioned and "to-scale" plans, sections, and details for each structure including:
         1) Layout plan for that structure.
         2) Sizes, locations, and vertical positions of duct bank windows and knockout panels.
         3) Locations and details for access openings, pulling irons, embedded cable supports and racks, and sumps.
         4) Details of structural reinforcement showing bar size and spacing; true position of reinforcement in structural members with clear concrete cover at both inside and outside faces; location, bar size, and spacing of added reinforcement around openings; and other details relevant to design and fabrication of the structure.
         5) Details of joints between adjacent precast sections, including provisions for overlap and for placement of sealants.

C. Samples:
    1. Portland cement concrete handholes and manholes.

D. Design data:
    1. Portland cement concrete handholes and manholes:
        a. Structural calculations:
            1) Submit complete structural calculations for each structure.
            2) Provide calculations bearing the seal and signature of a professional engineer licensed in the state of Utah.
            3) Calculations will be filed for record. Review comments will not be returned.
        b. Manufacturer's statement of materials used for fabrication and construction, in accordance with ASTM C858, for record. Include the following:
            1) Concrete mix design: For each concrete mix design to be used for the structures, include data describing:
                a) Source and type of cement.
                b) Sources, grading, and specific gravities of aggregates.
                c) Aggregate reactivity data.
                d) Concrete mix proportions and design strength.
                e) Type, name, and dosage of all admixtures included in the concrete mix.
            2) Reinforcing steel: Mill certificates.

E. Test reports:
    1. Portland cement concrete handholes and manholes:
        a. Fabricator's tests for compressive strength of concrete used in structures, made in accordance with recommendations of ASTM C858.

F. Certificates:
    1. Portland cement concrete handholes and manholes:
        a. Manufacturer's current plant certification under NPCA for the structures to be supplied.
            1) Certification shall be current and in-effect at the time structures are manufactured.
        b. Manufacturer's certification that handholes and manholes are in accordance with the requirements of ASTM C858.

G. Manufacturer's instructions:
    1. Instructions for handling and setting structures in place.
    2. Portland cement concrete handholes and manholes:
        a. Instructions for operation and maintenance of hatches.

H. Manufacturer's field reports:
    1. Portland cement concrete handholes and manholes:
        a. Manufacturer's inspection reports in accordance with ASTM C1037.

I. Closeout documents:
    1. Project record documents:
        a. Portland cement concrete handholes and manholes:
            1) Final, revised plans and details of as-constructed precast handholes and manholes if requested for record by the Engineer.

2. Warranties:
    a. Manufacturer's standard warranty for:
        1) Polymer concrete handholes.
        2) Portland concrete handholes and manholes and accessories.

1.06 QUALITY ASSURANCE

A. Qualifications:
    1. Designer:
        a. Portland cement concrete handholes and manholes:
            1) Professional Civil or Structural engineer qualified in the design of concrete structures and holding a current license in the state of Utah.
    2. Manufacturer:
        a. Portland cement concrete handholes and manholes:
            1) Holding current NPCA plant certification for the products produced.
            2) Demonstrating at least 5 years of experience in the design, production, and installation of products of the type required for this Work.
            3) Capable of providing structural designs prepared by a professional engineer licensed in the state where the structures will be installed.
            4) Providing inspection during fabrication and handling in accordance with the requirements of ASTM C1037.
    3. Installer:
        a. Capable of providing equipment of adequate capacity and mobility to handle and set units with proper bearing on the subgrade and without damage to the unit.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Packing, shipping, handling, and unloading:
    1. Package and brace structures to avoid damage during shipping and handling.
    2. Furnish crane or forklift for unloading and setting of portland cement concrete handholes and manholes.

B. Acceptance at site:
    1. Structures delivered to the site with cracks, damage, and damaged or missing accessories shall be removed from the site and replaced at no additional cost to the Owner.

C. Storage and protection:
    1. Store handholes and manholes and their appurtenances in areas protected from damage due to weather and site operations.

1.08 PROJECT CONDITIONS

A. Environmental requirements: As specified in Section 01610 - Project Design Criteria

1.09 SEQUENCING

A. Coordinate installation of precast electrical handholes and manholes with duct banks specified in Section 16133 - Duct Banks.

1.10 WARRANTY

A. Provide manufacturer's standard warranty for precast handhole and manhole structures and accessories.

1.11 SYSTEM START-UP

A. As specified in Section 16050 - Common Work Results for Electrical.

PART 2 PRODUCTS

2.01 MATERIALS

A. Cast-in-place concrete for fill at base sections of portland cement concrete manholes with deep sumps or ballast to resist buoyancy shall be "Class C" concrete as specified in Section 03300 - Cast-in-Place Concrete.

2.02 MANUFACTURED UNITS - POLYMER CONCRETE HANDHOLES

A. General:
   1. Enclosures, boxes, and cover shall conform to all test provisions of SCTE 77.

B. Manufacturers: One of the following or equal.
   1. Quazite Division of Hubble, Incorp.
   2. Carson Ind., LLC.

C. Materials:
   1. Polymer concrete with optional fiberglass reinforcement.
      a. Handholes constructed of plastic or fiberglass will not be permitted.

D. Components:
   1. Cover:
      a. Provide gasketed cover with lifting slot and stainless steel hex head bolts for attachment to box.
      b. Fasten cover to box using stainless steel hex head bolts.
      c. Skid-resistant surface: Coefficient of friction for walking surface on top of cover shall be at least 0.50 when measured in accordance with ASTM C1028.
      d. Custom logo not required.
   2. Box:
      a. Open-bottom base unless otherwise indicated on the Drawings.
         1) Stackable sections with interlocking joints to maintain horizontal and vertical alignment.
      b. Provide knockouts, terminators, pulling eyes, and inserts as required for a complete installation.
   3. Fabrication:
      a. All components in assembly (boxes and cover) shall be manufactured using matched surface tooling for consistency of production.

E. Load rating:
   1. Provide “TIER” rating based on Schedule of Electrical Handholes and Electrical Manholes indicated on the Drawings, and the following loading requirements:

Surface Loading Rating	Requirements
“Sidewalk”	“TIER 15” - “Medium Duty” For driveway, parking, and ramp areas where vehicle wheel loads will not exceed 2,000 pounds on a single wheel.
“Roadway”	Not allowed - “Heavy Duty” For highway traffic or AASHTO wheel loads of at least 16,000 pounds.

   2. Provide covers with “TIER” rating embossed or cast into the top surface.
   3. Design load rating of cover for an assembly may not exceed the design load rating of the box below.

F. Accessories:
   1. Provide 2 non-corroding steel lifting hooks for removing covers.

2.03 MANUFACTURED UNITS - PORTLAND CEMENT CONCRETE HANDHOLES AND MANHOLES

A. General:
   1. Provide portland cement concrete handholes and manholes configured and designed as indicated on the Drawings and specified.
   2. In accordance with ASTM C858 unless otherwise noted.
      a. Concrete: Provide units with minimum specified compressive strength (f’c) of 5,000 pounds per square inch and using Type II cement.

B. Manufacturers: One of the following, or equal:
   1. Oldcastle Precast.
   2. Jensen Precast.

C. Components:
   1. Floor:
      a. Construct floors as a monolith.
      b. Where sump or low-point drain is included, slope floor to that point.
   2. Roof, walls, and base:
      a. Designed and rated to support vehicle and pedestrian loads at the spans indicated.
      b. See the Electrical Handhole and Manhole Schedule indicated on the Drawings for required load rating by structure location.
   3. Access covers:
      a. Handholes: Aluminum plate hinged floor access door (hatch) as specified in Section 08320 - Floor Access Doors.
         1) Load rating:
            a) “Heavy Duty” for covers at locations designated for “Roadway” loads.
            b) “Medium Duty” or stronger for covers at locations designated for “Sidewalk” loads.

2) Minimum access door size not less than 36 inches square, unless otherwise indicated on the Drawings.
3) Provide bearing surface with pre-installed continuous elastomeric gasket to minimize water infiltration at lid.
4) Provide skid-resistant lid with cast-in or machined-in grid pattern and the word “ELECTRICAL” in block letters at least 1.5 inches high.

b. Manholes: Cast iron frame and cover:
1) Manhole rings and covers:
a) Gray cast iron in accordance with ASTM A48, Class 30B with ring and cover machined to fit with flat bearing surfaces.
b) in accordance with Owner’s standard design.
c) Cover with word “ELECTRICAL” cast into the top exposed face for electrical manholes.
d) Manhole riser access:
(1) Heavy-duty bottom flange frame with solid cover for placement on grade adjustment rings above top slab.
(2) 36-inch diameter nominal opening.
(3) Manufacturers: The following or equal.
(a) Neenah Foundry Co., R1640-D.
e) Embedded in top slab of structure:
(1) Heavy-duty top flange frame with solid cover for embedment in top slab of a structure.
(2) 36-inch diameter nominal opening.
(3) Manufacturers: The following or equal.
(a) Neenah Foundry Co., R6095.

D. Accessories:
1. Provide accessories as indicated on the Drawings and specified.
2. Materials at duct bank penetrations:
a. Joint filler as specified in Section 03150 - Concrete Accessories.
b. Backer rod and sealant as specified in Section 07900 - Joint Sealants.
3. Pulling irons:
a. Provide non-corroding cable pulling irons located for use with each current duct bank location and additional irons for use with duct banks that may be installed through future knockout panels.
b. Pulling irons may not be located on the floor.
c. Where pulling irons are installed on the wall, any pockets surrounding the irons shall have bottom surfaces sloped to drain.
d. Secure pulling eyes to structure reinforcement.
4. Cable racks and racking hardware:
a. Materials: Stainless steel as specified in Section 16070 - Hangers and Supports.
b. Embedded slots: Maximum depth of 1.5 inches.
5. Ladders and manhole rungs:
a. Ladders:
1) In accordance with OSHA Subpart D “Requirements for walking and working surfaces.”
2) Galvanized steel as specified in Section 05500 - Metal Fabrications
b. Manhole rungs:
1) Copolymer or fiberglass manhole rungs in accordance with OSHA Subpart D “Requirements for walking and working surfaces.”

6. Sumps and drains:
    a. Fiberglass or HDPE fabrications including removable lids to prevent tripping hazards.
7. Exterior dampproofing:
    a. Field applied to all wall and roof surfaces exposed to soil.

E. Fabrication:
1. Embeds:
    a. Install embedded items with provisions for drainage to remove dripping or standing water, and to minimize corrosion.
        1) Pulling irons may not be placed on the floor or in pockets that will collect water.
        2) Detail bottom of cable rack channels to provide a downward sloping “sill” at the bottom of each vertical channel, so that the channel slot drains toward the floor.
    b. Concrete cover:
        1) Provide minimum 0.75-inch clear concrete cover between embeds and surrounding reinforcement.
        2) Provide minimum 1.25-inch clear concrete cover between embed and exterior face of wall.

F. Tests and inspections:
1. Test and inspect structures in accordance with ASTM C858 and ASTM C1037.

PART 3 EXECUTION

3.01 GENERAL

A. Furnish and install precast electrical handholes and manholes as indicated on the Drawings and specified.

B. Install additional handholes and manholes required so installation procedures will conform to cable manufacturer’s pulling tension requirements.
1. Include proposed locations and details of such additional handholes and manholes with the submittals under this Section.

3.02 PREPARATION

A. Design:
1. Prepare detailed and scalable layouts for each manhole structure showing locations of conduit or duct bank penetrations, clearances, locations, and sizes of access openings and major accessories.

B. Protection:
1. Where handhole and manhole structures are installed adjacent to existing site structures or utilities, provide excavation support or other protection as required to maintain those facilities in service and to prevent damage to both existing and new facilities.

C. Site preparation:
1. Excavate and prepare exposed subgrade as indicated on the Drawings and as specified.

2. Install and compact foundation layer as indicated on the Drawings and specified.
3. Level foundation materials so that structures will be set plumb, and duct banks will be at proper grade and alignment.
    a. Install with uniform bearing on foundation materials.
    b. Wedging or blocking of base sections for leveling over the foundation materials will not be permitted.

3.03 INSTALLATION

A. General:
1. Protect handholes and manholes from displacement, flooding, or flotation.

B. Portland cement concrete handholes and manholes:
1. Install structures in accordance with ASTM C891 and the provisions of this Section.
    a. In the event of conflicts, the more restrictive provisions shall apply.
2. Clean and prime joints between adjacent precast sections.
    a. Install sealing compound between sections and provide watertight joints.
3. Set covers and hatches at elevations indicated on the Drawings.
    a. Securely attach frames to top of precast structures and grade adjustment rings.
4. Penetrations:
    a. Holes for duct banks and other penetrations may not be cut into precast handholes and manholes unless they are located at designated locations shown on the shop drawings or at knockout panels cast into the structure during manufacturing.
    b. Carefully remove concrete from knockout panel areas with saws.
        1) Ensure that break-back does not extend beyond the designated limits of the knockout panel.
    c. Coat any reinforcement cut or exposed during removal of knockout panel sections with minimum 2 coats of high solids epoxy as specified in Section 09960 - High-Performance Coatings.
        1) Apply epoxy coating applied over and at least 1-inch past the perimeter of the reinforcement.
5. Install duct banks and conduit penetrations in accordance with the penetration details indicated on the Drawings.
    a. Place all joint fillers, caulks, and sealants before coating exterior concrete surface with bituminous dampproofing.
6. Fill holes that were provided for handling or other temporary purposes with non-shrink cement grout using procedures as specified in Section 03300 - Cast-in-Place Concrete unless otherwise detailed by the manufacturer.
7. After structures are set and before backfilling, coat exterior below-grade surfaces (around the sidewalls, over the top slab, and around any vertical risers to grade) with 2 heavy coats of bituminous dampproofing.
    a. Apply dampproofing in accordance with the coating manufacturer’s instructions and at a rate of 40 to 60 square feet per gallon per coat.
    b. Mask over at least 1 inch back from joint caulks or sealants, and prevent dampproofing from coming in contact with those materials.
8. Backfill handholes and manholes as indicated on the Drawings and as specified.

C. Site tolerances:
   1. Set electrical handholes and manholes plumb and true at locations indicated on the Drawings.
   2. Tolerances on placing:
      a. Horizontal location: Plus or minus 1 inch.
      b. Vertical elevation: Plus or minus 1/2 inch.
      c. Plumb: Plus or minus 1/8 inch over 10 feet.

3.04 REPAIR/RESTORATION

A. Repair cracks or blemishes in concrete as described in Section 03300 - Cast-in-Place Concrete

3.05 ADJUSTING

A. After final grading is complete, adjust access covers to grade.

3.06 CLEANING

A. Before installation of cables in any duct banks and handholes or manholes, remove all concrete spoil, forms, debris, silt, dust, and other foreign material.

B. Pressure wash interior of structures if required to provide clean interior surfaces.
   1. Block drains and provide pumps to remove washwater from structures.
   2. Do not permit washwater to drain into subgrade soils.

3.07 SCHEDULES

A. See Drawings for Electrical Handhole and Electrical Manhole Schedule.

END OF SECTION

SECTION 02742

ASPHALTIC CONCRETE PAVING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Asphalt concrete pavement on prepared subgrade or aggregate base course, and on existing pavement, to lines, grades, compacted thicknesses, and cross sections indicated on the Drawings.

1.02 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO):
   1. Standard Specifications for Transportation Materials and Methods of Sampling and Testing:
      a. MP1: Specification for Performance Graded Asphalt Binder.

B. ASTM International (ASTM):
   1. C117 - Standard Test Method for Material Finer than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing.
   2. C131 - Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
   3. C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
   4. D977 - Standard Specification for Emulsified Asphalt.
   5. D2041 - Standard Test Method for Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures.
   6. D4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

1.03 DEFINITIONS

A. Bituminous prime coat: Consist of application of hot bituminous material on previously prepared base course.

1.04 SYSTEM DESCRIPTION

A. Performance requirements:
   1. Compact the asphalt concrete to at least 95 percent of the density of the theoretical maximum density in accordance with ASTM D2041.

1.05 SUBMITTALS

A. Proposed mix design and gradation of materials.

B. Quality control submittals:
   1. Certificate of Compliance.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Asphalt concrete delivery:
   1. Transport the mixture from the mixing plant to the point of use in vehicles having tight bodies previously cleaned of all foreign materials.
   2. Treat bodies as necessary to prevent material from sticking to the bodies.
   3. Cover each load with canvas or other suitable material of sufficient size and thickness to protect the asphalt mixture from the weather.

1.07 PROJECT CONDITIONS

A. Environmental requirements:
   1. Asphalt concrete:
      a. Place asphalt concrete only when surface is dry, and when atmospheric temperature in the shade is 40 degrees Fahrenheit and rising, or above 50 degrees Fahrenheit if falling.
      b. Do not place asphalt concrete when weather is foggy or rainy or when base on which material is to be placed is in wet or frozen condition.
   2. Prime coat:
      a. Do not apply prime coat when atmospheric temperature is below 60 degrees Fahrenheit.
      b. Apply prime coat only when base course is dry or contains moisture not in excess of that which will permit uniform distribution and desired penetration.

1.08 SEQUENCING AND SCHEDULING

A. Prime coat:
   1. Prior to requesting Engineer's acceptance for application, inspect area to be coated to determine its fitness to receive bituminous priming material.
   2. Do not begin application before area to be coated has been accepted for application by the Engineer.

PART 2 PRODUCTS

2.01 MATERIALS

A. Prime coat: Use bituminous material for prime coat conforming to requirements for SC-70 and apply at temperature of 105 to 175 degrees Fahrenheit at rate of 0.3 to 0.6 gallons per square yard by use of bituminous distributor.

B. Sand: Acceptable to the Engineer.

C. Tack coat: Grade SS-1h anionic emulsion in accordance with ASTM D977.

D. Asphalt concrete materials:
   1. Asphalt cement: Conform to requirements for asphalt cement, PG 64-28 AASHTO MP1.

2. Mineral aggregate:
   a. Consist of coarse aggregate of crushed stone or gravel composed of hard, durable particles, sand, and filler as follows:
      1) Coarse aggregate: Portion of material retained on Number 8 sieve. Fine aggregate: That portion passing Number 8 sieve.
   b. Provide composite material that is uniformly graded from coarse to fine and that complies with requirements of one of following gradings when tested in accordance with ASTM C136.
   c. Asphalt concrete: As indicated on the Drawings, 2-course plant mix for asphalt concrete having an overall thickness of 2 1/2 inches or more if not indicated. If less than 2-1/2 inches of asphalt concrete, use single-course plant mix.

Plant Mix, Two Course				**Plant Mix, Single Course**	
Seal, 3/4 inch Thick Minimum		**Base, 1-3/4 inch Thick Minimum**		**1-1/2 inch Thick Minimum**	
Sieve Size	**Percent Passing**	**Sieve Size**	**Percent Passing**	**Sieve Size**	**Percent Passing**
1/2"	100	1-1/4"	100	3/4"	100
3/8"	95 - 100	1"	87 - 100	1/2"	75 - 95
No. 4	50 - 70	3/4"	75 - 90	3/8"	65 - 85
No. 8	35 - 55	3/8"	55 - 72	No. 4	50 - 65
No. 30	15 - 30	No. 4	40 - 60	No. 8	35 - 50
No. 100	5 - 15	No. 8	30 - 50	No. 30	15 - 30
No. 200	3 - 8	No. 30	15 - 30	No. 100	5 - 15
		No. 100	5 - 15	No. 200	3 - 8
		No. 200	3 - 8		

3. Coarse aggregate:
   a. Consist of at least 70 percent by weight of each size aggregate and consist of particles that have at least 1 rough, angular surface produced by crushing:
      1) Have percentage of wear of not more than 50 at 500 revolutions, in accordance with ASTM C131.
   b. Aggregate plasticity index: Not more than 2 in accordance with ASTM D4318.
   c. Sand may be added to crusher or pit-run product to supply any deficiency in Number 8 sieve and filler may be added to supply any deficiency in Number 200 sieve material. If aggregate contains an excess of sand, wasting will be required.
   d. Filler:
      1) Use finely powdered limestone, portland cement, or other artificially or naturally powdered mineral dust acceptable to the Engineer.
      2) Weigh filler and add separately to each batch at time of proportioning.
      3) Use filler that is free from deleterious matter of any kind.

4) Fineness that meet the following requirements:
a) Passing Number 50 sieve: 100 percent.
b) Passing Number 200 sieve: At least 75 percent.
5) Determine amount of material passing the Number 200 sieve in accordance with ASTM C117.

e. Provide composite aggregate that is free from vegetable matter, lumps or balls of clay, adherent films of clay, or other matter which would prevent thorough coating of asphalt cement.

f. Materials derived from processing demolished, or removed asphalt concrete, are not acceptable.

E. Fog sealing: Asphalt emulsion, Grade SS-1h.

2.02 EQUIPMENT

A. Bituminous distributor: Designed and equipped so as to distribute bituminous material uniformly at even heat on variable widths of surface at readily determined and controlled rate with pressure range of 25 to 75 pounds per square inch.

B. Liquid asphalt distributor:
1. Designed and operated to distribute asphaltic material in uniform spray without atomization.
2. Equipped with bitumeter having dial registering feet of travel per minute.
a. Locate dial so that it is visible to truck driver so that he can maintain constant speed required for application at specified rate.
3. Equip pump with tachometer having dial registering gallons per minute passing through nozzles.
a. Locate dial so that it is readily visible to operator.
4. Provide means for accurately indicating temperature of asphaltic material in distributor at all times.
a. Locate thermometer well so that it is not in contact with, or close to, heating tube.
5. Have spray bar having normal width of application of not less than 12 feet and capable of providing for application of lesser width when necessary.
6. Provided with hose and spray nozzle attachment for applying asphaltic material to patches and areas inaccessible to spray bar.
7. Equipped with heating attachments and capable of circulating asphaltic material through spray bar during entire heating process.

C. Asphalt concrete mixing plants:
1. Equipment:
a. Use screen and storage bins at plant of sufficient capacity to furnish the necessary amount of all aggregates, when operating at the maximum capacity of the plant, with no periods of undue waiting for material.
1) Use bins consisting of at least 2 compartments, so proportioned as to ensure adequate storage of appropriate fractions of the aggregate.
2) Provide each compartment with an overflow pipe of such size and at such location as to prevent any backing up of material into other compartments.
b. Dryer:
1) Designed to heat and dry the aggregate to Specification requirements and to agitate it continuously during the heating.

2) Capable of preparing aggregates at a rate equal to the full-rated capacity of the plant.

c. Dust collector:
1) So constructed as to waste or return uniformly to the hot elevator all or any part of the material collected.

d. Mixer:
1) Adequate capacity, with twin shafts.

e. Thermometers:
1) Furnished for determining the temperature of the mix.

f. Weighing and measuring equipment:
1) Weighing or volumetric measuring equipment of sufficient capacity.
2) Devices to permit easy readjustment of any working part needing readjustment, so that the equipment will function properly and accurately.
3) Attach scales for weighing to the bucket.
4) Test and seal all weighing equipment by a representative of the Inspector of Weights and Measures having jurisdiction, as often as the Engineer may deem necessary to ensure accuracy.

g. Tanks for storage of bituminous material:
1) Capable of heating the material under effective and positive control at all times to temperatures within the range stipulated.

2. Asphalt concrete plant operation:
a. Mineral aggregate:
1) Dry and heat mineral and then screen into at least 2 fractions and conveyed into separate compartments ready for proportioning and mixing.
2) When combined with asphalt cement:

b. Aggregate:
1) Contain not more than 2 percent moisture by weight.
2) Be at a temperature within the range of that specified for the asphalt cement but not more than 25 degrees Fahrenheit above the temperature of the asphalt cement.

c. Combine dry aggregate in the plant in the proportionate amounts of each fraction of aggregate required to meet the specified grading.
1) Introduce the asphalt cement into the mixer in the amount and at the temperature for the particular material being used.
2) Continue mixing for at least 30 seconds, and for such longer period as may be necessary to coat all the particles.

d. When a continuous mixer is used, determine the mixing time by weight method using the following formula:
1) Mixing time in seconds = Pugmill dead capacity in pounds.
2) Pugmill output in pounds per second.

D. Asphalt-concrete-placing equipment:
1. Use equipment for placing, spreading, shaping, and finishing asphalt concrete consisting of a self-contained power machine operating in such manner that no supplemental spreading, shaping, or finishing is required to provide surface that complies with requirements for smoothness contained in this Section.
a. In areas inaccessible to the machine, hand spreading may be permitted.
2. Furnish 1 self-propelled, pneumatic-tired roller, and one 8-ton (minimum), smooth-wheel tandem roller.

a. When spreading is in excess of 100 tons per hour, furnish 1 additional roller of either type for each additional 100 tons, or fraction thereof, spread per hour.

2.03 MIXES

A. Asphalt cement:
   1. Do not mix at temperatures lower than 275 degrees Fahrenheit or higher than 325 degrees Fahrenheit.
   2. Usual amount of asphalt cement, by weight, to be added to aggregate be 5.4 to 5.8 percent of weight of mixture.

B. Asphalt concrete:
   1. Before being delivered to the site, mix aggregate with asphalt cement at the central mixing plant.
   2. Use mixing plants that are in good working order with no excessively worn parts and so equipped that:
      a. Temperatures of aggregates leaving dryer, of asphalt cement entering mixer, and of mix leaving mixer can be readily determined and positively controlled within Specification limits at all times.
      b. Weights of different sizes of aggregates and of asphalt cement as set by the Engineer can be consistently introduced into the mixer.
      c. Asphalt cement can be uniformly distributed throughout the mixture with aggregate completely coated.
      d. Mixing time can be positively controlled to minimum specified.
      e. Bin samples of aggregate can be readily obtained.
      f. Provide means of calibrating weighing devices.

PART 3 EXECUTION

3.01 PREPARATION

A. Protection
   1. Prime-coated surfaces:
      a. Maintain surfaces until succeeding layer of pavement has been placed.
      b. During this interval, protect primed surfaces against damage and repair any broken spots.

B. Surface preparation:
   1. Prime coat:
      a. Where portions of base course prepared for immediate treatment are excessively dry, sprinkle such portions lightly with water immediately in advance of prime coat application.
      b. Immediately following preparation of base course, apply bituminous material by means of bituminous distributor at the temperature previously specified.
      c. Apply priming material in manner that results in uniform distribution being obtained at all points of surface to be primed.
      d. Following the application of prime material, allow the surface to dry for a period of not less than 48 hours without being disturbed, or for such additional period of time as may be necessary to obtain penetration into

the base course and drying out or evaporation of the volatiles from prime material.

e. Spread sufficient sand on areas that show an excess of bituminous material to effectively blot up and cure the excess.

2. Base courses:
   a. Thoroughly clean base and apply prime coat before placing asphalt concrete.
   b. Thoroughly clean any existing base, surfacing, or pavement prior to placing plant-mixed surfacing.
   c. Where existing pavement is being widened or extended, cut to straight vertical face and treat with asphalt paint binder prior to paving operations.
   d. When asphalt concrete is to be applied over existing pavement and local irregularities in existing surface would result in course of more than specified thickness, bring surface of existing pavement to uniform contour by patching with asphalt concrete thoroughly tamped or rolled until it conforms with surrounding surface, and then apply tack coat.

3.02 APPLICATION

A. At existing asphalt to be paved over: Apply tack coat at minimum rate of 0.10 gallons per square yard.

B. Placing and compacting asphalt concrete:
   1. Placing and compacting asphalt mixture: Progress in sections generally not more than 750 linear feet in length.
   2. Spreading of mixture:
      a. Spread, shape, and finish by specified equipment.
      b. Spread each successive strip adjacent to previously spread strip.
      c. Do not compact minimum 6-inch width of each strip adjacent to new strip until after new strip has been placed.
      d. Spread as nearly continuous as possible.
      e. Laying against vertical surfaces such as gutters: Roughen and clean face of vertical surfaces as required for proper bonding and then paint with light coating of asphalt cement or emulsified asphalt.
      f. At terminations of new surface courses: Feather asphalt mixture into existing surface over such distance as may be required to produce smooth riding transition.
      g. Base-course and single-course construction: Joined by vertical butt joints, finished and rolled to smooth surface.
      h. Rolling:
         1) Perform initial or "breakdown" rolling with tandem power roller and follow spreading operation when mixture has reached temperature where it does not "pick up" on rolls.
         2) Keep rolls properly moistened but do not use surplus of water.
         3) Follow initial rolling with pneumatic roller when mixture is in proper condition and when rolling does not cause undue displacement, cracking, or shoving.
         4) Begin rolling at sides and progress gradually to center, lapping each preceding track until entire surface has been rolled.
         5) Terminate alternate trips of roller in stops at least three feet distant from any preceding stop.

6) At any place not accessible to roller, thoroughly compact mixture with tampers and finish, if necessary, with hot iron to provide uniform layer over entire width being paved.

3. Provide finish surface having uniform texture.

C. Full-depth asphalt pavement:
1. Contractor's option:
a. Install either full-depth asphalt pavement or asphalt over 6 inch aggregate base course where reservoir bottoms are indicated on the Drawings.
b. Not permitted to use one system in one location and another system elsewhere.
c. Install either asphalt and aggregate base material or full-depth asphalt pavement in areas where paving is indicated on the Drawings or specified to be 2 inches of asphalt concrete over aggregate base course.
d. If option is selected to install full-depth asphalt pavement, prepare subgrade as previously specified in this Section.
e. Substitute asphalt concrete for aggregate base at ratio of 1 inch of asphalt concrete to 2-1/2 inches of aggregate base material. Use full-depth asphalt pavement not less than 4 inches in thickness after compaction.
f. Place asphalt concrete in courses of not more than 4 inches.
g. Use compaction equipment in accordance with following course thicknesses:
1) 1- to 2-inch thickness: Minimum 8-ton roller.
2) 2- to 3-inch thickness: Minimum 10-ton roller.
3) 3- to 4-inch thickness: Minimum 12-ton roller.
2. Pneumatic rollers used for initial or secondary rolling: Use 12 to 15 tons with tires capable of 90-pounds-per-square-inch inflation pressure.
3. Asphalt concrete for full-depth asphalt pavement:
a. Asphalt concrete as previously specified in this Section.
b. Apply bituminous prime coats where full-depth asphalt pavement is installed.
c. Contractor's option: If Contractor elects to use full-depth asphalt pavement, at road shoulders reduce aggregate base course to minimum aggregate thickness of 4 inches.
4. Except for asphalt thickness, aggregate base course thickness, and prime coating, full-depth asphalt pavement shall comply with requirements of this Section.

3.03 FIELD QUALITY CONTROL

A. Placement:
1. Place the mixture on the roads, pavements, or walks at a temperature not less than 225 degrees Fahrenheit.

B. Tests:
1. Provide sampling and control testing for the asphalt concrete.
a. Type and size of the samples: Suitable to determine conformance with stability, density, thickness, compaction, and other specified requirements.
b. Use an approved power saw or core drill for cutting samples.
c. Furnish all tools, labor, and materials for cutting samples, testing, and replacing the pavement where samples were removed.
d. Take a minimum of 1 sample per 200 tons of asphalt concrete placed.

C. Inspection:
   1. Asphalt concrete:
      a. Test with a 10-foot straightedge laid on the surface parallel with the centerline of the road. Variation of the surface from the testing edge of the straightedge not to exceed 1/4 inch.

END OF SECTION

SECTION 02772

CONCRETE CURBS, GUTTERS, AND SIDEWALKS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Concrete curbs, gutters, sidewalks, driveways, access ramps, and alley intersections.

1.02 SYSTEM DESCRIPTION

A. Performance requirements: Construct various types of concrete curb, gutter, sidewalk, driveways and alley intersections to dimensions and details indicated on the Drawings.

1.03 SUBMITTALS

A. Product data: Submit data completely describing products.

B. Samples: Submit samples when requested.

1.04 PROJECT CONDITIONS

A. Environmental requirements.
   1. If concrete curb, gutter, sidewalk, or other site concrete is poured in weather conditions where the temperature may drop below the low level as indicated in Section 03300 - Cast-In-Place Concrete, the requirements for Cold Weather Concrete must be met.

1.05 SEQUENCING AND SCHEDULING (NOT USED)

PART 2 PRODUCTS

2.01 MATERIALS

A. Concrete: Class A, as specified in Section 03300 - Cast-In-Place Concrete.

B. Curb finishing mortar: 1 part portland cement to 2 parts sand.

C. Form release material: Light oil or other releasing agent of type which does not discolor concrete or interfere with the application of finishing mortar to curb tops and faces.

D. Joint materials:
   1. Expansion: As specified in Section 03150 - Concrete Accessories.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Conditions:
   1. Verify field conditions, including subgrade condition and interferences, before beginning construction.

3.02 PREPARATION

A. Surface preparation:
   1. Subgrade:
      a. Construct and compact true to grades and lines indicated on the Drawings and requirements as specified Section 02050 - Soils and Aggregates for Earthwork.
      b. Remove soft or unsuitable material to depth of not less than 6 inches below subgrade elevation and replace with satisfactory material.
   2. Forms and subgrade: Water immediately in advance of placing concrete.

3.03 INSTALLATION

A. Special techniques:
   1. Contractor's option:
      a. Construct concrete curbs and gutters by conventional use of forms, or by means of curb and gutter machine when acceptable to the Engineer.
      b. When use of machines designed specifically for work of this Section are accepted by the Engineer, results must be equal to or better than those produced by use of forms.
      c. Applicable requirements of construction that apply to use of forms also apply to use of machines.
      d. Discontinue use of machines when results are not satisfactory to the Engineer.

B. Forms:
   1. Carefully set to line and grade and securely stake in position forms conforming to dimensions of items to be constructed.
   2. Thoroughly clean prior to each use and coat with form releasing material.

C. Expansion and weakened-plane joints:
   1. Expansion joints:
      a. Construct vertically, and at right angles to centerline of street and match joints in adjacent pavement or sidewalks.
      b. Constructed at radius points, driveways, alley entrances, and at adjoining structures.
      c. Fill joints with expansion joint filler material.
   2. Weakened-plane joints:
      a. Construct as indicated on the Drawings.
      b. Match joint locations and details in adjacent curbs, gutters, and sidewalks.

D. Concrete:
   1. Placing:
      a. Thoroughly spade concrete away from forms so that no rock pockets exist next to forms and so that no coarse aggregate will show when forms are removed.
   2. Compacting:
      a. Compact by mechanical vibrators accepted by the Engineer.
      b. Continue tamping or vibrating until mortar flushes to surface and coarse aggregate is below concrete surface.
   3. Form removal:
      a. Front form faces: Do not remove before concrete has taken initial set and has sufficient strength to carry its own weight.
      b. Gutter and rear forms: Do not remove until concrete has hardened sufficiently to prevent damage to edges. Take special care to prevent damage.
   4. Finishing and curing: Comply with requirements as specified in Section 03366 - Tooled Concrete Finishing except as modified here:
      a. As soon as curb face forms are stripped, apply finishing mortar to the top and face of curb and trowel to a smooth, even finish. Finish with fine haired broom in direction of work.
      b. Where curb is installed without integral gutter, extend finish 2 inches below grade.
      c. Edge concrete at expansion joints to 1/4 inch radius.
      d. Flow lines of gutters shall be troweled smooth 4 inches out from curb face for integral curb and gutter and 4 inches on both sides of flowline for gutters without curbs.
      e. Sidewalks and ramps: Broom finish.

E. Backfilling:
   1. Unless otherwise specified, backfill behind curbs, gutters, or sidewalks with soil native to area and to lines and grades indicated on the Drawings.

3.04 FIELD QUALITY CONTROL

A. Tests:
   1. Curbs and gutters:
      a. Test face, top, back, and flow line with 10 foot straightedge or curve template longitudinally along surface.
      b. Correct deviations in excess of 1/4 inch.
   2. Gutters:
      a. Frequency of testing: When required by the Engineer, where gutters have slope of 0.8 foot per 100 feet or less, or where unusual or special conditions cast doubt on capability of gutters to drain.
      b. Test method: Establish flow in length of gutter to be tested by supplying water from hydrant, tank truck, or other source.
      c. Required results:
         1) 1 hour after supply of water is shut off, inspect gutter for evidence of ponding or improper shape.
         2) In event water is found ponded in gutter to depth greater than 1/2 inch, or on adjacent asphalt pavement, correct defect or defects in manner acceptable to the Engineer without additional cost to the Contract.

3.05 ADJUSTING

A. Repair portions of concrete damaged while stripping forms or, when damage is severe, replace such work at no additional cost to the Contract. Evidence of repairs shall not be noticeable in the finished product.

B. Remove and replace sections of work deficient in depth or not conforming to requirements indicated on the Drawings and specified in the Specifications at no additional cost to the Contract. Removal and replacement shall be the complete section between 2 joints.

END OF SECTION

SECTION 02939

SEEDING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Seeding.
   2. Erosion-control material(s).
   3. Seed bed preparation.
   4. Maintenance.

B. This section applies to small areas impacted by trenching or other disturbances. Areas graded or disturbed around the grit building will be landscaped by the Owner.

1.02 REFERENCES

A. Association of Official Seed Analysts (AOSA).

B. United States Department of Agriculture (USDA).

C. United States Environment Protection Agency (EPA).

1.03 DEFINITIONS

A. Duff layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.

B. Finish grade: Elevation of finished surface of planting soil.

C. Manufactured topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

D. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

E. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

F. Planting soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

G. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or top surface of a fill or backfill before planting soil is placed.

H. Surface soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil, but in disturbed areas such as urban environments, the surface soil can be subsoil.

I. Weeds: Includes Dandelion, Jimsonweed, Quackgrass, Horsetail, Morning Glory, Rush Grass, Mustard, Lambsquarter, Chickweed, Cress, Crabgrass, Canadian Thistle, Russian Thistle, Leafy Spurge, Nutgrass, Poison Oak, Blackberry, Tansy Ragwort, Bermuda Grass, Johnson Grass, Poison Ivy, Nut Sedge, Nimble Weed, Bindweed, Bent Grass, Wild Garlic, Perennial Sorrel, and Brome Grass, and dry noxious weeds.

1.04 SUBMITTALS

A. Product data: For each type of product indicated:
   1. Pesticides and herbicides: Include product label and manufacturer's application instructions specific to this Project.
   2. Fertilizer and organic matter: Include product label and manufacturer's application instructions specific to this Project.
   3. Soil amendment: Analysis.

B. Certification of grass seed: From seed vendor for each grass-seed monostand or mixture stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.
   1. Certification and inspection as required by governmental authorities of each seed mixture for Kentucky Bluegrass. Include identification of source and name and telephone number of supplier.

C. Qualification data: For qualified landscape Installer.

D. Samples: Imported topsoil, organic matter, erosion control blanket and mulch.

E. Product certificates: For soil amendments and fertilizers, from manufacturer.

F. Maintenance instructions: Recommended procedures to be established by Owner for maintenance of turf and meadows during a calendar year. Submit before expiration of required initial maintenance periods.

1.05 QUALITY ASSURANCE

A. Installer qualifications: A qualified landscape Installer whose work has resulted in successful turf and meadow establishment.
   1. Professional membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
   2. Experience: 5 years' successful experience in the installation of seeded areas similar in size to this project.
   3. Installer's field supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.

4. Personnel certifications: Installer's field supervisor shall have certification in all of the following categories from the Professional Landcare Network:
    a. Certified Landscape Technician - Exterior, with installation and irrigation specialty area(s).
5. Maintenance proximity: Not more than 2 hours' normal travel time from Installer's place of business to Project site.
6. Pesticide applicator: State licensed, commercial.

B. Soil-testing laboratory qualifications: An independent laboratory or university laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.

C. Soil analysis: For each unamended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; sodium absorption ratio; deleterious material; pH; and mineral and plant-nutrient content of the soil. Refer to plan notes for number and location of soil analysis tests.
1. Testing methods and written recommendations shall comply with USDA's Handbook No. 60.
2. The soil-testing laboratory shall oversee soil sampling, with depth, location, and number of samples to be taken per instructions from Engineer.
    a. A minimum of 3 representative samples shall be taken from varied locations for each soil to be used or amended for planting purposes.
3. Report suitability of tested soil for turf growth.
    a. Based on the test results, state recommendations for soil treatments and soil amendments to be incorporated.
        1) State recommendations in weight per 1,000 square feet or volume per cubic yard for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.
    b. Report presence of problem salts, minerals, or heavy metals, including aluminum, arsenic, barium, cadmium, chromium, cobalt, lead, lithium, and vanadium. If such problem materials are present, provide additional recommendations for corrective action.

D. Pre-installation conference: Conduct conference at project site.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Seed and other packaged materials:
1. Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws, as applicable.
2. Protect seed during delivery and storage.
3. Seed that has become wet or otherwise damaged will not be acceptable.

B. Deliver packaged materials in waterproof bags showing weight, chemical analysis and name or trademark of manufacturer.
1. Provide seed mixture in containers showing percentage of seed mix, year of production, net weight, date of packaging, percentage of purity (PLS), percentage of germination and location of packaging.

C. Local sourcing of seed not in sealed containers is permitted for smaller projects.

D. Label seed bags per variety.

E. Store materials in protected and covered storage until application or use.

F. Bulk materials:
   1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
   2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
   3. Accompany each delivery of bulk fertilizers, lime, and soil amendments with appropriate certificates.

G. Truck receipts: For verification of all soil amendments and imported topsoil.

1.07 SITE CONDITIONS

A. Planting restrictions: Plant during 1 of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance from date.
   1. Irrigated seed areas: Seed from ground thaw to July 31 and September 1 to October 15.
   2. Non-irrigated seed areas: Seed from March 15 to July 4 and September 1 to October 15.
   3. Pure Warm Season Grass Seed Areas: Seed from June 1 to August 15.
   4. Dormant Seeding Areas: Seed from October 15 to ground freeze.
   5. Per seed detail.

B. Coordinate with Contractor’s work requiring access to site over existing vegetation areas.
   1. No trucking or moving of equipment or materials shall be permitted over completed seed areas.

C. Coordinate with installation of all underground system piping and outlets.

D. Weather limitations:
   1. Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained.
   2. Apply products during favorable weather conditions according to manufacturer's written instructions.

1.08 WARRANTY

A. Warranty:
   1. Guarantee all seeding to be alive and healthy for 1 years following date of final completion by the Engineer.
   2. Seeded areas shall have an even stand of grass with germination, over 100 percent of the site within 45 days of seeding.
   3. All seeded grass areas are to be ensured of obtaining a satisfactory stand of growth.

4. The total area occupied by bare spots larger than 0.25 square feet must not exceed 10 percent of the total seeded area.
5. Maximum single bare spot size of irrigated seed 3 inches by 3 inches.
6. Maximum single bare spot size of non-irrigated seed is 1 square foot.
7. All seeded grass areas which do not meet the satisfactory stand of growth qualification shall be reseeded and mulched.

B. Replace seeding when it is no longer in a satisfactory condition or do not meet the preceding standard as determined by the Engineer or the duration of the Guarantee/Warranty Period.
   1. Make replacements as soon as possible within the recommended seeding schedule.

C. Replacements:
   1. Seed of same mix, quality and species as originally specified, as soon as possible within the recommended seeding schedule, with a new 1-year warranty commencing on date of replacement.
   2. Repairs and replacements shall be made at no expense to the Owner.

PART 2 PRODUCTS

2.01 GRASS SEED

A. Grass seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Journal of Seed Technology; Rules for Testing Seeds" for purity and germination tolerances.

B. Seed species:
   1. Seed of grass species as follows, with not less than 95 percent germination, not less than 85 percent pure seed, and not more than 0.5 percent weed seed.
   2. The percentage of material, other than grass seed in the mixture, shall not include more than 18 percent non-viable seed, chaff, hulls, live seed of crop plants (other than those specified), harmless inert matter.

C. Provide seed mixes per seed as indicated on the Drawings.

2.02 WATER

A. Use potable water for making up seed mixture. Plant effluent may be used for hydroseeding watering and maintenance, as specified in this Section.

2.03 SOIL AMENDMENTS

A. Soil amendments and fertilizer shall be applied as indicated on the Drawings unless imported topsoil is used.
   1. Soil amendment and fertilizer recommendations, along with supporting soil test analysis, shall be submitted to and approved by the Engineer prior to application on the site.

2.04 FERTILIZERS

A. Uniform in composition, free flowing and suitable for application with approved equipment, of the proportions necessary to eliminate any deficiencies of topsoil, as indicated in analysis.
   1. Fertilizer shall be delivered to the site fully labeled according 10 applicable state fertilizer laws and shall bear the name, tradename, trademark and warranty of the provider.

B. As indicated on the Drawings and notes.

2.05 PLANTING SOILS

A. Topsoil: Fertile soil, typical for locality, capable of sustaining vigorous plant growth, taken from drained site; free of subsoil, stones over 1 inch in diameter, clay clumps, or impurities, plants weeds and roots; pH value of minimum 6.5 and maximum 7.5.

B. Stockpiled on-site topsoil free of subsoil, stones over 1 inch in diameter, clay clumps, or impurities, plants, weeds and roots.

2.06 MULCHES

A. Mulching material:
   1. Straw mulch:
      a. Straw of oats, barley, wheat or rye only.
      b. Straw shall be free from weeds, foreign matter detrimental to plant life, and dry. 50 percent of straw shall be minimum 10 inches long.
      c. Hay or chopped cornstalks are not acceptable.
      d. Straw in such an advanced stage of decomposition as to smother or retard the normal growth of grass will not be accepted.
      e. Old straw mulch which breaks during crimping will not be accepted.
   2. Wood cellulose fiber mulch:
      a. Wood cellulose fiber mulch, containing no substance or factor which might inhibit germination or growth of grass seed, with organic tacilier.
      b. Wood fibers must be capable of being evenly dispersed and suspended when agitated in water.
      c. Furnish dyed wood cellulose fiber with green color to allow visual metering of its application.
   3. As indicated on the Drawings.

B. Hydroseeding Mulch: Wood fiber manufactured for hydroseeding:
   1. Manufacturers: One of the following or equal:
      a. Grass Growers.
      b. Conwed Corp., Fibers Div.
      c. Eva Cell Co.

C. Erosion control blanket:
   1. Jute matting, open weave.
   2. Excelsior erosion control blankets or approved equal:
      a. Regular blanket, machine produced mat of curled wood excelsior of 80 percent 6 inch or longer fiber length with a consistent width of fibers evenly distributed throughout mat; a photo-biodegradable extruded plastic netting shall cover the top side of blanket.

b. Netting shall be secured to wood excelsior by extra heavy lines of plastic woven into the width of each blanket.
c. Blanket shall be smolder resistant with no chemical additives.

3. As indicated on the Drawings.

D. Herbicide and pesticide: Submit labels for approval.

E. Stakes: Softwood lumber, chisel pointed.

2.07 PESTICIDES

A. General:
1. Pesticide, registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application.
2. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

B. Pre-emergent herbicide (Selective and Non-Selective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

C. Post-emergent herbicide (Selective and Non-Selective): Effective for controlling weed growth that has already germinated.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine areas to be planted for compliance with requirements and other conditions affecting performance.
1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
2. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.
3. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
4. Uniformly moisten excessively dry soil that is not workable and which is too dusty.

B. Start of work covered in this Section constitutes Contractor’s approval of all existing site conditions.
1. Proceed with installation only after unsatisfactory conditions have been corrected.

C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by the Engineer and replace with new planting soil.

3.02 PREPARATION

A. Protect existing and new structures, fences, utilities, sidewalks, paving, curbs, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
   1. Protect adjacent and adjoining areas from hydromulching overspray.
   2. Protect grade stakes set by others until directed to remove them.
   3. Protect landscaping and other features remaining as final work.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.03 TURF AREA PREPARATION

A. Limit turf subgrade preparation to areas to be planted.

B. Newly graded subgrades:
   1. Loosen/scarify subgrade to a minimum depth of 6 inches.
   2. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
   3. Repeat cultivation in areas where equipment used for hauling and spreading topsoil has compacted the subgrade.
   4. Tolerances: Top of subgrade plus or minus 1 inch.

C. Prepare subgrade and eliminate uneven areas and low spots.
   1. Maintain lines, levels, profiles and contours.
   2. Make changes in grade gradual. Blend slopes into level areas.

D. Do not prepare subgrade in areas of on-site plant preservation.

E. Do not bury foreign material beneath areas to be seeded.

F. Remove any contaminated subgrade.
   1. Apply superphosphate fertilizer directly to subgrade before loosening.
      a. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
      b. Mix lime with dry soil before mixing fertilizer.
   2. Spread planting soil to a depth of 6 inches but not less than required to meet finish grades after light rolling and natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.
      a. Spread approximately 1/2 the thickness of planting soil over loosened subgrade. Mix thoroughly into top 4 inches of subgrade. Spread remainder of planting soil.
      b. Reduce elevation of planting soil to allow for soil thickness of sod.

G. Unchanged subgrades: If turf is to be planted in areas unaltered or undisturbed by excavating, grading, or surface-soil stripping operations, prepare surface soil as follows:
   1. Remove existing grass, vegetation, and turf.
      a. Do not mix into surface soil.
   2. Loosen surface soil to a depth of at least 6 inches.

a. Apply soil amendments and fertilizers according to planting soil mix proportions and mix thoroughly into top 4 inches of soil.
b. Apply superphosphate fertilizer directly to surface soil before loosening.

3. Remove stones larger than 1 inch in any dimension and sticks, roots, trash, and other extraneous matter.
4. Legally dispose of waste material, including contaminated soils, grass, vegetation, and turf, off Owner's property.

H. Finish grading:
1. Grade seeding areas to a smooth, uniform surface plane with loose, uniformly fine texture.
2. Grade to within plus or minus 1/2 inch of finish elevation.
3. Roll and rake, remove ridges, fill depressions to meet finish grades, and ensure positive surface drainage.
4. Maintain profiles and contour of subgrade.
5. Limit finish grading to areas that can be planted in the immediate future.

I. Rip topsoil that has been spread to a minimum depth of 8 inches in one direction using an agricultural ripper with tines spaced at no greater than 18 inches.
1. Areas adjacent to walks, structures, curbs, etc., where the use of large mechanical equipment is difficult, shall be worked with smaller equipment or by hand.

J. Manually spread topsoil close to plant materials and structures to prevent damage.

K. Spread amendments, as determined by the soil test results or indicated on the Drawings, over the entire area to be seeded and incorporate into the top 6 inches of soil by disking or rototilling until a uniform mixture is obtained with no pockets of soil or amendments remaining.

L. Restore fine grade with float drag to remove irregularities resulting from tilling operations.
1. Float drag or rake in 2 directions.
2. Remove any additional stones over 1 inch that have come to the surface.
3. Perform drainage test by applying water with the irrigation system.
4. Do not plant until the finished grade is reviewed by the Engineer.
5. This review does not reduce Contractor's responsibility to provide a finished product that drains.

M. Apply fertilizer, if necessary, after smooth raking of topsoil and prior to planting of seed.
1. Apply fertilizer at a rate as determined by the soil tests or indicated on the Drawings.
2. Do not apply fertilizer at same time or with same machine as will be used to apply seed.
3. Mix thoroughly into upper 6 to 8 inches of soil.

N. Lightly water to aid the dissipation of fertilizer.

O. Remove any additional stones over 1 inch that have come to the surface.

P. Moisten prepared area before planting if soil is dry.
1. Water thoroughly and allow surface to dry before planting.

2. Do not create muddy soil.

Q. Before planting, obtain Engineer's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

R. Tolerances: Top of topsoil plus or minus 1/2 inch.

3.04 PREPARATION FOR EROSION-CONTROL MATERIALS

A. Install erosion-control materials in accordance with manufacturer's recommendations.

B. For erosion-control blanket or mesh, install from top of slope, working downward, and as recommended by material manufacturer for site conditions.
   1. Fasten as recommended by material manufacturer.

C. Moisten prepared area before planting if surface is dry.
   1. Water thoroughly and allow surface to dry before planting.
   2. Do not create muddy soil.

3.05 HYDROSEED WATERING

A. Provide temporary watering system or apply water with a water truck acceptable to Engineer.
   1. Plant effluent may be used for hydroseed watering.
   2. Do not place irrigation lines on top of embankment slope.

B. Germination Stage:
   1. Initiate watering sequence within 24 hours after hydromulching planted areas. Leave water on long enough to moisten soil thoroughly to a depth of the fiber, taking care not to supersaturate or wash fiber or soil particles off the slopes. Observe irrigation system continually while in operation.
   2. Contractor to repair all seed washing or erosion immediately.
   3. Irrigate fiber and seed lightly and frequently to maintain optimum moisture content for maximum germination. Determine irrigation sequence according to air temperature, prevailing wind velocity, soil texture, orientation, and other logistical problems.
   4. Keep soil moist at all times during germination period. Continue irrigation sequence until seedlings have grown beyond the germination stage, approximately 30 to 60 days.

C. Establishment Stage:
   1. Reduce watering frequency while increasing duration of the water sufficiently to allow for maximum water penetration for the expanding root system. Take care not to cause erosion.
   2. Precise watering reduction program to be determined by Contractor.

D. Hardening-off Stage:
   1. Reduce irrigation frequency while increasing the duration of each water cycle.
   2. A specific watering program to be approved by Owner.

3.06 HYDROSEED MOWING

A. Contractor to mow seeded areas prior to spring germination.

3.07 HYDROSEED MAINTENANCE

A. Maintain hydroseed areas for 1 year following final acceptance.

B. Maintenance involves watering, mowing, and any other activities required to establish and maintain the ground cover.

3.08 SEEDING

A. Preparation for seeding:
   1. Prior to seeding, if weeds exists, apply Round-Up herbicide per manufacturer's specifications after germination of weed seeds and at least 2 weeks prior to seeding.
   2. Do not spray on a day when wind is detectable.
   3. Remove remaining vegetative matter.
   4. Repeat herbicide application until no weeds are evident for 14 days after last herbicide application, as determined by the Engineer.

B. Drill seeding:
   1. Drill seed by means of a Brillion mechanical power-drawn drill seeders, or equal, to a maximum depth of 1/4-inch followed by packer wheels or drag chains to provide smooth finish.
   2. Seed at the rates given below.
   3. Seed in 2 passes at right angles to one another.
   4. Sow half the seed in each pass.
   5. Provide markers or other means to ensure that the successive seeded strips will overlap or be separated by a space no greater than the space between the rows planted by the equipment being used.
   6. Do not seed during windy weather.
   7. Restore fine grade after seeding as requested by the Engineer.
   8. Remove irregularities by hand raking or rolling.

C. In areas inaccessible to a drill seeder, broadcast seed by hand in 2 opposite directions.
   1. Rake in seed after broadcasting.
   2. Do not broadcast seed during windy weather.

D. Seeding rates:
   1. Seeding rates shall be as indicated on the Drawings for drill seeded areas.
   2. Hand and broadcast seeded areas shall receive 2 times the seeding rate indicated.

E. Do not seed areas in excess of that which can be mulched on same day.

F. Do not sow immediately following rain, when ground is too dry, frozen, or during windy periods.

G. Roll seeded area with roller not exceeding 100 pounds.

H. Immediately following seeding and compacting, apply mulch.

I. Sow seed with spreader or seed drill machine.
   1. Do not broadcast or drop seed when wind velocity exceeds 5 miles per hour.
   2. Evenly distribute seed by sowing equal quantities in 2 directions at right angles to each other.
      a. Do not use wet seed or seed that is moldy or otherwise damaged.
      b. Do not seed against existing trees.
         1) Limit extent of seed to outside edge of planting saucer.

J. Sow seed at a total rate as indicated on the Drawings.

K. For any Broadcast seeded areas rake seed lightly into top 1/8 inch of soil, roll lightly, and water with fine spray.

L. Protect seeded areas with erosion-control mats where indicated on the Drawings; install and anchor according to manufacturer's written instructions.

3.09 SEED ESTABLISHMENT ON SLOPES

A. Protect seeded areas with slopes and swales exceeding 1:4 with erosion-control blankets installed and stapled according to manufacturer's written instructions.

B. Roll fabric onto slopes without stretching or pulling.

C. Lay fabric smoothly on surface in direction of water flow.
   1. Bury top end of each section in 6-inch deep excavated topsoil trench.
   2. Provide 6-inch overlap of adjacent rolls.
   3. Backfill trench and rake smooth, level with adjacent soil.

D. Secure outside edges and overlaps at 24-inch intervals with stakes.

E. Lightly dress slopes with topsoil to ensure close contact between fabric and soil.

F. For sides of ditches, lay fabric laps in direction of water flow.
   1. Lap ends and edges minimum 6 inches.

3.10 MULCHING

A. Straw mulching:
   1. After seeding, apply 2 tons of small grained straw per acre.
      a. Spread straw to give a 1/2 inch to 1 inch thick layer of mulch (3 to 5 straws thick) and crimp in 2 to 3 inches with a mechanical crimper or other approved equipment.
   2. Hand crimping shall be employed in areas inaccessible to crimper, or where excessive slopes would cause unsatisfactory results.
   3. Crimping against the contour shall not be accepted.
   4. Apply water and tackifier with a fine spray immediately after each area has been mulched.
      a. Saturate to 4 inches of soil.

B. Hydromulching:
   1. Hydromulch all dormant seeded areas with a slurry mix containing additional tacifier.
   2. Utilize hydraulic equipment with nozzle adapted for hydraulic mulching with storage tanks having means of estimating volume used or remaining in the tank.
   3. Hydromulch shall consist of tacifier applied at a rate of 100 pounds per acre and a cellulose fiber mulch mixed to form a homogeneous slurry; spray applied to seeded area at a rate of 2,200 pounds per acre.
      a. Hydromulch applied to dormant seeded areas shall consist of tacifier applied at a rate of 150 pounds per acre and a cellulose fiber mulch mixed to form a homogeneous slurry; spray applied to seeded area at a rate of 2,200 pounds per acre.

C. Protect seeded areas with slopes not exceeding 1:4 by spreading straw mulch.
   1. Spread uniformly at a minimum rate of 2 tons per acre to form a continuous blanket 1-1/2 inches in loose thickness over seeded areas.
   2. Spread by hand, blower, or other suitable equipment.
      a. Anchor straw mulch by crimping into soil with suitable mechanical equipment.
      b. Bond straw mulch by spraying with asphalt emulsion at a rate of 10 to 13 gallons per 1,000 square feet.
         1) Take precautions to prevent damage or staining of structures or other plantings adjacent to mulched areas.
         2) Immediately clean damaged or stained areas.

D. Protect seeded areas from hot, dry weather or drying winds by applying hydro mulch and tacifier within 24 hours after completing seeding operations.
   1. Soak areas, scatter mulch uniformly to a thickness of 3/16 inch and roll surface smooth.

3.11 EXISTING VEGETATION RENOVATION

A. Renovate existing vegetation.

B. Renovate existing vegetation damaged by Contractor's operations, such as storage of materials or equipment and movement of vehicles.
   1. Reestablish vegetation where settlement or washouts occur or where minor regrading is required.
   2. Install topsoil as required.

C. Remove sod and vegetation from diseased or unsatisfactory vegetation areas; do not bury in soil.

D. Remove topsoil containing foreign materials such as oil drippings, fuel spills, stones, gravel, and other construction materials resulting from Contractor's operations, and replace with new planting soil.

E. Mow, dethatch, core aerate, and rake existing vegetation.

F. Prior to seeding, irrigate for a minimum of 2 weeks to allow germination of weed seeds.

1. Apply Round-Up herbicide per manufacturer's specifications after germination of weed seeds and at least 2 weeks prior to seeding.
2. Do not spray on a day when wind is detectable.
3. Remove remaining vegetative matter.
4. Repeat irrigation and herbicide application until no weeds are evident for 14 days after last herbicide application, as determined by the Engineer.

G. Remove waste and foreign materials, including weeds, soil cores, grass, vegetation, and turf, and legally dispose of them off Owner's property.

H. Till stripped, bare, and compacted areas thoroughly to a soil depth of 6 inches.

I. Apply soil amendments and initial fertilizers required for establishing new turf and mix thoroughly into top 4 inches of existing soil.
   1. Install new planting soil to fill low spots and meet finish grades.

J. Apply seed and protect with hydro mulch as required for new vegetation.

K. Water newly planted areas and keep moist until new turf is established.

3.12 SATISFACTORY SEED AREAS

A. Turf installations shall meet the following criteria as determined by the Engineer:
   1. Acceptance for soil preparation (topsoil installation) and final grading shall be given by the Engineer upon satisfactory completion of each section or area prior to seeding as indicated on the Drawings or as otherwise specified.
   2. Final completion for seeded areas shall be given by the Engineer as soon as there is an even stand of grass with germination over 100 percent of the site.
      a. Warranty:
         1) Guarantee all seeding to be alive and healthy for 2 years following date of final completion by the Engineer.
         2) Seeded areas shall have an even stand of grass with germination, over 100 percent of the site within 45 days of seeding.
         3) All seeded grass areas are to be ensured of obtaining a satisfactory stand of growth.
         4) The total area occupied by bare spots larger than 0.25 square feet must not exceed 10 percent of the total seeded area.
         5) Maximum single bare spot size of irrigated seed 3 inches by 3 inches.
         6) Maximum single bare spot size of non-irrigated seed is 1 square foot.
         7) All seeded grass areas which do not meet the satisfactory stand of growth qualification shall be reseeded and mulched.
      b. Re-seed areas that in the opinion of the Engineer do not meet the preceding standards.

B. Use specified materials to reestablish turf that does not comply with requirements and continue maintenance until turf is satisfactory.

3.13 SEEDED AREA MAINTENANCE

A. Maintain and establish seeded area by watering, noxious weed management, mowing, trimming, replanting, and performing other operations as required to establish a healthy, viable seeded area.

1. Roll, regrade, and replant bare or eroded areas and remulch.
2. Provide materials and installation the same as those used in the original installation.
    a. Fill in as necessary soil subsidence that may occur because of settling or other processes.
        1) Replace materials and seeded area damaged or lost in areas of subsidence.
    b. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
    c. Apply treatments as required to keep seeded area and soil free of pests and pathogens or disease.
        1) Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.

B. Watering: Install and maintain temporary piping, hoses, and seeded area watering equipment to convey water from sources and to keep meadow uniformly moist.
1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch.
    a. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
2. Water meadow with fine spray at a minimum rate of 1/2 inch per week or more for seed establishment for 6 weeks after planting or until seed establishment is determined by the Engineer (whichever is longer) unless rainfall precipitation is adequate.

3.14 PESTICIDE APPLICATION

A. Apply pesticides and other chemical products and biological control agents in accordance with requirements of authorities having jurisdiction and manufacturer's written recommendations.
1. Coordinate applications with Owner's operations and others in proximity to the Work.
2. Notify Owner before each application is performed.

B. Post-emergent herbicides (Selective and Non-Selective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written recommendations.

3.15 CLEANUP AND PROTECTION

A. Promptly remove soil and debris created by turf work from paved areas.
1. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Erect temporary fencing or barricades and warning signs as required to protect newly seeded areas from traffic.
1. Maintain fencing and barricades throughout initial seed establishment.

C. Remove nondegradable erosion-control measures after grass establishment period.

D. During landscape installation:
1. All areas shall be reasonably clean at the end of each workday.

2. Sidewalks and other paved areas shall be swept or washed down as needed.

E. Project completion:
   1. All debris, soil, and trash resulting from landscape operations shall be removed from the site.
   2. All paved areas shall be washed down.

END OF SECTION

SECTION 02952

PAVEMENT RESTORATION AND REHABILITATION

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Resurfacing roads and paved surfaces in which surface is removed or damaged by installation of new work.

1.02 SYSTEM DESCRIPTION

A. Performance requirements:
   1. Limiting dimensions:
      a. Determine the exact lengths and dimensions of such roads, pavements, parking areas, and walks that will require removal and replacement for new work.
      b. Join existing surfaces to terminals of new surfacing in smooth juncture.

1.03 SUBMITTALS

A. Mix designs:
   1. Prior to placement of asphalt concrete, submit full details, including design and calculations for the asphalt concrete mix proposed.
   2. Submit gradation of aggregate base.
   3. Submit proposed mix design of portland cement concrete.

PART 2 PRODUCTS

2.01 MATERIALS

A. Aggregate base course: As specified in Section 02050 - Soils and Aggregates for Earthwork.

B. Asphalt pavement: As specified in Section 02742 - Asphaltic Concrete Paving.

C. Portland cement concrete replacement material: Class A concrete as specified in Section 03300 - Cast-in-Place Concrete.

2.02 EQUIPMENT

A. Roads, pavements, parking areas, and walks:
   1. Equipment requirements: Good condition, capable of performing work intended in satisfactory manner.

2.03 ACCESSORIES

A. Material for painting asphalt concrete pavement: Tack coat as specified in Section 02742 - Asphaltic Concrete Paving.

PART 3 EXECUTION

3.01 INSTALLATION

A. Aggregate surface removal replacement:
   1. When trench cut is in aggregate surfaced areas, replace aggregate base course material with material matching existing material compacted to 95 percent of its maximum density.

B. Pavement removal and temporary asphalt replacement:
   1. Install temporary asphalt pavement or first course of permanent pavement replacement immediately following backfilling and compaction of trenches that have been cut through existing pavement.
   2. Except as otherwise provided, maintain this temporary pavement in safe and reasonably smooth condition until required permanent pavement is installed.
   3. Remove and dispose of temporary paving from project site.
   4. Where longitudinal trench is partly in pavement, replace pavement to original pavement edge, on a straight line, parallel to centerline of roadway.
   5. Where no part of longitudinal trench is in pavement, surfacing replacement shall only be required where existing surfacing materials have been removed.

C. Asphalt pavement replacement:
   1. Replace asphalt pavement to same thickness as adjacent pavement and match as nearly as possible adjacent pavement in texture, unless otherwise indicated on the Drawings.
   2. Cut existing asphalt pavements to be removed for trenches or other underground construction by wheel cutter, clay spade, or other device capable of making neat, reasonably straight and smooth cut without damaging adjacent pavement. Cutting device operation shall be subject to acceptance of Engineer.
   3. Cut and trim existing pavement after placement of required aggregate base course and just prior to placement of asphalt concrete for pavement replacement, and paint trimmed edges with material for painting asphalt concrete pavement immediately prior to constructing new abutting asphalt pavements. No extra payment will be made for these items, and all costs incurred in performing this work shall be incidental to pipe laying or pavement replacement.
   4. Conform replacement of asphalt pavement to contour of original pavement.

D. Portland cement concrete pavement replacement:
   1. Where trenches lie within portland cement concrete section of streets, alleys, sidewalks, and similar concrete construction, saw cut such concrete (to a depth of not less than 1-1/2 inches) to neat, vertical, true lines in such manner adjoining surfaces are not damaged.
   2. Place portland cement concrete replacement material to dimension as indicated on the Drawings.
   3. Provide expansion joints that match existing.

4. Before placing replacement concrete, thoroughly clean edges of existing pavement and wash with neat cement and water.
5. Surface finish: Wood float finish.

E. Curb, gutter, and sidewalk replacement:
1. Where any concrete curb, gutter, or sidewalk has been removed or displaced, replace to nearest construction joints with new Class A curb, gutter, or sidewalk to same dimensions and finish as original construction that was removed:
a. Provide expansion joints of same spacing and thickness as original construction.

F. Asphalt pavements:
1. Trim existing asphalt pavements which are to be matched by pavement widening or pavement extension to neat true line with straight vertical edges free from irregularities with saw specifically designed for this purpose. Minimum allowable depth of cut shall be 1-1/2 inches.
2. Cut and trim existing pavement after placement of required aggregate base course and just prior to placement of asphalt concrete for pavement widening or extension, and paint trimmed edges with material for painting asphalt concrete pavement immediately prior to constructing new abutting asphalt concrete pavements.
3. No extra payment will be made for these items and all costs incurred in performing this work shall be incidental to widening or pavement extension.

3.02 FIELD QUALITY CONTROL

A. Tests:
1. Asphalt concrete as specified in Section 02742 - Asphaltic Concrete Paving.
2. Concrete as specified in Section 03300 - Cast-in-Place Concrete.

B. Inspection:
1. Asphalt concrete:
a. Lay 10-foot straightedge parallel to centerline of trench when the trenches run parallel to street, and across pavement replacement when trench crosses street at angle.
b. Remove and correct any deviation in cut pavement replacement greater than 1/4 inch in 10 feet.
2. Portland cement concrete replacement pavement:
a. Lay 10-foot straightedge either across pavement replacement or longitudinal with centerline of gutter or ditch.
b. Remove and correct any deviation in cut pavement replacement greater than 1/4 inch in 10 feet.

END OF SECTION

SECTION 03055

ADHESIVE-BONDED REINFORCING BARS AND ALL THREAD RODS IN CONCRETE

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Bonding reinforcing bars and all thread rods in concrete using adhesives.

1.02 REFERENCES

A. American Concrete Institute (ACI).
   1. 355.4 - Qualification of Post-Installed Adhesive Anchors in Concrete and Commentary.

B. American National Standards Institute (ANSI):
   1. Standard B212.15 - Carbide Tipped Masonry Drills and Blanks for Carbide Tipped Masonry Drills.

C. ASTM international (ASTM):
   1. C881 - Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.

D. Concrete Reinforcing Steel Institute (CRSI).

E. ICC Evaluation Service, Inc. (ICC-ES):
   1. AC308 - Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements.

F. Society for Protective Coatings (SSPC):
   1. SP-1 - Solvent Cleaning.

1.03 DEFINITIONS

A. Evaluation Service Report (ESR): Report prepared by ICC-ES, or other testing agency acceptable to Engineer and to the Building Official, that documents testing and review of a product to confirm that it complies with the requirements of designated ICC-ES Acceptance Criteria, and to document its acceptance for use under the Building Code specified in Section 01410 - Regulatory Requirements.

1.04 SUBMITTALS

A. Product data: Technical data for adhesives, including:
   1. Manufacturer's printed installation instructions (MPII).
   2. Independent laboratory test results indicating allowable loads in tension and shear for concrete of the types included in this Work, with load modification factors for temperature, spacing, edge distance, and other installation variables.
   3. Handling and storage instructions.

B. Quality control submittals:
    1. Special inspection: Detailed step-by-step instructions for the special inspection procedures required by the building code specified in Section 01410 - Regulatory Requirements.
    2. For each adhesive to be used, Evaluation Report confirming that the product complies with the requirements of AC308 for both un-cracked and cracked concrete and for use in Seismic Design Categories A through F.
    3. Installer qualifications:
        a. Submit evidence of successful completion of adhesive manufacturer's installation training program.
        b. Submit evidence of current certification for installation of inclined and overhead anchors under sustained tension loading.

C. Inspection and testing reports:
    1. Inspections: Field quality control: Reports of inspections and tests.
        a. Inspections: Field quality assurance: Reports of special inspections and tests.

1.05 QUALITY ASSURANCE

A. Qualifications:
    1. Installation requirements:
        a. Have available at the site, and install anchors in accordance with, the adhesive manufacturer's printed installation instructions.
    2. Installer qualifications:
        a. Demonstrating successful completion of adhesive manufacturer's onsite training program for installation of adhesive-bonded anchors.
        b. Holding current certification for installation of adhesive-bonded anchors by a qualified organization acceptable to the Engineer and to the Building Official.
            1) Organizations/certification programs deemed to be qualified are:
                a) ACI-CRSI Adhesive Anchor Installer Certification Program.
                b) Adhesive anchor manufacturer's certification program, subject to acceptance by the Engineer and the Building Official.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Store and protect products as follows, unless more restrictive requirements are recommended by the manufacturer:
    1. Store adhesives and adhesive components on pallets or shelving in a covered-storage area protected from weather.
    2. Control temperature to maintain storage within manufacturer's recommended temperature range.
        a. If products have been stored at temperatures outside manufacturer's recommended range, test by methods acceptable to the Engineer to confirm acceptability before installing in the Work.
    3. Dispose of products that have passed their expiration date.

1.07 PROJECT CONDITIONS

A. As specified in Section 01610 - Project Design Criteria and Section 01612 - Seismic Design Criteria.

B. Seismic Design Category (SDC) for structures is indicated on the Drawings.

PART 2 PRODUCTS

2.01 GENERAL

A. Like items of materials: Use end products of one manufacturer in order to achieve structural compatibility and singular responsibility.

B. Adhesives shall have a current Evaluation Report documenting testing and compliance with the requirements or ACI 355.4 and of ICC-ES AC308 for use with un-cracked concrete and with cracked concrete in the Seismic Design Category specified.

C. Bond reinforcing bars and all thread rods in concrete using epoxy adhesive unless other adhesives specified are specifically indicated on the Drawings or approved in writing by the Engineer.

2.02 EPOXY ADHESIVE

A. Materials:
   1. Meeting the physical requirements of ASTM C881, Type IV, Grade 3, Class B or C depending on site conditions.
   2. 2-component, 100 percent solids, insensitive to moisture.
   3. Cure temperature, pot life, and workability: Compatible with intended use and environmental conditions.

B. Packaging:
   1. Disposable, self-contained cartridge system furnished in side-by-side cartridges designed to fit into a manually or pneumatically operated caulking gun, and with resin and hardener components isolated until mixing through manufacturer's static mixing nozzle.
      a. Nozzle designed to dispense components in the proper ratio and to thoroughly blend the components for injection from the nozzle directly into prepared hole.
      b. Provide nozzle extensions as required to allow full-depth insertion and filing from the bottom of the hole.
   2. Container markings: Include manufacturer's name, product name, batch number, mix ratio by volume, product expiration date, ANSI hazard classification, and appropriate ANSI handling precautions.

C. Manufacturers: One of the following or equal:
   1. Hilti, Inc., HIT-RE 500-V3.
   2. Powers Fasteners, Inc., Powers Pure110+.
   3. Simpson Strong-Tie Co., Inc., SET-XP.

2.03 ACRYLIC AND HYBRID ADHESIVE

A. Materials:
   1. 2-component, high-solids, acrylic-based or hybrid acrylic and epoxy-based adhesive.

2. Approved by the manufacturer for installation at substrate temperatures of 0 degrees Fahrenheit and above.

B. Packaging:
   1. Disposable, self-contained cartridge system furnished in side-by-side cartridges designed to fit into a manually or pneumatically operated caulking gun, and with resin and hardener components isolated until mixing through manufacturer's static mixing nozzle. Nozzle designed to dispense components in the proper ratio and to thoroughly blend the components for injection from the nozzle directly into prepared hole.
   2. Container markings: Include manufacturer's name, product name, batch number, mix ratio by volume, product expiration date, ANSI hazard classification, and appropriate ANSI handling precautions.

C. Manufacturers: One of the following or equal:
   1. Hilti, Inc., HIT-HY-200.
   2. Simpson Strong-Tie Co., Inc., AT-XP.

2.04 ALL THREAD RODS

A. Materials: As specified in Section 05120 - Structural Steel for rods, nuts and washers.

2.05 REINFORCING BARS

A. As specified in Section 03200 - Concrete Reinforcing.

PART 3 EXECUTION

3.01 GENERAL

A. Execution of this work is restricted to installers who have personally completed the adhesive manufacturer's on-site training for the products to be installed, and who are personally certified through a qualified certification program described under Quality Assurance and accepted by the Engineer and the Building Official.
   1. Do not install holes or adhesive until training is complete.

B. Perform work in strict compliance with the accepted MPII and the following instructions. Where the accepted MPII and the instructions conflict, the MPII shall prevail.

C. Install reinforcing bars and all thread rods to embedment depth, and at spacing and locations indicated on the Drawings.
   1. If embedment depth is not indicated, contact Engineer for requirements.
   2. Do not install adhesive-bonded all thread rods or reinforcing bars in upwardly inclined or overhead applications unless accepted in advance by Engineer.

3.02 PREPARATION

A. Do not begin installation of adhesive bonded anchors until:
   1. Concrete has achieved an age of at least 21 days after placement.

2. On-site training in installation of adhesive bonded anchors by manufacturer's technical representative is complete. Do not drill holes in concrete or install adhesive and embeds in holes.

B. Review manufacturer's printed installation instructions (MPII) and "conditions of use" stipulated in the Evaluation Report before beginning work.
   1. Bring to the attention of the adhesive manufacturer's technical representative any discrepancies between these documents, and resolve before proceeding with installation.

C. Install adhesive bonded anchors in full compliance with manufacturer's printed installation instructions using personnel who have successfully completed manufacturer's on-site training for products to be used and who hold certifications specified in this Section.

D. Confirm that adhesive and substrate receiving adhesive are within manufacturer's recommended range for temperature and moisture conditions, and will remain so during the curing time for the product.

3.03 HOLE SIZING AND INSTALLATION

A. Drilling holes:
   1. Determine location of reinforcing bars or other obstructions with a nondestructive indicator device, and mark locations with construction crayon on the surface of the concrete.
   2. Do not damage or cut existing reinforcing bars, electrical conduits, or other items embedded in the existing concrete without prior acceptance by Engineer.

B. Hole drilling equipment:
   1. Electric or pneumatic rotary impact type with medium or light impact.
      a. Installation of anchors in cored holes is not permitted.
      b. Set drill to "rotation only" mode, or to "rotation plus hammer" mode in accordance with the manufacturer's installation instructions and the requirements of the Evaluation Report.
      c. Where edge distances are less than 2 inches and "rotation plus hammer" mode is permitted, use lighter impact equipment to prevent micro-cracking and concrete spalling during the drilling process.
   2. Drill bits: Carbide-tipped in accordance with ANSI B212-15 unless otherwise recommended by the manufacturer or required as a "condition of use" in the Evaluation Report.
      a. Hollow drill bits with flushing air systems are preferred. Air supplied to hollow drill bits shall be free of oil, water, or other contaminants that will reduce bond.

C. Hole diameter: As recommended in the manufacturer's installation instructions and the Evaluation Report.

D. Hole depth: As recommended in the manufacturer's installation instructions to provide minimum effective embedment indicated on the Drawings.

E. Obstructions in drill path:
   1. If an existing reinforcing bar or other obstruction is hit while drilling a hole, unless otherwise accepted by Engineer, stop drilling. Prepare and fill the hole with dry-pack mortar. Relocate the hole to miss the obstruction and drill another hole to the required depth.
      a. Obtain Engineer's acceptance of distance between abandoned and relocated holes before proceeding with the relocation.
      b. Allow dry-pack mortar to cure to a strength equal to that of the surrounding concrete before resuming drilling in the area.
      c. Epoxy grout may be substituted for dry-pack mortar when accepted by Engineer.
   2. Avoid drilling an excessive number of holes in an area of a structural member, which would excessively weaken the member and endanger the stability of the structure.
   3. When existing reinforcing steel is encountered during drilling and when specifically accepted by Engineer, enlarge the hole by 1/8 inch, core through the existing reinforcing steel at the larger diameter, and resume drilling at original hole diameter using pneumatic rotary impact drill.
   4. Bent bar reinforcing bars: Where edge distances are critical, and interference with existing reinforcing steel is likely, if acceptable to Engineer, drill hole at 10 degree (or less) angle from axis of reinforcing bar or all thread rod being installed.

F. Cleaning holes:
   1. Insert air nozzle to bottom of hole and blow out loose dust.
      a. Use compressed air that is free of oil, water, or other contaminants that will reduce bond.
      b. Provide minimum air pressure of 90 pounds per square inch for not less than 4 seconds.
   2. Using a stiff bristle brush with diameter that provides contact around the full perimeter of the hole, vigorously brush hole to dislodge compacted drilling dust.
      a. Insert brush to the bottom of the hole and withdraw using a simultaneous twisting motion.
      b. Repeat at least 4 times.
   3. Repeat the preceding steps as required to remove drilling dust or other material that will reduce bond, and in the number of cycles required by the MPII and the Evaluation Report.
   4. Leave prepared holes clean and dry.
   5. Protect prepared and cleaned holes from contamination and moisture until adhesive is installed.
   6. Re-clean and dry previously prepared holes if, in the opinion of the Engineer, the hole has become contaminated after initial cleaning.

3.04 INSTALLATION OF ADHESIVE AND INSERTS

A. Clean and prepare inserts reinforcing bars and all thread rods:
   1. Prepare embedded length of reinforcing bars and all thread rods by cleaning to bare metal. Inserts shall be free of oil, grease, paint, dirt, mill scale, rust, or other coatings that will reduce bond.

2. Solvent clean prepared reinforcing bars and all thread rods over the embedment length in accordance with SSPC SP-1. Provide an oil and grease free surface for bonding of adhesive to steel.

B. Fill holes with adhesive:
   1. Starting at the bottom of the hole, fill hole with adhesive inserting the reinforcing bar or all thread rod.
   2. Fill hole as nozzle is withdrawn without creating air voids.
   3. Unless otherwise indicated on the Drawings, fill hole with sufficient adhesive so that excess adhesive is extruded out of the hole when the reinforcing bar or all thread rod is inserted.
   4. Where necessary, seal hole at surface of concrete to prevent loss of adhesive during curing.

C. Installing reinforcing bars and all thread rods.
   1. Unless otherwise indicated on the Drawings, install bars and rods perpendicular to the concrete surface.
   2. Insert reinforcing bars and all thread rods into adhesive in accordance with manufacturer's recommended procedures.
   3. Confirm that insert has reached the designated embedment in the concrete, and that adhesive completely surrounds the embedded portion.
   4. Securely brace bars and all thread rods in place to prevent displacement while the adhesive cures. Bars and rods displaced during curing will be considered damaged and replacement will be required.
   5. Clean excess adhesive from the mouth of the hole.

D. Curing and loading.
   1. Provide and maintain curing conditions recommended by the adhesive manufacturer for the period required to fully cure the adhesive at the temperature of the concrete.
   2. Do not disturb or load bonded embeds until manufacturer's recommended cure time, based on temperature of the concrete, has elapsed.

3.05 POST-INSTALLATION ACTIVITIES

A. Do not bend bars or all-thread rods after bonding to the concrete, unless accepted in advance by the Engineer.

B. Attachments to all thread rods:
   1. After assemblies to be connected are placed, install nuts and washers for threaded rods as indicated on the Drawings.
   2. Draw nuts down tight, using practices specified for "snug tight" installation of bolts in steel to steel connections.

3.06 FIELD QUALITY CONTROL

A. Provide field quality control over the Work of this Section as specified in Section 01450 - Quality Control.

B. Do not allow work described in this Section to be performed by individuals who do not hold the specified certifications and who have not completed the specified job site training.

C. Manufacturer's services:
   1. Before beginning installation, furnish adhesive manufacturer's technical representative to conduct on-site training in proper storage and handling of adhesive, drilling and cleaning of holes, and preparation and installation of reinforcing bars and all thread rods.
      a. Provide notice of scheduled training to Engineer and to Special Inspector(s) not less than 10 working days before training occurs. Engineer and Special Inspector may attend training sessions.
   2. Submit record, signed by the manufacturer's technical representative, listing Contractor's personnel who completed the training. Only qualified personnel who have completed manufacturer's on-site training shall perform installations.

D. Field inspections and testing:
   1. Hole drilling and preparation.
   2. Results: Submit records of inspections and testing to Engineer by electronic copies within 24 hours after completion.

3.07 FIELD QUALITY ASSURANCE

A. Provide field quality assurance over the Work of this Section as specified in Section 01450 - Quality Control.

B. Special inspections, special tests, and structural observation:
   1. Provide as specified in Section 01455B - Special Tests and Inspections.
   2. Frequency of inspections:
      a. Unless otherwise indicated on the Drawings or in this Section, provide periodic special inspection as required by the Evaluation Report for the product installed.
      b. Provide continuous inspection for the initial installation of each type and size of adhesive bonded reinforcing bar and all thread rod. Subsequent installations of the same anchor may be installed with periodic inspection as defined in subsequent paragraphs.
      c. Provide continuous inspection of all drilling, cleaning and bonding activities for bars and rods installed in horizontal an upwardly inclined positions.
   3. Preparation:
      a. Review Drawings and Specifications for the Work to be observed.
      b. Review adhesive manufacturer's MPII and recommended installation procedures.
      c. Review Evaluation Report "Conditions of Use" and "Special Inspection" requirements.
   4. Inspection: Periodic:
      a. Initial inspection. Provide an initial inspection for each combination of concrete and reinforcing bar strength or concrete strength and all thread rod material being installed. During initial inspection, observe the following for compliance with the installation requirements.
         1) Concrete: Class (minimum specified compressive strength) and thickness.
         2) Environment: Temperature conditions at work area, and moisture conditions of concrete and drilled hole.
         3) Holes: Locations, spacing, and edge distances; verification of drill bit compliance with requirements; cleaning equipment and procedures;

cleanliness of hole. Before adhesive is placed, confirm that depth and preparation of holes conforms to the requirements of the Contract Documents, the MPII, and the "conditions of use" listed in the Evaluation Report.

4) Adhesive: Product manufacturer and name; lot number and expiration date; temperature of product at installation; installation procedure. Note initial set times observed during installation.

5) Reinforcing bars and all thread rods: Material diameter and length; steel grade and/or strength; cleaning and preparation; cleanliness at insertion; minimum effective embedment provided.

b. Subsequent inspections: Subsequent installations of the same reinforcing bars or all thread rods may be performed without the presence of the special inspector, provided that:

1) There is no change in personnel performing the installation, the general strength and characteristics of the concrete receiving the inserts, or the reinforcing bars and all thread rods being used.

2) For ongoing installations, the special inspector visits the site at least once per day during each day of installation to observe the work for compliance with material requirements and installation procedures.

5. Inspection: Continuous.

a. Make observations as described under "Inspection - Periodic, Initial Inspection" during all drilling, cleaning, and bonding activities for all bars and rods installed.

6. Records of inspections:

a. Provide a written record of each inspection using forms acceptable to the Engineer and to the Building Official.

b. Submit electronic copies of inspection reports to Engineer within 24 hours after completion of inspection.

END OF SECTION

SECTION 03071

EPOXIES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Epoxy.
   2. Epoxy gel.
   3. Epoxy bonding agent.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. C881 - Standard Specification for Epoxy-Resin-Base Systems for Concrete.
   2. C882 - Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear.
   3. D638 - Standard Test Method for Tensile Properties of Plastics.
   4. D695 - Standard Test Method for Compressive Properties of Rigid Plastics.

1.03 SYSTEM DESCRIPTION

A. Performance requirements:
   1. Provide epoxy materials that are new.
   2. Store and use products within limitations set forth by manufacturer.
   3. Perform and conduct work of this Section in neat orderly manner.

1.04 SUBMITTALS

A. General: Submit as specified in Section 01330 - Submittal Procedures.

B. Product Data: Submit manufacturer's data completely describing epoxy materials:
   1. Submit evidence of conformance to ASTM C881. Include manufacturer’s designations of Type Grade, Class, and Color.
   2. Submit documentation that materials meet or exceed the specified strength and performance characteristics. Indicate test methods and test results.

C. Quality control submittals:
   1. Manufacturer's installation instructions.

PART 2 PRODUCTS

2.01 MATERIALS

A. General:
   1. Moisture tolerant, water-insensitive, two-component epoxy resin adhesive material containing 100 percent solids, and meeting or exceeding the

performance properties specified when tested in accordance with the standards specified.

B. Epoxy: Low viscosity product in accordance with ASTM C881; Types I, II and IV; Grade 1; Class C.
   1. Manufacturers: One of the following or equal:
      a. BASF, MasterInject 1500.
      b. Dayton Superior, Sure Inject J56.
      c. Sika Corporation, Sikadur 35 Hi-Mod LV.
   2. Required properties:

Table 1 - Material Properties - Epoxy.

Property	Test Method	Required Results ("neat")
Tensile Strength (7-day)	ASTM D638	7,100 pounds per square inch, minimum.
Compressive Strength (7-day)	ASTM D695	11,000 pounds per square inch, minimum.
Bond Strength (2-day)	ASTM C882	1,500 pounds per square inch, minimum. Concrete failure before failure of epoxy.
Viscosity (mixed)		250-550 centipoise
Notes:	Testing results are for materials installed and cured at a temperature between 72 and 78 degrees Fahrenheit for 7 days, unless otherwise noted.	

C. Epoxy gel: Non-sagging product in accordance with ASTM C881, Types I and IV, Grade 3, Class C.
   1. Manufacturers: One of the following or equal:
      a. BASF, MasterEmaco ADH 327.
      b. Dayton Superior, Sure Anchor J50.
      c. Sika Corp., Sikadur 31, Hi-Mod Gel.
   2. Required properties:

Table 2 - Material Properties - Epoxy Gel.

Property	Test Method	Required Results ("neat")
Tensile Strength (7-day)	ASTM D638	2,000 pounds per square inch, minimum.
Compressive Yield Strength (7-day)	ASTM D695	8,000 pounds per square inch, minimum.
Bond Strength (14-day)	ASTM C882	1,500 pounds per square inch, minimum.
Notes:	Testing results are for materials installed and cured at a temperature between 72 and 78 degrees Fahrenheit for 7 days, unless otherwise noted.	

D. Epoxy bonding agent: Non-sagging product in accordance with ASTM C881, Type II, Grade 2, Class C.
   1. Manufacturers: One of the following or equal:
      a. BASF, MasterEmaco ADH 326.
      b. Dayton Superior, Sure Bond J58.
      c. Sika Chemical Corp., Sikadur 32 Hi-Mod LPL.
   2. Required properties.

Table 3 - Material Properties - Epoxy Bonding Agent		
Property	**Test Method**	**Required Results**
Tensile Strength (7-day)	ASTM D638	3,300 pounds per square inch, minimum.
Compressive Yield Strength (7-day)	ASTM D695	8,300 pounds per square inch, minimum.
Bond Strength (14-days)	ASTM C882	1,800 pounds per square inch, minimum. Concrete failure before failure of epoxy bonding agent.
Notes:	Testing results are for materials installed and cured at a temperature between 72 and 78 degrees Fahrenheit for 7 days, unless otherwise noted.	

   3. If increased contact time is required for concrete placement, epoxy resin/portland cement bonding agent as specified in Section 03072 - Epoxy Resin/Portland Cement Bonding Agent may be used instead of epoxy bonding agent.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install and cure epoxy materials in accordance with manufacturer's installation instructions.

B. Epoxy:
   1. Apply in accordance with manufacturer's installation instructions.

C. Epoxy gel:
   1. Apply in accordance with manufacturer's installation instructions.
   2. Use for vertical or overhead work, or where high viscosity epoxy is required.
   3. Epoxy gel used for vertical or overhead work may be used for horizontal work.

D. Epoxy bonding agent:
   1. Apply in accordance with manufacturer's installation instructions.
   2. Bonding agent will not be required for filling form tie holes or for normal finishing and patching of similar sized small defects.

END OF SECTION

SECTION 03072

EPOXY RESIN/PORTLAND CEMENT BONDING AGENT

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Epoxy resin/portland cement bonding agent.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. C109 - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens).
   2. C348 - Standard Test Method for Flexural Strength of Hydraulic-Cement Mortars.
   3. C496 - Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens.
   4. C882 - Standard Test Method for Bond Strength of Epoxy-Resin Systems Used With Concrete By Slant Shear.

B. Federal Highway Administration (FHWA):
   1. FHWA-RD-86-193 - Highway Concrete Pavement Technology Development and Testing Volume V: Field Evaluation of SHRP C9206 Test Sites (Bridge Deck Overlays).

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Sika Corp., Sika Armatec 110.

B. Substitutions: The use of other than the specified product will be considered, providing the Contractor requests its use in writing to the Engineer. This request shall be accompanied by:
   1. A certificate of compliance from an approved independent testing laboratory that the proposed substitute product meets or exceeds specified performance criteria, tested in accordance with the specified test standards.
   2. Documented proof that the proposed substitute product has a 1-year proven record of performance of bonding portland cement mortar/concrete to hardened portland cement mortar/concrete, confirmed by actual field tests and 5 successful installations that the Engineer can investigate.

2.02 MATERIALS

A. Epoxy resin/portland cement adhesive:
   1. Component "A" shall be an epoxy resin/water emulsion containing suitable viscosity control agents. It shall not contain butyl glycidyl ether.
   2. Component "B" shall be primarily a water solution of a polyamine.

3. Component "C" shall be a blend of selected portland cements and sands.
4. The material shall not contain asbestos.

2.03 PERFORMANCE CRITERIA

A. Properties of the mixed epoxy resin/portland cement adhesive:
   1. Pot life: 75 to 105 minutes.
   2. Contact time: 24 hours.
   3. Color: Dark gray.

B. Properties of the cured epoxy resin/portland cement adhesive:
   1. Compressive strength in accordance with ASTM C109:
      a. 3 day: 4,500 pounds per square-inch minimum.
      b. 7 days: 6,500 pounds per square-inch minimum.
      c. 28 days: 8,500 pounds per square-inch minimum.
   2. Splitting tensile strength in accordance with ASTM C496:
      a. 28 days: 600 pounds per square-inch minimum.
   3. Flexural strength:
      a. 1,100 pounds per square-inch minimum in accordance with ASTM C348.
   4. Bond strength in accordance with ASTM C882 modified at 14 days:
      a. 0 hours open time: 2,800 pounds per square-inch minimum.
      b. 24 hours open time: 2,600 pounds per square-inch minimum.
   5. The epoxy resin/portland cement adhesive shall not produce a vapor barrier.
   6. Material must be proven to prevent corrosion of reinforcing steel when tested under the procedures as set forth by the FHWA Program Report Number FHWA-RD-86-193. Proof shall be in the form of an independent testing laboratory corrosion report showing prevention of corrosion of the reinforcing steel.

PART 3 EXECUTION

3.01 INSTALLATION

A. Mixing the epoxy resin: Shake contents of Component "A" and Component "B." Empty all of both components into a clean, dry mixing pail. Mix thoroughly for 30 seconds with a jiffy paddle on a low-speed with 400 to 600 revolutions per minute drill. Slowly add the entire contents of Component "C" while continuing to mix for a minimum of 3 minutes and until uniform with no lumps. Mix only the quantity that can be applied within its pot life.

B. Placement procedure:
   1. Apply to prepared surface with stiff-bristle brush, broom, or "hopper-type" spray equipment:
      a. For hand applications: Place fresh plastic concrete/mortar while the bonding bridge adhesive is wet or dry, up to 24 hours.
      b. For machine applications: Allow the bonding bridge adhesive to dry for 12 hours minimum.

C. Adhere to all limitations and cautions for the epoxy resin/portland cement adhesive in the manufacturer's current printed literature.

3.02 CLEANING

A. Leave finished work and work area in a neat, clean condition without evidence of spillovers onto adjacent areas.

END OF SECTION

SECTION 03102

CONCRETE FORMWORK

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Concrete formwork.

1.02 REFERENCES

A. American Concrete Institute (ACI):
   1. 117 - Specifications for Tolerances for Concrete Construction and Materials and Commentary.

B. Underwriters Laboratories (UL).

1.03 DEFINITIONS

A. Green concrete: Concrete with less than 100 percent of the minimum specified compressive strength ($f'_{c)}$.

1.04 SYSTEM DESCRIPTION

A. Design requirements:
   1. Design of concrete forms, falsework, and shoring in accordance with local, state, and federal regulations.
   2. Design forms and ties to withstand concrete pressures without bulging, spreading, or lifting of forms.

B. Performance requirements:
   1. Construct forms so that finished concrete conforms to shapes, lines, grades, and dimensions indicated on the Drawings.
   2. It is intended that surface of concrete after stripping presents smooth, hard, and dense finish that requires minimum amount of finishing.
   3. Provide sufficient number of forms so that the work may be performed rapidly and present uniform appearance in form patterns and finish.
   4. Use forms that are clean and free from dirt, concrete, and other debris.
      a. Coat with form release agent if required, prior to use or reuse.

1.05 SUBMITTALS

A. Information on proposed forming system:
   1. Submit in such detail as the Engineer may require to assure himself that intent of the Specifications can be complied with by use of proposed system.
   2. Alternate combinations of plywood thickness and stud spacing may be submitted.

1.06 QUALITY ASSURANCE

A. Qualifications of formwork manufacturers: Use only forming systems by manufacturers having a minimum of 5 years' experience, except as otherwise specified, or accepted in writing by the Engineer.

B. Regulatory requirements: Install work of this Section in accordance with local, state, and federal regulations.

PART 2 PRODUCTS

2.01 MANUFACTURED UNITS

A. Forms: Built-up plywood:
   1. Built-up plywood forms may be substituted for prefabricated forming system subject to following minimum requirements:
      a. Size and material:
         1) Use full size 4-foot by 8-foot plywood sheets, except where smaller pieces are able to cover entire area.
         2) Sheet construction: 5-ply plywood sheets, 3/4-inch nominal, made with 100 percent waterproof adhesive, and having finish surface that is coated or overlaid with surface which is impervious to water and alkaline calcium and sodium hydroxide of cement.
      b. Wales: Minimum 2-inch by 4-inch lumber.
      c. Studding and wales: Contain no loose knots and be free of warps, cups, and bows.

B. Forms: Steel or steel framed:
   1. Steel forms:
      a. Rigidly constructed and capable of being braced for minimum deflection of finish surface.
      b. Capable of providing finish surfaces that are flat without bows, cups, or dents.
   2. Steel framed plywood forms:
      a. Provide forms that are rigidly constructed and capable of being braced.
      b. Plywood paneling: 5-ply, 5/8-inch nominal or 3/4-inch nominal, made with 100 percent waterproof adhesive, and having finish surface that is coated or overlaid with surface which is impervious to water and alkaline calcium and sodium hydroxide of cement.

C. Form release agent.
   1. Effective, non-staining, bond-breaking coating compatible with form surfaces and concrete mixes used.

D. Form ties:
   1. General:
      a. Provide form ties for forming system selected that are manufactured by recognized manufacturer of concrete forming equipment.
      b. Do not use wire ties or wood spreaders of any form.
      c. Provide ties of type that accurately tie, lock, and spread forms.

d. Provide form ties of such design that when forms are removed, they locate no metal or other material within 1-1/2 inches of the surface of the concrete.
e. Do not allow holes in forms for ties to allow leakage during placement of concrete.

2. Cone-snap ties:
a. Cone-snap ties shall form a cone shaped depression in the concrete with minimum diameter of 1 inch at the surface of the concrete and minimum depth of 1-1/2 inches.
b. Provide neoprene waterseal washer that is located near the center of the concrete.

3. Taper ties:
a. Neoprene plugs for taper tie holes: Size so that after they are driven, plugs are located in center third of wall thickness.

E. Incidentals:
1. External angles:
a. Where not otherwise indicated on the Drawings, provide with 3/4-inch bevel, formed by utilizing true dimensioned wood or solid plastic chamfer strip on walkways, slabs, walls, beams, columns, and openings.
b. Provide 1/4-inch bevel formed by utilizing true dimensioned wood or solid plastic chamfer strip on walkways, walls, and slabs at expansion, and construction joints.

2. Keyways: Steel, plastic, or lumber treated with form release agent.

PART 3 EXECUTION

3.01 EXAMINATION

A. Site verification of conditions:
1. Do not place concrete until forms have been checked for alignment, level, and strength, and mechanical and electrical inserts or other embedded items for correct location.

3.02 INSTALLATION

A. Forms: Built-up plywood:
1. Studding:
a. Spaced at 16 inches or 24 inches on center.
b. Closer spacing may be required depending upon strength requirements of the forms, in order to prevent any bulging surfaces on faces of finished concrete work.
c. Install studs perpendicular to grain of exterior plys of plywood sheets.

2. Wales: Form wales of double lumber material with minimum size as specified in this Section.
3. Number of form reuses: Depends upon durability of surface coating or overlay used, and ability to maintain forms in condition such that they are capable of producing flat, smooth, hard, dense finish on concrete when stripped.

B. Forms: Steel or steel framed:
1. Steel forms:
a. Adequately brace forms for minimum deflection of finish surface.

2. Steel framed plywood forms:
    a. Rigidly construct and brace with joints fitting closely and smoothly.
    b. Number of form reuses: Depends upon durability of surface coating or overlay used.
3. Built-up plywood forms: As specified in this Section may be used in conjunction with steel forms or steel framed plywood forms for special forming conditions such as corbels and forming around items which will project through forms.

C. Form bracing and alignment:
1. Line and grade: Limit deviations to tolerances which will permit proper installation of structural embedded items or mechanical and electrical equipment and piping.
2. Formwork:
    a. Securely brace, support, tie down, or otherwise hold in place to prevent movement.
    b. Make adequate provisions for uplift pressure, lateral pressure on forms, and deflection of forms.
3. When second lift is placed on hardened concrete: Take special precautions in form work at top of old lift and bottom of new lift to prevent:
    a. Spreading and vertical or horizontal displacement of forms.
    b. Grout "bleeding" on finish concrete surfaces.
4. Pipe stubs, anchor bolts, and other embedded items: Set in forms where required.
5. Cracks, openings, or offsets at joints in formwork: Close those that are 1/16-inch or larger by tightening forms or by filling with acceptable crack filler.

D. Forms: Incidentals:
1. Keyways: Construct as indicated on the Drawings.
2. Reentrant angles: May be left square.
3. Level strips: Install at top of wall concrete placements to maintain true line at horizontal construction joints.
4. Inserts:
    a. Encase pipes, anchor bolts, steps, reglets, castings, and other inserts, as indicated on the Drawings or as required, in concrete.
5. Pipe and conduit penetrations:
    a. Install pipe and conduit in structures as indicated on the Drawings, and seal with materials as specified in Section 7900 - Joint Sealants.

E. Form release agent:
1. Apply in accordance with manufacturer’s instructions.

F. Form ties:
1. Cone-snap ties: Tie forms together at not more than 2-foot centers vertically and horizontally.

3.03 FORM REMOVAL

A. Keep forms in place for at least the periods indicated in the following paragraphs.
1. Vertical forms:
    a. Keep vertical forms in place for a minimum of 24 hours after concrete is placed.

b. If, after 24 hours, concrete has sufficient strength and hardness to resist surface or other damage, forms may be removed.

2. Other forms and shoring: Keep in place:
   a. Sides of footings: 24 hours minimum.
   b. Vertical sides of beams, girders, and similar members: 48 hours minimum.
   c. Bottom of slabs, beams, and girders: Until concrete strength reaches specified strength f'_c or until shoring is installed.
   d. Shoring for slabs, beams, and girders: Shore until concrete strength reaches specified strength.
   e. Wall bracing: Brace walls until concrete strength of beams and slabs laterally supporting wall reaches specified strength.

B. Green concrete:
   1. No heavy loading on green concrete will be permitted.

3.04 SURFACE REPAIRS AND FINISHING

A. Immediately after forms are removed, carefully examine concrete surfaces, and repair any irregularities in surfaces and finishes as specified in Section 03300 - Cast-in-Place Concrete.

B. Form ties: Remove form ties from surfaces. Fill tie holes as follows:
   1. Remove form ties from surfaces.
   2. Roughen cone shaped tie holes by heavy sandblasting before repair.
   3. Dry pack cone shaped tie holes with dry-pack mortar as specified in Section 03600 - Grouting.
   4. Taper ties:
      a. After forms and taper ties are removed from wall, plug tie holes with neoprene plug as follows:
         1) Heavy sandblast and then clean tie holes.
         2) After cleaning, drive neoprene plug into each of taper tie holes with steel rod. Final location of neoprene plug shall be in center third of wall thickness. Bond neoprene plug to concrete with epoxy.
         3) Locate steel rod in cylindrical recess and against middle of plug during driving.
            a) At no time are plugs to be driven on flat area outside cylindrical recess.
      b. Dry-pack of taper tie holes:
         1) After installing plugs in tie holes, coat tie hole surface with epoxy bonding agent and fill with dry-pack mortar as specified in Section 03600 - Grouting.
            a) Place dry-pack mortar in holes in layers with thickness not exceeding tie hole diameter and heavily compact each layer.
            b) Dry-pack the outside of the hole no sooner than 7 days after the inside of the hole has been dry packed.
            c) Wall surfaces in area of dry-packed tie holes: On the water side of water containing structures and the outside of below grade walls:
               (1) Cover with minimum of 10 mils of epoxy gel.
               (2) Provide epoxy gel coating on wall surfaces that extend minimum of 2 inches past dry-pack mortar filled tie holes.

(3) Provide finish surfaces that are free from sand streaks or other voids.

3.05 TOLERANCES:

A. Finished concrete shall conform to shapes, lines, grades, and dimensions indicated on the Drawings.

B. Construct work within the tolerances in accordance with ACI 117, except as modified in the following paragraphs or as indicated on the Drawings.
   1. General:
      a. At certain locations in the Work, tolerances required for equipment placement and operation may be more restrictive than the general tolerance requirements of this Section.
      b. Confirm equipment manufacturers' required tolerances for location and operation of equipment that will be installed, and construct concrete to satisfy those requirements.
   2. Slabs:
      a. Slope: Uniformly sloped to drain when slope is indicated on the Drawings.
      b. Slabs indicated to be level: Have maximum vertical deviation of 1/8-inch in 10-foot horizontal length without any apparent changes in grade.
   3. Circular tank walls:
      a. The Contractor may deviate from finish line indicated on the Drawings by use of forms with chord lengths not to exceed 2 feet.
   4. Inserts and embedments:
      a. Set inserts and embedments to tolerances required for proper installation and operation of equipment or systems to which insert pertains.
      b. Maximum tolerances: As follows:

Item	Tolerance
Sleeves and inserts	Plus 1/8 Minus 1/8 inches.
Anchor bolts:	
Projected ends	Plus 1/4 Minus 0.0 inches.
Axial alignment	Not more than 2 degrees off the axis indicated on the Drawings.
Setting location	Plus 1/16 Minus 1/16 inches.

C. Remove and replace work that does not conform to required tolerances. Procedures and products employed in and resulting from such re-work shall be acceptable to the Engineer.

END OF SECTION

SECTION 03150

CONCRETE ACCESSORIES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Waterstops.
   2. Joint fillers.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. D570 - Standard Test Method for Water Absorption of Plastics.
   2. D624 - Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers.
   3. D638 - Standard Test Method for Tensile Properties of Plastics.
   4. D746 - Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
   5. D747 - Standard Test Method for Apparent Bending Modulus of Plastics by Means of a Cantilever Beam.
   6. D792 - Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
   7. D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
   8. D1752 - Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.
   9. D2240 - Standard Test Method for Rubber Property - Durometer Hardness.

B. U. S. Army Corps of Engineers (USACE):
   1. CRD-C-572, Specification for Polyvinyl Chloride Waterstop.

1.03 SUBMITTALS

A. Product data:
   1. Polyvinyl chloride waterstops: Complete physical characteristics.
   2. Preformed expansion joint material: Sufficient information on each type of material for review to determine conformance of material to requirements specified.

B. Samples:
   1. Polyvinyl chloride waterstop.

C. Laboratory test reports: Indicating that average properties of polyvinyl chloride waterstops material and finish conform to requirements specified in this Section.

D. Quality control submittals:
   1. Certificates of Compliance:
      a. Written certificates that polyvinyl chloride waterstops supplied on this Project meet or exceed physical property in accordance with USACE CRD-C-572 and the requirements of this Section.
   2. Manufacturer's instructions: For materials specified in this Section that are specified to be installed with such instructions.

1.04 QUALITY ASSURANCE

A. Mock-ups:
   1. Welding demonstration:
      a. Demonstrate ability to weld acceptable joints in polyvinyl chloride waterstops before installing waterstop in forms.

B. Field joints:
   1. Polyvinyl chloride waterstops field joints: Free of misalignment, bubbles, inadequate bond, porosity, cracks, offsets, and other defects which would reduce the potential resistance of material to water pressure at any point. Replace defective joints. Remove faulty material from site and disposed of by Contractor at its own expense.

C. Inspections:
   1. Quality of welded joints will be subject to acceptance of Engineer.
   2. Polyvinyl chloride waterstop: Following defects represent partial list that will be grounds for rejection:
      a. Offsets at joints greater than 1/16 inch or 15 percent of the material thickness, at any point, whichever is less.
      b. Exterior crack at joint due to incomplete bond, which is deeper than 1/16 inch or 15 percent of material thickness, at any point, whichever is less.
      c. Any combination of offset or crack that will result in net reduction in cross section of waterstop in excess of 1/16 inch or 15 percent of material thickness, at any point, whichever is less.
      d. Misalignment of joint that will result in misalignment of waterstop in excess of 1/2 inch in 10 feet.
      e. Porosity in welded joint as evidenced by visual inspection.
      f. Bubbles or inadequate bonding.

PART 2 PRODUCTS

2.01 JOINT FILLERS

A. General:
   1. Use specific type in applications as indicated on the Drawings.
   2. Do not use scrap or recycled materials to manufacture joint fillers.

B. Preformed expansion joint materials:
   1. Bituminous fiber expansion joint material:
      a. Properties:
         1) Thickness: To match joint width indicated on the Drawings.
         2) Asphalt-impregnated fiber in accordance with ASTM D1751.

b. Manufacturers: One of the following or equal:
1) Durajoint.
2) W.R. Meadows, SealTight Fibre Expansion Joint.

2. Synthetic sponge rubber expansion joint material:
a. Properties:
1) Thickness: As recommended for width indicated on the Drawings.
2) Material in accordance with ASTM D1752, Type I.
b. Manufacturers: One of the following or equal:
1) Williams Products Inc., Everlastic 1300.
2) W.R. Meadows, SealTight Sponge Rubber.

2.02 WATERSTOPS

A. Waterstops - polyvinyl chloride (PVC):
1. Manufactured from prime virgin polyvinyl chloride plastic compound containing the plasticizers, resins, stabilizers, and other materials necessary to meet the requirements as specified in this Section.
2. Manufacturers: One of the following or equal:
a. Vinylex Corp.
b. Greenstreak Plastic Products Co., Inc.
3. Type: Ribbed waterstop:
a. Construction joints: 6-inch wide ribbed type.
b. Expansion joint for wall penetrations for concrete encased electrical duct banks: 6-inch ribbed type with hollow center bulb.
c. Expansion joints: 9-inch wide ribbed type with hollow center bulb.
d. Dumbbell-type waterstop will not be allowed unless otherwise specified or indicated on the Drawings.
e. No scrap or reclaimed material shall be used.
4. Properties as indicated in the following table:

Physical Characteristics	Test Method	Required Results
Specific Gravity	ASTM D792	Not less than 1.3.
Hardness	ASTM D2240	70 to 90 Type A15 Shore durometer.
Tensile Strength	ASTM D638	Not less than 2,000 pounds per square inch.
Ultimate Elongation	ASTM D638	Not less than 300 percent.
Alkali Extraction	CRD-C-572	Change in weight after 7 days: Between minus 0.1 percent and plus 0.25 percent. Change in hardness after 7 days: Not more than plus 5 points.
Low Temperature Brittle Point	ASTM D746	No sign of cracking or chipping at -35 degrees Fahrenheit.
Water Absorption	ASTM D570	Not more than 0.15 percent after 24 hours.

Physical Characteristics	Test Method	Required Results
Accelerated Extraction Test	CRD-C-572	Tensile strength: Not less than 1,600 pounds per square inch. Elongation: Not less than 280 percent.
Stiffness in Flexure	ASTM D747	Not less than 600 pounds per square inch.
Tear Resistance	ASTM D624	Not less than 225 pounds per inch.
Thickness	-	3/8 inch.
Center Bulb		
6-inch Waterstops	-	7/8 inch or 1-inch nominal outside diameter.
9-inch Waterstops	-	For expansion joints 1 inch and narrower: 1-inch nominal outside diameter. For expansion joints wider than 1 inch: 2-inch nominal outside diameter.
Allowable Tolerances		
Width	-	Plus or minus 3/16 inch.
Thickness	-	Plus or minus 1/32 inch.

B. Waterstops - hydrophilic rubber:
   1. As specified in Section 03154 - Hydrophilic Rubber Waterstop.

PART 3 EXECUTION

3.01 INSTALLATION

A. Waterstops:
   1. General:
      a. Store waterstops so as to permit free circulation of air around waterstop material and prevent direct exposure to sunlight.
      b. Install waterstops in concrete joints where indicated on the Drawings.
      c. Carry waterstops in walls into lower slabs and join to waterstops in slabs with appropriate types of fittings.
      d. In waterbearing structures: Provide all joints with waterstops, whether indicated on the Drawings or not.
      e. Provide waterstops that are continuous.
      f. Set waterstops accurately to position and line as indicated on the Drawings.
      g. Hold and securely fix edges in position at intervals of not more than 24 inches so that they do not move during placing of concrete.
      h. Position the waterstop so that symmetrical halves of waterstop are equally divided between concrete pours. Center axis of waterstop shall be coincident with centerline of the joint.

i. Do not drive nails, screws, or other fasteners through waterstops in vicinity of construction joints.
j. Use wires at not more than 24 inches on centers near outer edge of waterstop to tie waterstops into position.
k. Special clips may be used in lieu of wires, at Contractor's option.
l. Terminate waterstops 3 inches from top of finish surfaces of walls and slabs unless otherwise specified or indicated on the Drawings.
m. When any waterstop is installed in concrete on one side of joint, while the other half or portion of the waterstop remains exposed to the atmosphere for more than 2 days, take suitable precautions to shade and protect exposed waterstop from direct rays of sunlight during entire exposure and until exposed portion is embedded in concrete.
n. When placing concrete at waterstops in slabs, lift edge of waterstop while placing concrete below the waterstop. Manually force waterstop against and into concrete, and then cover waterstop with fresh concrete.

2. Polyvinyl chloride waterstop:
a. Install waterstops so that joints are watertight.
b. Weld joints such as unions, crosses, ells, and tees, with thermostatically controlled equipment recommended by waterstop manufacturer:
1) Do not damage material by heat sealing.
2) Make joints by overlapping, then simultaneously cut ends of sections to be spliced so they will form smooth even joint. Heat cut ends with splicing tool until the plastic melts. Press 2 ends together until plastic cools.
3) Maintain continuity of waterstop ribs and tubular center axis.
4) The splices shall have tensile strength of not less than 60 percent of unspliced materials tensile strength.
c. Butt joints of ends of 2 identical waterstop sections may be made while material is in forms.
d. Manufacturer shall factory prefabricate joints for crosses and tees.
e. Split-type waterstops will not be permitted except where specifically indicated on the Drawings.

B. Joints:
1. Construct construction and expansion joints as indicated on the Drawings.
2. Preformed expansion joint material: Fasten expansion joint strips to concrete, masonry, or forms with adhesive. No nailing will be permitted, nor shall expansion joint strips be placed without fastening.

END OF SECTION

SECTION 03154

HYDROPHILIC RUBBER WATERSTOP

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Hydrophilic rubber waterstop.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension.
   2. D570 - Standard Test Method for Water Absorption of Plastics.
   3. D792 - Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
   4. D2240 - Standard Test Method for Rubber Property-Durometer Hardness.

1.03 SUBMITTALS

A. General:
   1. Submit the following items for each type, style and size of hydrophilic waterstop to be installed.
   2. Product data:
      a. Manufacturer’s product data sheets.
         1) Include complete physical dimensions, expansion characteristics, and laboratory test reports indicating that average material properties conform to the requirements specified.
         2) Provide data sheets for all materials to be included in the waterstop system.
   3. Samples:
      a. Minimum 6-inch long samples of each type of waterstop to be used if requested by the Engineer.
   4. Manufacturer's installation instructions:
      a. Installation instructions and recommended installation details for the complete waterstop system, and for each component used in that system.

PART 2 PRODUCTS

2.01 HYDROPHILIC RUBBER WATERSTOP

A. General:
   1. System composed of flexible hydrophilic urethane polymer with preformed strips, adhesives, paste, fasteners, and other accessories required for a complete and watertight installation.
      a. To ensure compatibility of materials, a single manufacturer shall provide all products and accessories for the hydrophilic waterstop system.
      b. Products incorporating bentonite are not acceptable under this Section.

c. Provide waterstop and accessories resistant to degradation under cyclic wetting and drying.

B. Hydrophilic strip waterstop:
1. Pre-formed strips of flexible hydrophilic rubber designed to undergo controlled expansion when exposed to moisture:
a. Strips manufactured to limit expansion in directions parallel to the plane of the joint, and to direct expansion against confining material perpendicular to that plane.
2. Provide normal or low-expansion pressure as scheduled and as indicated on the Drawings.
3. Manufacturers: One of the following or equal:
a. Hydrophilic strip:
1) Adeka Ultra Seal USA, MC-2010MN.
2) Greenstreak, Hydrotite CJ1020-2K.
b. Low expansion hydrophilic strip:
1) Adeka Ultra Seal USA, KBA-1510FP.
2) Greenstreak, Hydrotite CJ0725-3K.

C. Hydrophilic paste waterstop.
1. Single-component gun grade paste of hydrophilic rubber designed to undergo controlled expansion when exposed to moisture after initial curing.
2. Manufacturers: One of the following or equal:
a. Adeka Ultra Seal USA: P-201.
b. Greenstreak: Leakmaster LV-1.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install products in accordance with manufacturer's instructions and recommended details.

B. Prepare concrete joint surfaces:
1. Use wire brushing or scraping to expose an uncontaminated, solid surface.
2. Clean prepared surface with high-pressure air or water to remove residue and debris.
3. Confirm that prepared surfaces conform to manufacturer’s recommendations for surface profile and moisture conditions before installing materials.

C. Provide manufacturer’s recommended lap, splice, and corner details for hydrophilic waterstops.
1. Use hydrophilic paste at all corner joints and overlap splices of hydrophilic strips.

D. Hydrophilic strip waterstop:
1. Install primers and adhesives when recommended by the manufacturer before setting hydrophilic strips.
2. Keep hydrophilic strip taut during the fastening process.
3. Secure hydrophilic strip in place with concrete nails, screws, or adhesive.

4. Provide installation with no gap between the hydrophilic strip and the concrete to which it is attached. At rough or irregular surfaces, set hydrophilic strip waterstop strip in a bead of hydrophilic paste.
    a. Fill all voids and rough areas under the hydrophilic strip with hydrophilic paste.
    b. Allow hydrophilic paste to cure in accordance with manufacturer's recommendations before encapsulating paste in fresh concrete.

3.02 SCHEDULE

A. At the following joint locations/conditions, use the hydrophilic strip waterstop configuration noted unless otherwise indicated on the Drawings.

B. Concrete construction joints:
    1. Under all of the following conditions, use hydrophilic strip waterstop set in a bed of hydrophilic paste waterstop, and screw strip waterstop to concrete surface:
        a. Slab or wall thickness is greater than 10 inches.
        b. Waterstop is placed between 2 rows of steel reinforcement.
        c. Concrete cover from waterstop to nearest concrete face is at least 4 inches.
    2. Under any one of the following conditions, use low-expansion hydrophilic strip waterstop set in bed of hydrophilic paste waterstop and screw strip to concrete surface:
        a. Waterstop is placed on 1 side of a single row of steel reinforcement, or
        b. Concrete cover from waterstop to nearest concrete face is less than 4 inches.

C. Pipe penetrations through concrete:
    1. Pipe diameter less than 4 inches: Not allowed.
    2. Pipe diameter of 4 to 24 inches: Continuous bead of hydrophilic paste waterstop, minimum 1/4 inch high by 1/2 inch wide, encircling pipe.
    3. Pipe diameter greater than 24 inches: Continuous hydrophilic strip waterstop around perimeter of pipe, with hydrophilic paste seal at lapped ends of strip.

END OF SECTION

SECTION 03200

CONCRETE REINFORCING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Reinforcing bars.
      a. Carbon steel.
   2. Thread bars.
   3. Bar supports.
   4. Tie wires.
   5. Mechanical reinforcing bar couplers.
   6. Mechanical reinforcing bar end anchors (terminators).

1.02 REFERENCES

A. American Concrete Institute (ACI):
   1. 318 - Building Code Requirements for Structural Concrete and Commentary.
   2. SP-66 - ACI Detailing Manual.

B. American Iron and Steel Institute (AISI).

C. American Welding Society (AWS):
   1. D1.4 - Structural Welding Code - Reinforcing Steel.

D. ASTM International (ASTM):
   1. A493 - Standard Specification for Stainless Steel Wire and Wire Rods for Cold Heading and Cold Forging.
   2. A615 - Standard Specification for Deformed and Plain Carbon Steel Bars for Concrete Reinforcement.
   3. A706 - Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.

E. Concrete Reinforcing Steel Institute (CRSI):
   1. Manual of Standard Practice.

F. ICC Evaluation Service (ICC-ES):
   1. AC133 - Acceptance Criteria for Mechanical Connector Systems for Steel Reinforcing Bars.
   2. AC347 - Acceptance Criteria for Headed Deformed Bars.

1.03 DEFINITIONS

A. Architectural concrete: Concrete surfaces that will be exposed to view in the finished work. For purposes of this Section, architectural concrete includes the following:
   1. Concrete surfaces specified to receive paints or coatings.

2. Exposed concrete in open basins, channels, and similar liquid containing structures, that is located above a line 2 feet below the normal operating water surface elevation in that structure.

B. Bars: Reinforcement or reinforcing bars as specified in this Section.

C. Evaluation Report: Report prepared by ICC-ES , or by other testing agency acceptable to the Engineer and to the Building Official, that documents testing and review of a product to confirm that it complies with the requirements of designated ICC-ES Acceptance Criteria, and its acceptance for use under the Building Code specified in Section 01410 - Regulatory Requirements.

D. Give away bars: Reinforcing bars that are not required by the Contract Documents, but are installed by the Contractor to provide support for the required reinforcing bars.

E. Wire supports: Metal reinforcing supports constructed of steel wire as specified. Includes individual high chairs, continuous high chairs, bolsters and other similar configurations and shapes.

1.04 SYSTEM DESCRIPTION

A. The drawings contain notes describing the size and spacing of reinforcement and its placement, details of reinforcement at wall corners and intersections, and details of extra reinforcement around openings in concrete, and other related information.

1.05 SUBMITTALS

A. General:
   1. Submit in accordance with 01330 - Submittal Procedures.
   2. Changes to reinforcement in Contract Documents:
      a. Indicate in a separate letter submitted with shop drawings any changes to reinforcement indicated on the Drawings or specified.
      b. Such changes will not be acceptable unless Engineer has accepted them in writing.

B. Product data:
   1. Bar supports:
      a. Wire bar supports:
         1) Schedule of support materials to be provided and locations of use.
   2. Mechanical reinforcing bar couplers. For each type and/or series to be provided:
      a. Evaluation Report documenting compliance with the requirements of ICC-ES AC133.
      b. Details, properties, and dimensions of couplers. Include type or size identification, and bar size(s) and grade(s) for which the coupler is suitable.
      c. Manufacturer’s installation and testing instructions.
      d. Manufacturer's statement that products installed in accordance with manufacturer's recommended procedures will develop strengths and limit slip as specified in this Section.

3. Mechanical reinforcing bar end anchors (terminators):
    a. Evaluation Report documenting compliance with the requirements of ICC-ES AC307.
    b. Details, properties, and dimensions of end anchors. Include type or size identification, and bar size(s) and grade(s) for which the end anchor is suitable.
    c. Manufacturer's installation and testing instructions.
    d. Manufacturer's statement that products installed in accordance with manufacturer's recommended procedures will develop strengths and limit slip as specified in this Section.

C. Shop drawings:
    1. Reinforcement shop drawings:
        a. Submit drawings showing bending and placement of reinforcement required by the Contract Documents.
        b. Clearly indicate structures or portions of structures covered by each submittal.
        c. Shop drawings shall conform to the recommendations of the CRSI Manual of Standard Practice and ACI SP-66.
        d. Use the same bar identification marks on bending detail drawings, placement drawings, and shipping tags.
        e. Submittals consisting solely of reinforcing bar schedules, without accompanying placement drawings, will not be accepted unless accepted under prior written agreement with Engineer.
    2. Reinforcement placement drawings:
        a. Clearly show placement of each bar listed in the bill of materials, including additional reinforcement at corners and openings, and other reinforcement required by details in the Contract Documents.
        b. Clearly identify locations of reinforcement with coatings (e.g., galvanized or epoxy) and with yield strength other than ASTM A615, Grade 60.
        c. Show splice locations.
        d. Indicate locations of mechanical reinforcing couplers if used.
        e. Show locations of reinforcing bar end anchors, if used.
    3. Reinforcement fabrication drawings:
        a. If bend types or nomenclature differs from that recommended in the CRSI Manual of Standard Practice, provide details showing bend types and dimensional designations.
        Clearly identify reinforcement with coatings and with yield strength other than ASTM A615, Grade 60.

D. Samples (when requested by Engineer):
    1. Bar supports/wire reinforcement supports: Samples of each type of chair and bolster proposed for use. Submit with letter stating where each type will be used.
    2. Precast concrete bar supports: Samples of each type of precast support proposed for use. Submit with letter stating where each will be used.

E. Test reports:
    1. Certified copy of mill test for each steel used. Show physical properties and chemical analysis.
        a. Mill test reports may be submitted as record documents at the time the reinforcement from that heat of steel is shipped to the site.

b. In such cases, submit certificates under the shop drawing submittal number with the letter "R" (for record date) appended to the end (e.g., of the reinforcement was submitted as 03320-002-1, deliver the associated mill certificate as submittal 03320-002-1R).

2. Mechanical reinforcing bar couplers:
   a. Current Evaluation Report confirming that couplers provide specified tension and compression strength and conform to specified limits on total slip within the coupler.
   b. Certified copy of mill tests for heat(s) of steel incorporated into the reinforcing bar couplers shipped.
   c. For threaded sleeve type couplers, heat treatment lot numbers for each shipment.
3. Reinforcing bar end anchors:
   a. Current Evaluation Report confirming that end anchors provide specified tension strength.
   b. Certified copy of mill tests for heat(s) of steel incorporated into the materials shipped.

F. Manufacturer's instructions:
1. Mechanical reinforcing bar couplers:
   a. Manufacturer's installation instructions.
   b. Manufacturer's instructions for confirmation testing of couplers after reinforcing bars have been inserted into the couplers.
2. Mechanical reinforcing bar end anchors:
   a. Manufacturer's installation instructions.
   b. Manufacturer's instructions for confirmation testing of end anchors.

G. Special procedures:
1. Welding procedures conforming to AWS D1.4 for reinforcement to be field welded.
   a. Procedures qualification record.

H. Qualifications statements:
1. Welder qualifications.

I. Closeout documents:
1. Field quality control and inspection reports.
2. Field quality assurance special inspection and testing reports.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Packing and shipping:
1. Deliver bars bundled and tagged with identifying tags.

B. Acceptance at site:
1. Reinforcing bars: Deliver reinforcing bars lacking grade identification marks with letter containing manufacturer's guarantee of grade.

1.07 SEQUENCING AND SCHEDULING

A. Bar supports:
1. Do not place concrete until samples and product data for bar supports have been accepted by Engineer.

PART 2 PRODUCTS

2.01 MATERIALS

A. Reinforcing bars:
   1. Provide reinforcement of the grades and quality specified, fabricated from new stock, free from excessive rust or scale, and free from unintended bends or other defects affecting its usefulness.
   2. Reinforcing bars:
      a. ASTM A615 Grade 60 deformed bars, including the following requirements, or ASTM A706 Grade 60 deformed bars.
         1) Actual yield strength based on mil tests of reinforcement provided shall not exceed the minimum yield strength specified in this Section by more than 18,000 pounds per square inch.
         2) Ratio of actual ultimate tensile strength to actual tensile yield strength shall not be less than 1.25.
   3. Reinforcing bars designated or required to be welded:
      a. Low-alloy, ASTM A706 Grade 60, deformed bars.

B. Bar supports:
   1. Wire supports:
      a. All stainless steel bar supports:
         1) Conforming to CRSI Manual of Standard Practice recommendations for types and details, but custom fabricated entirely from stainless steel wire conforming to ASTM A493, AISI Type 316.
      b. Stainless steel protected bar supports:
         1) Conforming to CRSI Manual of Standard Practice Class 2, Type B, and consisting of bright basic wire support fabricated from cold-drawn carbon steel wire with stainless steel ends attached at the bottom of each leg.
         2) Stainless steel wire ends shall conform to ASTM A493, AISI Type 316 and shall extend at least 3/4 inch inward from the formed surface of the concrete.
      c. Bright basic wire bar supports.
         1) Conforming to CRSI Manual if Standard Practice, Class 3.
   2. Plastic supports:
      a. Manufacturers: The following or equal:
         1) Aztec Concrete Accessories.
   3. Deformed steel reinforcing bar supports:
      a. Fabricated of materials and to CRSI details recommended for typical reinforcement embedded in concrete and bent to dimensions required to provide specified clearances and concrete cover.
   4. Precast concrete bar supports ("dobies"):
      a. Pre-manufactured, precast concrete blocks with cast-in annealed steel wires, 16-gauge or heavier.
      b. Compression strength of concrete: Equal to or exceeding the compression strength of the surrounding concrete.
      c. Block dimensions:
         1) Height to provide specified concrete cover.
         2) Footprint not less than 3 inches by 3 inches, and adequate to support the weight of the reinforcement and maintain specified concrete cover without settling into the underlying surface.

C. Tie wires:
   1. General use: Black annealed steel wire, 16-gauge or heavier.

D. Mechanical reinforcing bar couplers and end anchors:
   1. General:
      a. Only products conforming to the requirements of ACI 318 for mechanical splices, and holding a current Evaluation Report that documents the following performance characteristics, will be considered for use.
      b. Strength of coupler: Capable of developing tension and compression strength not lower than the lesser of the following:
         1) ACI 318 "Type 2" units: In static tension and compression:
            a) Minimum 125 percent of the ASTM-specified minimum yield strength of the reinforcement being spliced or terminated.
            b) Minimum 100 percent of the ASTM-specified minimum ultimate strength of the reinforcement being spliced or terminated.
      c. Slip of reinforcing bars within coupler: Total slip of the reinforcing bars within the splice sleeve limited as follows:
         1) For bar sizes #14 and smaller, elongation between gauge points measured clear of the splice sleeve not exceeding 0.010 inches after coupler has been loaded to a tension of 30,000 pounds per square inch and load relaxed to a tension of 3,000 pounds per square inch.
      d. Fabrication:
         1) Threaded joints:
            a) Provide threaded ends designed so that cross-threading of bars will not occur during assembly.
            b) Fabricate male ends for female couplers using coupler manufacturer’s bar threading equipment to ensure proper taper and thread engagement.
         2) Mark each sleeve with heat treatment lot number.
   2. Couplers: Threaded - Reinforcing bar splice at construction joints.
      a. Steel sleeve butt splice with tapered internal threads in forged or swaged head, and nailing flange for attaching to forms. Provide with matching, tapered male-threaded dowels for insertion and tightening into threaded sleeve after form removal.
         1) Provide sleeve with factory-installed plugs to prevent concrete mortar from entering internally threaded coupler.
         2) Provide optional clipped nailing flanges as required to maintain minimum specified concrete cover over all surfaces of coupler.
      b. Holding current Evaluation Report demonstrating acceptance under ICC ES AC133.
      c. Manufacturers: One of the following or equal:
         1) Dayton Superior, DBDI Splice System.
         2) ERICO-Pentair, Lenton Form Saver.
   3. Couplers: Threaded - reinforcing bar splice:
      a. Steel sleeve butt splice with tapered internal threads at each end for joining to matching tapered male threads on reinforcing bars.
      b. Holding current Evaluation Report demonstrating acceptance under ICC ES AC133.
      c. Manufacturers: One of the following, or equal:
         1) Dayton Superior: Taper-Lock System.
         2) ERICO-Pentair: Lenton Taper Threaded Splicing System.

4. End anchors:
    a. Headed steel disc with tapered internal female threads for joining to matching tapered male threads on reinforcing bars.
    b. Holding current Evaluation Report demonstrating acceptance under ICC ES AC347.
    c. Manufacturers: One of the following or equal:
        1) Dayton Superior, Taper-Lock End Anchor Disc.
        2) ERICO-Pentair, Inc., Lenton Terminator.

2.02 FABRICATION

A. Shop fabrication and assembly:
    1. Cut and bend bars in accordance with provisions of ACI 318 and the CRSI Manual of Standard Practice.
    2. Bend bars cold. Use bending collars to develop the recommended bend radius.
    3. Provide bars free from defects and kinks and from bends not indicated on the Drawings.
    4. Circumferential and radiused reinforcement: Roll to the radius required for its location in the structure before installation.
    5. Bars to be fitted with mechanical couplers or mechanical end anchors:
        a. Fabricate threaded ends for connections in shop using manufacturer's recommended tools. Field fabrication is not allowed.
        b. Cut ends square.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of conditions:
    1. Reinforcing bars and welded wire reinforcement:
        a. Verify that reinforcement is new stock, free from rust scale, loose mill scale, excessive rust, dirt, oil, and other coatings that will adversely affect bonding capacity when placed in the Work.
    2. Welded wire fabric:
        a. Verify that sheets are not curled or kinked before or after installation.

3.02 PREPARATION

A. Surface preparation:
    1. Reinforcing bars - uncoated:
        a. Clean reinforcement of concrete, dirt, oil and other coatings that will adversely affect bond before embedding bars in subsequent concrete placements.
        b. Thin coating of red rust resulting from short exposure will not be considered objectionable. Thoroughly clean bars having rust scale, loose mill scale, or thick rust coat.
        c. Partially embedded reinforcement: Remove concrete or other deleterious coatings from dowels and other projecting bars by wire brushing or sandblasting before bars are embedded in subsequent concrete placements.

3.03 INSTALLATION

A. Reinforcing bars: General:
   1. Field-cutting of reinforcing bars is not permitted.
   2. Field-bending of reinforcing bars, including straightening and rebending, is not permitted.

B. Placing reinforcing bars:
   1. Accurately place bars to meet position and cover requirements indicated on the Drawings and specified. Secure bars in position.
   2. Tolerances for placement and minimum concrete cover: As listed in Table 1.

Table 1 - Reinforcement Placing Tolerances

Member	Tolerance on Reinforcement Location (1)	Tolerance on Minimum Concrete Cover (1,2)
Slabs, beams, walls and columns except as noted below:		
10 inches thick and less	± 3/8 inch	- 3/8 inch
More than 10 inches thick	± 1/2 inch	- 1/2 inch
Formed soffits:	As noted above	- 1/4 inch
Longitudinal location of bends and ends of reinforcement:		
Conditions not listed below:	± 2 inches	- 1/2 inch
At discontinuous ends of brackets and corbels	± 1/2 inch	- 1/4 inch
At discontinuous ends of other members:	± 1 inch	- 1/2 inch

Notes:
(1) ± indicates "plus or minus;" - indicates "minus;" + indicates "plus."
(2) Tolerance on cover is limited as noted, but decrease in cover shall not exceed one third of the minimum cover indicated on the Drawings.

   3. Spacing between bars:
      a. Minimum clear spacing between bars in a layer:
         1) As indicated on the Drawings, but not less than the larger of 1.5 times the bar diameter or 1-1/2 inches.
      b. Minimum clear spacing between bars in 2 or more parallel layers:
         1) Place bars in upper layers directly above bars in lower layers.
         2) Minimum spacing between layers: As indicated on the Drawings, but not less than the larger of 1.5 times the bar diameter or 1-1/2 inches.
      c. Limits on minimum clear spacing between bars also applies to the clear spacing between a lap splice and the adjacent bars and/or lap splices.
   4. Lap splices for bars:
      a. Lap splice locations and lap splice lengths: as indicated on the Drawings. Where lap lengths are not indicated, provide in accordance with ACI 318.

b. Unless otherwise specifically indicated on the Drawings (and noted as "non-contact lap splice"), install bars at lap splices in contact with each other and fasten together with tie wire.
c. Where bars are to be lap spliced at concrete joints, ensure that bars project from the first concrete placement a length equal to or greater than minimum lap splice length indicated on the Drawings.
d. Stagger lap splices where indicated on the Drawings.
e. Where lap splice lengths are not indicated on the Drawings, provide lap splice lengths in accordance with ACI 318.

C. Reinforcing supports:
1. Provide supports of sufficient numbers, sizes, and locations to maintain concrete cover, to prevent sagging and shifting, and to support loads during construction without displacement and without gouging or indentation into forming surfaces.
a. Quantities and locations of supports shall not be less than those indicated in ACI SP-66 and the CRSI Manual of Standard Practice.
2. Do not use brick, concrete masonry units, concrete spalls, rocks, wood, or similar materials for supporting reinforcement.
3. Do not use "give away bars" that have less cover than that required by the Contract Documents. Do not adjust the location of reinforcement required by the Contract Documents to provide cover for give away bars.
4. Provide bar supports of height required to maintain the clear concrete cover indicated on the Drawings.
5. Provide bar supports at formed vertical faces to maintain the clear concrete cover indicated on the Drawings.
6. Schedule of reinforcement support materials: Provide bar supports as indicated in Table 2.

Table 2 - Reinforcement Support Materials

Case	Location	Material
a.	Concrete placed over earth and concrete seal slabs ("mud mats"):	Precast concrete bar supports or stainless steel wire supports on stainless steel plates.
b.	Concrete placed against forms and exposed to water or wastewater process liquids (whether or not such concrete received additional linings or coatings):	All stainless steel bar supports.
c.	Concrete placed against forms and exposed to earth, weather, frequent washdown, or groundwater in the finished work	All stainless steel bar supports.
d.	Concrete placed against forms and exposed to interior equipment/piping areas in the finished work	Stainless steel protected bars supports.
e.	Between mats of reinforcement, and fully embedded within a concrete member	Bright basic wire bars supports, or deformed steel reinforcing bars.

D. Tying of reinforcing:
   1. Fasten reinforcement securely in place with wire ties.
   2. Tie reinforcement at spacings sufficient to prevent shifting.
      a. Provide at least 3 ties in each bar length. (Does not apply to dowel lap splices or to bars shorter than 4 feet, unless necessary for rigidity).
   3. Tie slab bars at every intersection around perimeter of slab.
   4. Tie wall bars and slab bar intersections other than around perimeter at not less than every fourth intersection, but at not more than the spacing indicated in Table 3:

Table 3 - Maximum Spacing of Tie Wires for Reinforcement

Bar Size	Slab Bar Spacing (Inches)	Wall Bar Spacing (Inches)
Bars Number 5 and Smaller	60	48
Bars Number 6 through Number 9	96	60
Bars Number 10 and Number 11	120	96

   5. After tying:
      a. Bend ends of wires inward towards the center of the concrete section. Minimum concrete cover for tie wires shall be the same as cover requirements for reinforcement.
      b. Remove tie wire clippings from inside forms before placing concrete.

E. Welded wire fabric reinforcement:
   1. Install only where indicated on the Drawings or accepted in advance by Engineer.
   2. Install necessary tie wires, spacing chairs, and supports to keep welded wire fabric at its designated position in the concrete section while concrete is being placed.
   3. Straighten welded wire fabric to make sheets flat in the Work.
   4. Do not allow wire fabric to drape between supports unless such a configuration is specifically indicated on the Drawings.
      a. If fabric is displaced during placement of concrete, make provisions to restore it to the designated location using methods acceptable to Engineer.
   5. Bend welded wire fabric as indicated on the Drawings or required to fit Work.
   6. Lap splice welded wire fabric as indicated on the Drawings.
      a. If lap splice length is not indicated, splice in accordance with ACI 318, but not less than 1 1/2 courses of fabric or 8 inches minimum. Tie laps at ends and at not more than 12 inches on center.

F. Welding reinforcing bars:
   1. Weld reinforcing bars only where indicated on the Drawings or where acceptance is received from Engineer prior to welding.
   2. Perform welding in accordance with AWS D1.4 and welding procedures accepted by Engineer.
      a. Conform to requirements for minimum preheat and interpass temperatures.
   3. Submit:
      a. Welding procedures specification.
      b. Procedures qualification record.

c. Welder qualification test record.

4. Do not tack weld reinforcing bars except where specifically indicated on the Drawings.

G. Reinforcing bar mechanical couplers and end anchors:
1. Install only at locations indicated on the Drawings or where prior approval has been obtained from Engineer.
2. Install in accordance with manufacturer's instructions and requirements of Evaluation Report.
a. Make splices using manufacturer's standard equipment, jigs, clamps, and other required accessories.
b. After assembly of the splice, tighten using torque load not less than that recommended by the manufacturer.
3. Unless greater cover is indicated on the Drawings, provide clear cover from surface of concrete to outside face of couplers that is not less than the minimum concrete cover specified for typical reinforcement.
a. If cover is less than required, contact Engineer for evaluation of conditions before modifying locations of bars or placing concrete.
b. Modifications to maintain or provide required concrete cover, such as addition of concrete ; re-positioning of stirrups, ties, etc., may be completed only after approval by Engineer.

3.04 FIELD QUALITY CONTROL

A. Provide quality control for the Work of this Section as specified in Section 01450 - Quality Control.

B. Field inspections and testing:
1. Submit records of inspections and testing to Engineer in electronic format within 24 hours after completion.

C. Manufacturer's services:
1. Furnish manufacturer's technical representative to conduct jobsite training regarding proper storage, handling, and installation of mechanical reinforcing bar couplers and bar end anchors for personnel who will perform the installation. Engineer may attend training session.

3.05 FIELD QUALITY ASSURANCE

A. Provide quality assurance as specified in Section 01450 - Quality Control.

B. Special inspections and tests:
1. Provide as specified in Section 01455B - Special Tests and Inspections.
2. Frequency of inspections:
a. Unless otherwise indicated on the Drawings or in this Section, provide periodic special inspection as required by the Building Code specified in Section 01410 - Regulatory Requirements.
3. Preparation:
a. Review Drawings and Specification for the Work to be observed.
b. Review approved submittal sand shop drawings.
4. Inspections: Special inspection shall include, but is not limited to, the following items.

a. Reinforcement: General:
    1) Type (material) and location of reinforcement supports.
    2) Bar material/steel grade and bar size.
    3) Location, placement, and spacing of bars.
    4) Clear concrete cover over reinforcement.
    5) Lap splice: Location and lap length. Bars within tolerances for contact (unless non-contact splice is indicated on the Drawings.)
    6) Bar hooks and development lengths embedded within concrete sections as indicated on the Drawings.
    7) Reinforcement tired in position and tie wire legs turned inward toward the center of the concrete section.
b. Reinforcement: Welding:
    1) Inspector qualification and inspections shall be in accordance with the requirements of AWS D1.4.
    2) Provide periodic inspection for:
        a) Weldability of reinforcement other than ASTM A706.
        b) Single pass fillet welds with thickness less than or equal to 5/16 inch.
    3) Provide continuous inspection for:
        a) Other welds.
        b) Welds at mechanical reinforcing bar couplers and end anchors.
    4) In addition to visual inspection, Owner may inspect reinforcing bar welds by other methods, including radiographic inspection.

5. Mechanical reinforcing bar couplers and end anchors:
    a. Special inspection shall include, but is not limited to, the following items:
        1) Coupler and end anchor model and identification.
        2) Couplers and end anchors are installed in accordance with the requirements of the Engineering Report for each product.
        3) Confirmation of the following:
            a) Grade and size of reinforcing bars.
            b) Positon of couplers and end anchors.
            c) Insertion length of reinforcement.
            d) Tightening of bars in the couplers and end anchors.
6. Records of inspections:
    a. Provide a written record of each inspection using forms acceptable to the Engineer and to the Building Official.
    b. Submit electronic copies of inspection reports to Engineer within 24 hours after completion of inspections.

3.06 NON-CONFORMING WORK

A. Before placing concrete, adjust or remove and re-install reinforcement to conform to the requirements of the Contract Documents.

END OF SECTION

SECTION 03300

CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Cast-in-place concrete.

1.02 REFERENCES

A. American Concrete Institute (ACI):
   1. 305 - Hot Weather Concreting Standard.
   2. 306 - Cold Weather Concreting Standard.
   3. 318 - Building Code Requirements for Structural Concrete and Commentary.
   4. 350 - Code Requirements for Environmental Engineering Concrete Structures and Commentary.
   5. Manual of Concrete Practice.

B. ASTM International (ASTM):
   1. C31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
   2. C33 - Standard Specification for Concrete Aggregates.
   3. C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
   4. C40 - Standard Test Method for Organic Impurities in Fine Aggregates for Concrete.
   5. C42 - Standard Test Method of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
   6. C88 - Standard Test Method of Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
   7. C94 - Standard Specification for Ready-Mixed Concrete.
   8. C114 - Standard Test Methods for Chemical Analysis of Hydraulic Cement.
   9. C117 - Standard Test Method for Materials Finer that 75-m (No. 200) Sieve in Mineral Aggregates by Washing.
   10. C123 - Standard Test Method for Lightweight Particles in Aggregate.
   11. C131 - Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
   12. C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
   13. C142 - Standard Test Method for Clay Lumps and Friable Particles in Aggregate.
   14. C143 - Standard Test Method for Slump of Hydraulic-Cement Concrete.
   15. C150 - Standard Specification for Portland Cement.
   16. C156 - Standard Test Method for Water Loss [from a Mortar Specimen] Through Liquid Membrane-Forming Curing Compounds for Concrete.
   17. C157 - Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.
   18. C171 - Standard Specifications for Sheet Materials for Curing Concrete.
   19. C172 - Standard Practice for Sampling Freshly Mixed Concrete.

20. C173 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
21. C227 - Standard Test Method for Potential Alkali Reactivity of Cement-Aggregate Combinations (Mortar-Bar Method).
22. C260 - Standard Specification for Air-Entraining Admixtures for Concrete.
23. C295 - Standard Guide to Petrographic Examination of Aggregates for Concrete.
24. C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
25. C311 - Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland-Cement Concrete.
26. C494 - Standard Specification for Chemical Admixtures for Concrete.
27. C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
28. C856 - Standard Practice for Petrographic Examination of Hardened Concrete.
29. C1260 - Standard Test Method of Potential Alkali Reactivity of Aggregates (Mortar Bar Method).
30. C1293 - Standard Test Method for Determination of Length Change of Concrete Due to Alkali-Silica Reaction.
31. D75 - Standard Practice for Sampling Aggregates.
32. D2103 - Standard Specification for Polyethylene Film and Sheeting.

1.03 DEFINITIONS

A. Alkali: Sum of sodium oxide and potassium oxide calculated as sodium oxide.

B. Cementitious materials: Portland cement and fly ash.

C. Cold weather: A period when for more than 3 consecutive days, the average daily outdoor temperature drops below 40 degrees Fahrenheit. The average daily temperature is the average of the highest and lowest temperatures during the period from midnight to midnight. When temperatures above 50 degrees Fahrenheit occur during more than half of any 24-hour duration, the period shall no longer be regarded as cold weather.

D. Cold weather concreting: Operations for placing, finishing, curing, and protection of concrete during cold weather.

E. Green concrete: Concrete with less than 100 percent of the specified strength.

F. Hairline crack: Crack with a crack width of less than 4 thousandths of an inch.

G. Hot weather: A period when project conditions such as low humidity, high temperature, solar radiation, and high winds, promote rapid drying of freshly placed concrete.

H. Hot weather concreting: Operations for placing, finishing, curing, and protection of concrete during hot weather.

1.04 SYSTEM DESCRIPTION

A. Performance requirements:
   1. General:
      a. Except as otherwise specified, provide concrete composed of portland cement, fly ash, fine aggregate, coarse aggregate, admixtures and water so proportioned and mixed as to produce plastic, workable mixture in accordance with requirements as specified in this Section and suitable to specific conditions of placement.
      b. Proportion materials in a manner that will secure lowest water-cementitious materials ratio that is consistent with good workability, plastic and cohesive mixture, and a mixture that is within specified slump range.
      c. Proportion fine and coarse aggregates in manner such as not to produce harshness in placing or honeycombing.
   2. It is the intent of this Section to secure for every part of the Work concrete with homogeneous mixture, which when hardened will have required strength, watertightness, and durability:
      a. It is recognized that some surface hairline cracks and crazing will develop in the concrete surfaces.
      b. Construction and expansion joints have been specified and positioned in structures as indicated on the Drawings, and curing methods specified, for purpose of reducing number and size of cracks, due to normal expansion and contraction expected from specified concrete mixes.
      c. Repair cracks which develop in walls or slabs and repair cracks which show any signs of leakage until all leakage is stopped.
      d. Pressure inject visible cracks, other than hairline cracks and crazing, in following areas with epoxy as specified in Section 03931 - Epoxy Injection System:
         1) Floors and walls of water bearing structures.
         2) Walls and overhead slabs of passageways or occupied spaces, outsides of which are exposed to weather or may be washed down and are not specified to receive separate waterproof membrane.
         3) Other items not specified to receive separate waterproof membrane: Slabs over water channels, wet wells, reservoirs, and other similar surfaces.
      e. Walls or slabs, as specified above, that leak or sweat because of porosity or cracks too small for successful pressure injection with epoxy: Seal on water or weather side by coatings of surface sealant system, as specified in this Section.
      f. Pressure injection and sealing: Continue as specified above until structure is watertight and remains watertight for not less than 1 year after final acceptance or date of final repair, whichever occurs later in time.
   3. Workmanship and methods: Provide concrete work, including detailing of reinforcing, conforming with best standard practices and as set forth in ACI 318, ACI 350, Manual of Concrete Practices, and recommended practices.

1.05 SUBMITTALS

A. Cement mill tests:
   1. Include alkali content representative of each shipment of cement for verification of compliance with specified requirements.

2. Provide mill test reports dated not more than 90 days before the date of submittal.

B. Cold weather concreting:
   1. Procedures for the production, transportation, placement, protection, curing, and temperature monitoring for concrete during cold weather.
   2. Procedures to be implemented upon abrupt changes in weather conditions or equipment failures.

C. Concrete mixes: Full details, including mix design calculations for concrete mixes proposed for use for each class of concrete:
   1. Include information on correction of batching for varying moisture contents of fine aggregate.
   2. Source quality test records with mix design submittal:
      a. Include calculations for required compressive strength (f'_{cr}) based on source quality test records.

D. Concrete aggregate tests: Certified copies in triplicate of commercial laboratory tests not more than 90 days old of all samples of concrete aggregates:
   1. Coarse aggregate:
      a. Abrasion loss.
      b. Clay lumps and friable particles.
      c. Coal and lignite.
      d. Materials finer than 200 sieve.
      e. Reactivity.
      f. Shale and chert.
      g. Soundness.
   2. Fine aggregate:
      a. Clay lumps.
      b. Color.
      c. Decantation.
      d. Reactivity.
      e. Shale and chert.
      f. Soundness.

E. Drying shrinkage test data.

F. Fine or coarse aggregate batched from more than 1 bin: Analyses for each bin, and composite analysis made up from these, using proportions of materials to be used in mix.

G. Fly ash Certificate of Compliance: Identify source of fly ash and certify compliance in accordance with ASTM C618.

H. For conditions that promote rapid drying of freshly placed concrete such as low humidity, high temperature, and wind: Corrective measures for use prior to placing concrete.

I. Hot weather concreting: Procedures for production, placement, finishing, curing, protection, and temperature monitoring for concrete during hot weather and appropriate corrective measures.

J. Heating equipment for cold weather concreting: Information on type of equipment used for heating materials and new concrete in process of curing during excessively cold weather.

K. Information on mixing equipment.

L. Product data: Submit data completely describing products.

M. Sequence of concrete placing: Submit proposed sequence of placing concrete showing proposed beginning and ending of individual placements.

N. Sieve analysis: Submit sieve analyses of fine and coarse aggregates being used in triplicate at least every 3 weeks and at any time there is significant change in grading of materials.

O. Trial batch test data:
   1. Submit data for each test cylinder.
   2. Submit data that identifies mix and slump for each test cylinder.

P. Weather monitoring: Records of:
   1. Relative humidity.
   2. Site ambient temperature.
   3. Wind speed.

Q. Temperature of freshly placed concrete.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Packing and shipping:
   1. Deliver, store, and handle concrete materials in manner that prevents damage and inclusion of foreign substances.
   2. Deliver and store packaged materials in original containers until ready for use.
   3. Deliver aggregate to mixing site and handle in such manner that variations in moisture content will not interfere with steady production of concrete of specified degree of uniformity and slump.

B. Acceptance at site: Reject material containers or materials showing evidence of water or other damage.

1.07 PROJECT CONDITIONS

A. Environmental requirements:
   1. Monitoring weather conditions:
      a. Install an outdoor weather station capable of measuring and recording ambient temperature, wind speed, and humidity. Furnish instruments accurate to within 2 degrees Fahrenheit, 5 percent relative humidity, and 1 mile per hour wind speed.
      b. Measure and record temperature of fresh concrete. Furnish and use sufficient number of maximum and minimum self-recording thermometers to adequately measure temperature of concrete.
      c. Monitor and keep records of the weather forecast starting at least 48 hours prior to placing concrete in order to allow enough time for taking appropriate measures pertaining to Hot or Cold weather concreting.

2. Hot weather concreting:
    a. Initiate evaporation control measures when concrete and air temperatures, relative humidity of the air, and the wind velocity have the capacity to evaporate water from a free surface at a rate that is equal to or greater than 0.2 pounds per square feet per hour. Determine evaporation rate using the Menzel Formula and monograph in ACI 305 3.1.3.
    b. When ambient air temperature is above 85 degrees Fahrenheit: Prior to placing concrete, cool forms and reinforcing steel by water cooling to below 90 degrees Fahrenheit.
    c. Monitor weather conditions at the site including air temperature, humidity, and wind speed, to assess the need for evaporation control measures begin monitoring site conditions no later than 1 hour before the start of concrete placement. Continue to monitor site conditions at intervals of 30 minutes until concrete curing has begun.
    d. Temperature of concrete mix at time of placement: Keep temperature below 90 degrees Fahrenheit by methods which do not impair quality of concrete.
    e. For conditions that promote rapid drying of freshly placed concrete such as low humidity, high temperature, and wind: Take corrective measures to minimize rapid water loss from concrete:
    f. Furnish and use sufficient number of maximum and minimum self-recording thermometers to adequately measure temperature around concrete.
3. Cold weather concreting:
    a. Concrete placed below ambient air temperature of 45 degrees Fahrenheit and falling or below 40 degrees Fahrenheit:
        1) Make provision for heating water.
    b. Follow recommendations of ACI 306 for preparation, placement, and protection of concrete during cold weather.
    c. If materials have been exposed to freezing temperatures to degree that any material is below 35 degrees Fahrenheit: Heat such materials.
    d. Heating water, cement, or aggregate materials:
        1) Do not heat in excess of 160 degrees Fahrenheit.
    e. Protection of concrete in forms:
        1) Do not remove forms from concrete when outside ambient air temperature is below 50 degrees Fahrenheit until concrete has attained its minimum specified compressive strength. Evidence of strength shall be based on by testing of cylinders stored in the field under equivalent conditions to those at the concrete structure.
        2) Protect by means of covering with tarpaulins, or other acceptable covering acceptable to Engineer.
        3) Provide means for circulating warm moist air around forms in manner to maintain temperature of 50 degrees Fahrenheit for at least 5 days.

1.08 SEQUENCING AND SCHEDULING

A. Schedule placing of concrete in such manner as to complete any single placing operation to construction, or expansion joint.

PART 2 PRODUCTS

2.01 MATERIALS

A. Admixtures:
   1. General:
      a. Do not use admixtures of any type, except as specified, unless written acceptance has been obtained from the Engineer.
      b. Admixtures shall be compatible with concrete and other admixtures. Admixtures other than pozzolans shall be the products of a single manufacture to ensure compatibility.
      c. Do not use admixtures containing chlorides calculated as chloride ion in excess of 0.5 percent by weight of cement.
      d. Use in accordance with manufacturer's recommendations. Add each admixture to concrete mix separately.
   2. Air entraining admixture:
      a. Provide concrete with 6 percent, within 1.5 percent, entrained air of evenly dispersed air bubbles at time of placement.
      b. In accordance with ASTM C260.
   3. Water reducing admixture:
      a. May be used at the Contractor's option.
      b. In accordance with ASTM C494, Type A or Type D.
      c. Not contain air-entraining agents.
      d. Liquid form before adding to the concrete mix.
      e. No decrease in cement is permitted as result of use of water reducing admixture.
   4. Super-plasticizers: Are not to be used without acceptance by Engineer.

B. Aggregate:
   1. General:
      a. Provide concrete aggregates that are sound, uniformly graded, and free of deleterious material in excess of allowable amounts specified.
      b. Grade aggregate in accordance with ASTM C136 and D75.
      c. Provide unit weight of fine and coarse aggregate that produces in place concrete with weight of not less than 140 pounds per cubic foot.
      d. Do not use aggregate made from recycled materials such as crushed and screened hydraulic-cement concrete, brick, and other construction materials.
   2. Fine aggregate:
      a. Provide fine aggregate for concrete or mortar consisting of clean, natural sand or of sand prepared from crushed stone or crushed gravel.
      b. Do not provide aggregate having deleterious substances in excess of following percentages by weight of contaminating substances.
         1) In no case shall total exceed percent listed.

Item	**Test Method**	**Percent**
Removed by decantation (dirt, silt, etc.)	ASTM C117	3
Shale or Chert	ASTM C123 ASTM C295*	1 1
Clay Lumps	ASTM C142	1

Item	Test Method	Percent
Removed by decantation (dirt, silt, etc.)	ASTM C117	3

* Test Method C123 is used to identify particles in the sample lighter than 2.40 Specific Gravity. Test Method C295 is used to identify which of the lightweight particles are shale or chert. If the results of Test Method C123 are less than 1 percent, Test Method C295 is not required.

c. Except as otherwise specified, grade fine aggregate from coarse to fine in accordance with ASTM C33.

3. Coarse aggregate:
   a. Provide coarse aggregate consisting of gravel or crushed stone made up of clean, hard, durable particles free from calcareous coatings, organic matter, or other foreign substances.
   b. Not exceeding 15 percent by weight, of thin or elongated pieces having length greater than 5 times average thickness.
   c. Deleterious substances: Not in excess of following percentages by weight, and in no case having total of all deleterious substances exceeding 2 percent.

Item	Test Method	Percent
Shale or chert	ASTM C123 ASTM C295*	1.25 1
Coal and lignite	ASTM C123	1/4
Clay lumps and friable particles	ASTM C142	1/4
Materials finer than Number 200 sieve	ASTM C117	1/2**

* Test Method C123 is used to identify particles in the sample lighter than 2.40 Specific Gravity. Test Method C295 is used to identify which of the lightweight particles are shale, chert, coal, or lignite. If the results of Test Method C123 are less than 1.25 percent (the minimum combined percentage of shale, chert, coal and lignite), Test Method C295 is not required.

** Except when material finer than Number 200 sieve consists of crusher dust, maximum amount shall be 1 percent.

d. Grading:
   1) Aggregate for Class A, B, C, D, and E concrete: In accordance with ASTM C33, Size Number 57, except as otherwise specified or authorized in writing by the Engineer.
   2) Aggregate for Class CE concrete for encasement of electrical conduits:
      a) Graded in accordance with ASTM C33, Size Number 8.

C. Concrete sealer:
   1. Manufacturers: One of the following or equal:
      a. Euclid Chemical Co., Diamond Hard.
      b. L&M Construction Chemicals, SealHard.

D. Conduit encasement coloring agent:
   1. Color: Red color concrete used for encasement of electrical ducts, conduits, and similar type items.
   2. Manufacturers: One of the following or equal:
      a. Davis Co., #100 Utility Red.
      b. I. Reiss Co., Inc., equivalent product.
      c. Euclid Chemical Co., Increte Division, “Colorcrete Brick Red.”
   3. Conduit encasement concrete: Mix into each cubic yard of concrete 10 pounds of coloring agent.

E. Evaporation retardant:
   1. Manufacturers: One of the following or equal:
      a. BASF, Confilm.
      b. Euclid Chemical Co., Eucobar.

F. Fly ash:
   1. Fly ash in accordance with ASTM C618, Class F, may be used in concrete made with Type II portland cement.
   2. Maximum of 15 percent by weight of fly ash to total weight of cementitious materials.
      a. The total weight of cementitious materials shall not be less than minimum cementitious materials listed in Table A.
   3. Do not use in concrete made with portland-pozzolan cement.
   4. Loss on ignition: Not exceed 4 percent.

G. Keyway material: Steel, plastic, or lumber.

H. Nonslip abrasive:
   1. Aluminum oxide abrasive size 8/16, having structure of hard aggregate that is, homogenous, nonglazing, rustproof, and unaffected by freezing, moisture, or cleaning compounds.
   2. Manufacturers: One of the following or equal:
      a. Exolon Co.
      b. Abrasive Materials, Inc.
      c. Euclid Chemical Co., “Non-Slip Aggregate”.

I. Portland cement:
   1. Conform to specifications and tests in accordance with ASTM C150, Types II or III, low alkali, except as specified otherwise.
   2. Have total alkali containing not more than 0.60 percent.
   3. Exposed concrete in any individual structure: Use only one brand of portland cement.
   4. Cement for finishes or repairs: Provide cement from same source and of same type as concrete to be finished or repaired.

J. Sheet membrane for curing:
   1. Polyethylene film:
      a. In accordance with ASTM C171.
      b. Color: White.
      c. Thickness: Nominal thickness of polyethylene film shall not be less than 0.0040 inches when measured in accordance with ASTM D2103.

Thickness of polyethylene film at any point shall not be less than 0.0030 inches.

d. Loss of moisture: Not exceed 0.055 grams per square centimeter of surface when tested in accordance with ASTM C156.

K. Sprayed membrane curing compound: Clear type with fugitive dye in accordance with ASTM C309, Type 1D.

L. Surface sealant system:
1. Manufacturers: One of the following or equal:
a. Euclid Chemical Co., Vandex Super.
b. Kryton International, Inc., Krystol T1.
c. Xypex Chemical Corp., Xypex Concentrate.

M. Water:
1. Water for concrete, washing aggregate, and curing concrete: Clean and free from oil and deleterious amounts of alkali, acid, organic matter, or other substances.
2. Chlorides and sulfate ions:
a. Water for conventional reinforced concrete: Use water containing not more than 1,000 milligrams per liter of chlorides calculated as chloride ion, nor more than 1,000 milligrams per liter of sulfates calculated as sulfate ion.
b. Water for prestressed or post-tensioned concrete: Use water containing not more than 650 milligrams per liter of chlorides calculated as chloride ion, or more than 800 milligrams per liter of sulfates calculated as sulfate ion.

2.02 EQUIPMENT

A. Mixing concrete:
1. Mixers may be of stationary plant, paver, or truck mixer type.
2. Provide adequate equipment and facilities for accurate measurement and control of materials and for readily changing proportions of material.
3. Mixing equipment:
a. Capable of combining aggregates, cementitious materials, and water within specified time into thoroughly mixed and uniform mass and discharging mixture without segregation.
b. Maintain concrete mixing plant and equipment in good working order and operated at loads, speeds, and timing recommended by manufacturer or as specified.
c. Proportion cementitious materials and aggregate by weight.

B. Machine mixing:
1. Batch plant shall be capable of controlling delivery of all material to mixer within 1 percent by weight of individual material.
2. If bulk cementitious materials are used, weigh them on separate visible scale which will accurately register scale load at any stage of weighing operation from zero to full capacity.
3. Prevent cementitious materials from coming into contact with aggregate or with water until materials are in mixer ready for complete mixing with all mixing water.

4. Procedure of mixing cementitious materials with sand or with sand and coarse aggregate for delivery to project site, for final mixing and addition of mixing water will not be permitted.
5. Retempering of concrete will not be permitted.
6. Discharge entire batch before recharging.
7. Volume of mixed material per batch: Not exceed manufacturer's rated capacity of mixer.
8. Mixers:
    a. Perform mixing in batch mixers of acceptable type.
    b. Equip each mixer with device for accurately measuring and indicating quantity of water entering concrete, and operating mechanism such that leakage will not occur when valves are closed.
    c. Equip each mixer with device for automatically measuring, indicating, and controlling time required for mixing:
        1) Interlock device to prevent discharge of concrete from mixer before expiration of mixing period.

C. Transit-mixed concrete:
1. Mix and deliver in accordance with ASTM C94.
2. Total elapsed time between addition of water at batch plant and discharging completed mix:
    a. Not to exceed 90 minutes.
    b. Elapsed time at project site shall not exceed 30 minutes.
3. Under conditions contributing to quick setting, total elapsed time permitted may be reduced by the Engineer.
4. Equip each truck mixer with device interlocked to prevent discharge of concrete from drum before required number of turns and furnish device that is capable of counting number of revolutions of drum.
5. Continuously revolve drum after it is once started until it has completely discharged its batch:
    a. Do not add water until drum has started revolving.
    b. Right is reserved to increase required minimum number of revolutions or to decrease designated maximum number of revolutions allowed, if necessary, to obtain satisfactory mixing. The Contractor will not be entitled to additional compensation because of such increase or decrease.

D. Other types of mixers: In case of other types of mixers, mixing shall be as follows:
1. Mix concrete until there is uniform distribution of materials, and discharge mixer completely before recharging.
2. Neither speed nor volume loading of mixer shall exceed manufacturer's recommendations.
3. Continue mixing for minimum of 1-1/2 minutes after all materials are in drum, and for batches larger than 1 cubic yard increase minimum mixing time 15 seconds for each additional cubic yard or fraction thereof.

2.03 MIXES

A. Measurements of materials:
1. Measure materials by weighing, except as otherwise specified or where other methods are specifically authorized in writing by the Engineer.
2. Furnish apparatus for weighing aggregates and cementitious materials that is suitably designed and constructed for this purpose.

3. Accuracy of weighing devices: Furnish devices that have capability of providing successive quantities of individual material that can be measured to within 1 percent of desired amount of that material.
4. Measuring or weighing devices: Subject to review by the Engineer. Shall bear valid seal of the Sealer of Weights and Measures having jurisdiction.
5. Weighing cementitious materials:
    a. Weigh cementitious materials separately.
    b. Cement in unbroken standard packages (sacks): Need not be weighed.
    c. Weigh bulk cementitious materials and fractional packages.
6. Measure mixing water by volume or by weight.

B. Concrete proportions and consistency:
1. Provide concrete that can be worked readily into corners and angles of forms and around reinforcement without excessive vibration and without permitting materials to segregate or free water to collect on surface.
2. Prevent unnecessary or haphazard changes in consistency of concrete.
3. Ratio of coarse aggregate to fine aggregate: Not less than 1.0 or more than 2.0 for all concrete Classes, with exception of Class CE.
4. Aggregate:
    a. Obtain aggregate from source that is capable of providing uniform quality, moisture content, and grading during any single day's operation.
5. Maximum concrete mix water to cementitious materials ratio, minimum cementitious materials content, and slump range: Conform to values specified in Table A in this Section.
6. Concrete batch weights: Control and adjust to secure maximum yield. At all times, maintain proportions of concrete mix within specified limits.
7. Mix modification: If required, by the Engineer, modify mixture within limits set forth in this Section.

C. Concrete mixes:
1. Proportioning of concrete mix: Proportion mixes based on required compressive strength f'_{cr}.
2. Mixes:
    a. Adjusting of water: After acceptance, do not change mixes without acceptance by Engineer, except that at all times adjust batching of water to compensate for free moisture content of fine aggregate.
    b. Total water content of each concrete class: Not exceed those specified in Table A in this Section.
    c. Checking moisture content of fine aggregate: Furnish satisfactory means at batching plant for checking moisture content of fine aggregate.
3. Change in mixes: Submit new mix design and perform new trial batch and test program as specified in this Section.

D. Classes of concrete:
1. Provide concrete consisting of 6 classes: Classes A, B, C, D, E, and CE. Use where specified or indicated on the Drawings.
2. Weight of concrete classes: Provide classes of concrete having minimum weight of 140 pounds per cubic foot.
3. Class B concrete: Class B concrete may be substituted for Class A concrete, when high-early strength concrete is needed in areas specifically accepted by the Engineer and that do not require sulfate resistant concrete.

4. Class C concrete: Class C concrete may be used for fill for unauthorized excavation, for thrust blocks and ground anchors for piping, for bedding of pipe, and where indicated on the Drawings.
5. Class D concrete: Use Class D for precast concrete items.
6. Class E concrete: Class E concrete shall be used as indicated on the Drawings for modifications to the existing bioreactor walls and foundations, including the new trench drains. A higher strength concrete is necessary in these locations.
7. Class CE concrete: Use Class CE for electrical conduit encasements.
8. All other concrete, unless specified or otherwise indicated on the Drawings: Use Class A concrete.

TABLE A1: CONCRETE

Class	Minimum Specified Compressive Strength f'_c at 28 Days (Pounds per Square Inch)	Water-to-Cementitious Materials Ratio	Cementitious Materials per Cubic Yard of Concrete by Weight (Pounds)	Slump Range (Inches)
A (Type II cement)	4,500	0.40 to 0.42	564 to 658	2 to 4
B (Type III cement)	4,500	0.40 to 0.42	564 to 658	2 to 4
C	2,500	Maximum 0.62	Minimum 423	3 to 6
CE	2,500	Maximum 0.62	Minimum 423	3 to 6
D	5,000	0.40 to 0.45	564 to 658	2 to 4
E	5,500	0.40 to 0.42	564 to 658	2 to 4

9. Pumped concrete: Provide pumped concrete that complies with all requirements of this Section.
10. Do not place concrete with slump outside limits indicated in Table A.
11. Classes:
    a. Classes A, C, D, E, and CE concrete: Make with Type II low alkali portland cement.
    b. Class B concrete: Make with Type III low alkali portland cement.
    c. Admixtures: Provide admixtures as specified in this Section.

E. Air entraining admixture:
1. Add agent to batch in portion of mixing water.
2. Batch solution by means of mechanical batcher capable of accurate measurement.

2.04 SOURCE QUALITY CONTROL

A. Tests:
1. Trial batches:
    a. After concrete mix designs have been accepted by Engineer, have trial batches of the accepted Class A, Class B, Class D and Class E concrete mix designs prepared by testing laboratory acceptable to the Engineer.

b. Prepare trial batches using cementitious materials and aggregates proposed to be used for the Work.
c. Prepare trial batches with sufficient quantity to determine slump, workability, consistency, and finishing characteristics, and to provide sufficient test cylinders.
d. Test cylinders: Provide cylinders having 6-inch diameter by 12-inch length and that are prepared in accordance with ASTM C31 for tests specified in this Section.
e. Determine slump in accordance with ASTM C143.
f. Test cylinders from trial batch:
    1) Test 8 cylinders for compressive strength in accordance with ASTM C39:
        a) Test 4 cylinders at 7 days and 4 at 28 days.
        b) Establish ratio between 7 day and 28 day strength for mix. 7-day strength may be taken as satisfactory indication of 28-day strength provided effects on concrete of temperature and humidity between 7 day and 28 day are taken into account.
    2) Average compressive strength of 4 test cylinders tested at 28 days: Equal to or greater than required average compressive strength (f'_{cr}) on which concrete mix design is based.
g. Drying shrinkage:
    1) Prepare 5 drying shrinkage specimens in accordance with ASTM C157, except as modified in this Section.
    2) Remove drying shrinkage specimens from molds at age of 23 hours within 1 hour after trial batching, then immediately place them in water at 73 degrees Fahrenheit within 3 degrees for at least 30 minutes and then measure specimens within 30 minutes thereafter to determine original length.
        a) Then submerge specimens in saturated limewater at 73 degrees Fahrenheit within 3 degrees for moist curing.
    3) Make measurement to determine expansion expressed as percentage of original length at age 7 days.
        a) Use length at age 7 days as base length for drying shrinkage calculations.
    4) Immediately store specimens in humidity controlled room maintained at 73 degrees Fahrenheit within 3 degrees and 50 percent within 4 percent relative humidity for remainder of test.
    5) Make and report measurements to determine shrinkage expressed as percentage of base length separately for 7, 14, 21, and 28 days of drying after 7 days of moist curing.
    6) Drying shrinkage deformation:
        a) Measure drying shrinkage deformation of each specimen as difference between base length and length after drying at each test age.
        b) Measure average drying shrinkage deformation of specimens to nearest 0.0001 inch at each test age.
        c) If drying shrinkage of any specimen departs from average of test age by more than 0.0004 inch, disregard results obtained from that specimen and test another specimen.
        d) Shrinkage of trial batch concrete at 28 days drying age shall not exceed 0.045 percent maximum.

h. If trial batch tests do not meet specified requirements for slump, strength, workability, consistency, drying shrinkage, and finishing, change concrete mix design proportions and, if necessary, source of aggregate.
   1) Perform additional trial batches and tests until an acceptable trial batch is produced that meets requirements of this Section.
i. Perform test batches and tests required to establish trial batches and acceptability of materials without change in Contract Price.
j. Do not place concrete until the concrete mix design and trial batch have been accepted by Engineer.

2. Required average compressive strength:
   a. Determine required average compressive strength (f'_{cr}) for selection of concrete proportions for mix design, for each class of concrete, using calculated standard deviation for its corresponding specified compressive strength (f'_c,) in accordance with ACI 318 and ACI 350.
   b. When test records of at least 30 consecutive tests that span period of not less than 45 calendar days are available, establish standard deviation as in accordance with ACI 318 and ACI 350 and as modified in this Section.
   c. Provide test records from which to calculate standard deviation that represent materials, quality control procedures, and conditions similar to materials, quality control procedures, and conditions expected to apply in preparation of concrete for the Work.
   d. Provide test records with materials and proportions that are more restricted than those for the Work.
   e. Specified compressive strength (f'_c) of concrete used in test records: Within 1,000 pounds per square inch of that specified for the Work.
   f. When lacking adequate test records for calculation of standard deviation meeting requirements, determine required average compressive strength f'_{cr} from following Table B.

TABLE B
REQUIRED AVERAGE COMPRESSION STRENGTH

Specified Compressive Strength f'_c (pounds per square inch)	**Required Average Compressive Strength f'_{cr} (pounds per square inch)**
Less than 3,000	f'_c + 1,000
3,000 to 5,000	f'_c + 1,200
Over 5,000	$1.10f'_c$ + 700

3. Aggregate:
   a. Testing of concrete aggregate is at Contractor's expense.
   b. Provide test reports representing samples of materials taken and tested at the following times:
      1) Not more than 60 days prior to the date on the proposed materials for concrete mixes.
      2) Not more than 60 days prior to any change in the source of aggregates, including suppliers and/or quarries.
      3) Whenever there is a significant change in aggregate quality or gradation from a previously submitted and accepted source.
   c. Sample aggregate in accordance with ASTM D75.

d. Fine and coarse aggregates:
    1) Gradation: Test in accordance with ASTM C136. Use sieves with square openings for testing grading of aggregates.
    2) Alkali-silica reactivity:
        a) Provide fine and coarse aggregate with expansion not greater than 0.10 percent at 14 days when tested in accordance with ASTM C1260, unless the aggregate has been determined to be not deleteriously reactive based on testing in accordance with one of the following:
            (1) ASTM C227: Expansion not greater than 0.05 percent and 3 months, and not greater than 0.10 percent at 6 months.
            (2) ASTM C1293: Expansion not greater than 0.04 percent at 1 year.

e. Fine aggregate:
    1) Provide fine aggregate that does not contain strong alkali nor organic matter which gives color darker than standard color when tested in accordance with ASTM C40.
    2) Provide aggregate having soundness in accordance with ASTM C33 when tested in accordance with ASTM C88.

f. Coarse aggregate:
    1) Soundness when tested in accordance with ASTM C88: Have loss not greater than 10 percent when tested with sodium sulfate.
    2) Abrasion Loss: Not exceed 45 percent after 500 revolutions when tested in accordance with ASTM C131.

g. Fly ash:
    1) Sampling and testing: Sample and test fly ash in accordance with ASTM C311.

h. Portland cement:
    1) Determination of alkali content: In accordance with ASTM C114.

PART 3 EXECUTION

3.01 INSTALLATION

A. Liquid evaporation retardant:
    1. Under conditions that result in rapid evaporation of moisture from the surface of the concrete, immediately after the concrete has been screeded, coat the surface of the concrete with a liquid evaporation retardant.
    2. Apply the evaporation retardant again after each work operation as necessary to prevent drying shrinkage cracks.
    3. Conditions which result in rapid evaporation of moisture may include one or more of the following:
        a. Low humidity.
        b. Windy conditions.
        c. High temperature.

B. Surface sealant system:
    1. Apply as recommended by manufacturer published instructions.
    2. Where concrete continues to sweat or leak, apply additional coats of surface sealant until the sweating or leaks stop.

C. Joints and bonding:
   1. As far as practicable construct concrete work as monolith.
   2. Locations of construction, expansion, and other joints are indicated on the Drawings or as specified in this Section.
   3. Time between placement of adjacent concrete separated by joints:
      a. Provide not less than 3 days (72 hours) between placement of adjacent sections for the following:
         1) Slabs.
         2) Walls.
      b. Provide not less than 7 days (168 hours) between placement of upper and lower pours for the following:
         1) Walls over slabs.
         2) Slabs over walls.
         3) Slabs keyed into the sides of walls.
   4. Construction joints:
      a. Where construction joints are not indicated on the Drawings, provide construction joints in slabs and walls at intervals not greater than 35 feet.
      b. In order to preserve strength and watertightness of structures, make no other joints, except as authorized the Engineer.
      c. At construction joints, thoroughly clean concrete of laitance, grease, oil, mud, dirt, curing compounds, mortar droppings, or other objectionable matter by means of heavy sandblasting.
      d. Cleaning of construction joints:
         1) Wash construction joints free of sawdust, chips, and other debris after forms are built and immediately before concrete or grout placement.
         2) Should formwork confine sawdust, chips, or other loose matter in such manner that it is impossible to remove them by flushing with water, use vacuum cleaner for their removal, after which flush cleaned surfaces with water.
         3) Provide cleanout hole at base of each wall and column for inspection and cleaning.
      e. At horizontal joints: As initial placement over cold joints, thoroughly spread bed of cement grout as specified in Section 03600 - Grouting with a thickness of not less than 1/2 inch nor more than 1 inch.
   5. Take special care to ensure that concrete is well consolidated around and against waterstops and waterstops are secured in proper position.
   6. Construction and expansion joints:
      a. Constructed where and as indicated on the Drawings.
      b. Waterstops, expansion joint material, synthetic rubber sealing compound, and other similar materials: As specified in Sections 03150 - Concrete Accessories and 07900 - Joint Sealants.
   7. Repair of concrete: Where it is necessary to repair concrete by bonding mortar or new concrete to concrete which has reached its initial set, first coat surface of set concrete with epoxy bonding agent as specified in Section 03071 - Epoxies.

D. Conveying and placing concrete:
   1. Convey concrete from mixer to place of final deposit by methods that prevent separation or loss of materials.

2. Use equipment for chuting, pumping, and conveying concrete of such size and design as to ensure practically continuous flow of concrete at delivery end without segregation of materials.
3. Design and use chutes and devices for conveying and depositing concrete that direct concrete vertically downward when discharged from chute or conveying device.
4. Keep equipment for conveying concrete thoroughly clean by washing and scraping upon completion of day's placement.

E. Placing concrete:
1. Place no concrete without prior authorization of the Engineer.
2. Do not place concrete until:
    a. Reinforcement is secure and properly fastened in its correct position and loose form ties at construction joints have been retightened.
    b. Dowels, bucks, sleeves, hangers, pipes, conduits, anchor bolts, and any other fixtures required to be embedded in concrete have been placed and adequately anchored.
    c. Forms have been cleaned and oiled as specified.
3. Do not place concrete in which initial set has occurred, or that has been retempered.
4. Do not place concrete during rainstorms or high velocity winds.
5. Protect concrete placed immediately before rain to prevent water from coming in contact with such concrete or winds causing excessive drying.
6. Keep sufficient protective covering on hand at all times for protection of concrete.
7. After acceptance, adhere to proposed sequence of placing concrete, except when specific changes are requested and accepted by the Engineer.
8. Notify the Engineer in writing of readiness, not just intention, to place concrete in any portion of the work:
    a. Provide this notification in such time in advance of operations, as the Engineer deems necessary to make final inspection of preparations at location of proposed concrete placing.
    b. Place forms, reinforcement, screeds, anchors, ties, and inserts in place before notification of readiness is given to the Engineer.
    c. Depositing concrete:
        1) Deposit concrete at or near its final position to avoid segregation caused by rehandling or flowing.
        2) Do not deposit concrete in large quantities in one place and work along forms with vibrator or by other methods.
        3) Do not drop concrete freely into place from height greater than 5 feet.
        4) Use tremies for placing concrete where drop is over 5 feet.
        5) Commence placement of concrete on slopes, starting at bottom of slope.
9. Place concrete in approximately horizontal layers not to exceed 24 inches in depth and bring up evenly in all parts of forms.
10. Continue concrete placement without avoidable interruption, in continuous operation, until end of placement is reached.
11. After concrete placement begins, continue concrete placement without significant interruption. Plan and implement precautions to prevent any delay, between layers being placed, from exceeding 20 minutes.
12. If concrete is to be placed over previously placed concrete and more than 20 minutes has elapsed, spread layer of cement grout not less than 1/2 inch in

thickness nor more than 1 inch in thickness over surface before placing additional concrete.

13. Placement of concrete for slabs, beams, or walkways:
    a. If cast monolithically with walls or columns, do not commence until concrete in walls or columns has been allowed to set and shrink.
    b. Allow set time of not less than 1 hour for shrinkage.

F. Consolidating concrete:
1. Place concrete with aid of acceptable mechanical vibrators.
2. Thoroughly consolidate concrete around reinforcement, pipes, or other shapes built into the work.
3. Provide sufficiently intense vibration to cause concrete to flow and settle readily into place and to visibly affect concrete over radius of at least 18 inches.
4. Vibrators:
    a. Keep sufficient vibrators on hand at all times to vibrate concrete as placed.
    b. In addition to vibrators in actual use while concrete is being placed, have on hand minimum 1 spare vibrator in serviceable condition.
    c. Do not place concrete until it has been ascertained that all vibrating equipment, including spares, are in serviceable condition.
5. Take special care to place concrete solidly against forms to leave no voids.
6. Take every precaution to make concrete solid, compact, and smooth. If for any reason surfaces or interiors have voids or are in any way defective, repair such concrete in manner acceptable to the Engineer.

G. Footings and slabs on grade:
1. Do not place concrete on ground or compacted fill until subgrade is in moist condition acceptable to the Engineer.
2. If necessary, sprinkle subgrade with water not less than 6 or more than 20 hours in advance of placing concrete.
3. If subgrade becomes dry prior to concrete placement, sprinkle again, without forming pools of water.
4. Do not place concrete if subgrade is muddy or soft.

H. Loading concrete:
1. Green concrete:
    a. No heavy loading of green concrete will be permitted.
2. No backfill shall be placed against concrete walls, connecting slabs, or beams until the concrete has reached the specified strength.
3. Use construction methods, sequencing, and allow time for concrete to reach adequate strength to prevent overstress of the concrete structure during construction.

I. Curing concrete:
1. General:
    a. Cure concrete by methods specified in this Section.
    b. Keep concrete continuously moist and at a temperature of at least 50 degrees Fahrenheit for minimum of 7 days after placement.
    c. Cure concrete to be painted with water or sheet membrane.

d. Do not use sprayed membrane curing or sealing compounds on concrete surfaces that are to receive paint or upon which any material is to be bonded.
e. Water cure or sheet membrane cure concrete slabs that are specified to be sealed by concrete sealer.
f. Cure other concrete by water curing or sprayed membrane curing compound at the Contractor's option.
g. Floor slabs may be cured using sheet membrane curing.

2. Water curing:
   a. Keep surfaces of concrete being water cured constantly and visibly moist day and night for period of not less than 7 days.
   b. Each day forms remain in place count as 1 day of water curing.
   c. No further curing credit will be allowed for forms in place after contact has once been broken between concrete surface and forms.
   d. Do not loosen form ties during period when concrete is being cured by leaving forms in place.
   e. Flood top of walls with water at least 3 times per day, and keep concrete surfaces moist at all times during 7 day curing period.
3. Sprayed membrane curing compound:
   a. Apply curing compound to concrete surface after repairing and patching, and within 1 hour after forms are removed.
   b. If more than 1 hour elapses after removal of forms, do not use curing compound, but use water curing for full curing period.
   c. If surface requires repairing or painting, water cure such concrete surfaces.
   d. Do not remove curing compound from concrete in less than 7 days.
   e. Curing compound may be removed only upon written request by Contractor and acceptance by Engineer, stating what measures are to be performed to adequately cure concrete.
   f. Take care to apply curing compound to construction joints. Apply to all surfaces along full profile of joints.
   g. After curing period is complete, remove curing compound placed within construction joint profile by heavy sandblasting prior to placing any new concrete.
   h. Contractor's Option: Instead of using curing compound for curing of construction joints, such joints may be water cured.
   i. Apply curing compound by mechanical, power operated sprayer and mechanical agitator that will uniformly mix all pigment and compound.
   j. Apply curing compound in at least 2 coats.
   k. Apply each coat in direction 90 degrees to preceding coat.
   l. Apply curing compound in sufficient quantity so that concrete has uniform appearance and that natural color is effectively and completely concealed at time of spraying.
   m. Continue to coat and recoat surfaces until specified coverage is achieved and until coating film remains on concrete surfaces.
   n. Thickness and coverage of curing compound: Provide curing compound having film thickness that can be scraped from surfaces at any and all points after drying for at least 24 hours.
   o. The Contractor is cautioned that method of applying curing compound specified in this Section may require more curing compound than normally suggested by manufacturer of curing compound and also more than is customary in the trade.

p. Apply amounts specified in this Section, regardless of manufacturer's recommendations or customary practice.
q. If the Contractor desires to use curing compound other than specified curing compound, coat sample areas of concrete wall with proposed curing compound and also similar adjacent area with specified compound in specified manner for comparison:
1) If proposed sample is not equal or better, in opinion of the Engineer, in all features, proposed substitution will not be allowed.
r. Prior to final acceptance of the work, remove, by sandblasting or other acceptable method, any curing compound on surfaces exposed to view, so that only natural color of finished concrete is visible uniformly over entire surface.

4. Sheet membrane curing:
a. Install sheet membrane as soon as concrete is finished and can be walked on without damage.
b. Seal joints and edges with small sand berm.
c. Keep concrete moist under sheet membrane.

J. Cold weather concreting:
1. Preparation before concreting:
a. Remove snow, ice, and frost from the surfaces, including reinforcement against which the concrete is to be placed.
b. The subgrade shall be free of frost before concrete placing begins.
c. Do not place concrete around any embedment that is at a temperature below freezing and is sufficiently massive as to cause the adjacent concrete to freeze.

2. Placement of concrete:
a. Placement temperature:
1) The minimum temperature of concrete immediately after placement shall be as specified in Table C.
2) The temperature of concrete as placed shall not exceed the values shown in Table C by more than 20 degrees Fahrenheit.
b. Protection temperature:
1) Unless otherwise specified, the minimum temperature of concrete during the protection period shall be as shown Table C.
2) Temperatures specified to be maintained during the protection period shall be those measured at the concrete surface, whether the surface is in contact with formwork, insulation, or air.
3) Measure the temperature with a surface measuring device accurate to 2 degrees Fahrenheit.
4) Measure the temperature of concrete in each placement at regular time intervals as specified in the contract documents.
c. Termination of protection:
1) The maximum decrease in temperature measured at the surface of the concrete in a 24-hour period shall not exceed the values listed in Table C.
2) Do not exceed these limits until the surface temperature of the concrete is within 20 degrees Fahrenheit of the ambient temperature of surrounding temperatures.
3) When the surface temperature of the concrete is within 20 degrees Fahrenheit of the ambient temperature, all protection may be removed.

TABLE C CONCRETE TEMPERATURE REQUIREMENTS		
Least dimension of section (inches)	**Minimum temperature of concrete as placed and to be maintained during the protection period (degrees Fahrenheit)**	**Maximum for gradual decrease in surface temperature during any 24 hour period after end of protection period (degrees Fahrenheit)**
Less than 12	55	50
12 to less than 36	50	40
36 to 72	45	30
Greater than 72	40	20

3. Curing of concrete:
   a. Prevent concrete from drying during the required curing period. If water curing is used, terminate use at least 24 hours before any anticipated exposure of the concrete to freezing temperatures.
4. Protection of concrete:
   a. Combustion heaters: Vent flue gases from combustion heating units to the outside of the enclosures.
   b. Overheating and drying: Place and direct heaters and ducts to avoid areas of overheating or drying of the concrete surface.
   c. Maximum air temperature: During the protection period, do not expose the concrete surface to air having a temperature more than 20 degrees Fahrenheit above the values shown in Table C unless higher values are required by an accepted curing method.
   d. Protection against freezing:
      1) Cure and protect concrete against damage from freezing for a minimum of 3 days, unless otherwise specified.
         a) Maintain the surface temperature of the concrete as specified in Table C.
      2) During periods not defined as cold weather, but when freezing temperatures may occur, protect concrete surfaces against freezing for the first 24 hours after placing.

3.02 CONCRETE FINISHING

A. Provide concrete finishes as specified in Section 03366 - Tooled Concrete Finishing.

B. Edges of joints:
   1. Provide joints having edges as indicated on the Drawings.
   2. Protect wall and slab surfaces at edges against concrete spatter and thoroughly clean upon completion of each placement.

3.03 FIELD QUALITY CONTROL

A. Testing of concrete:
   1. During progress of construction, the Owner will have tests made to determine whether the concrete, as being produced, complies with requirements specified.

2. Tests will be performed in accordance with ASTM C31, ASTM C39, and ASTM C172.
3. The Owner or the Owner's authorized agent, other than the contractor, shall hire a Certified Independent Laboratory that will make and deliver test cylinders to the laboratory and testing expense will be borne by the Owner.
4. Furnish test equipment.
5. Make provisions for and furnish concrete for test specimens, and provide manual assistance to the Engineer in preparing said specimens.
6. Assume responsibility for care of and providing of curing conditions for test specimens in accordance with ASTM C31.
7. Sampling frequency:
    a. 1 set of test cylinders for each 150 cubic yards of each class of concrete.
    b. Minimum of 1 set of test cylinders for each class of concrete placed.
    c. Not less than 1 set of test cylinders for each half-day's placement.
    d. At least 2 sets of test cylinders for each structure.

B. Compressive strength tests:
1. Set of 3 cylinder specimens, 6-inch diameter by 12 inch long.
2. Information: Test 1 cylinder at 7 days.
3. Acceptance: Test 2 cylinders at 28 days.

C. Slump tests:
1. Test slump of concrete using slump cone in accordance with ASTM C143.
2. Do not use concrete that does not meet specification requirements in regards to slump:
    a. Remove such concrete from project site.
    b. Test slump at the beginning of each placement, as often as necessary to keep slump within the specified range, and when requested to do so by the Engineer.

D. Air entrainment tests:
1. Test percent of entrained air in concrete at beginning of each placement, as often as necessary to keep entrained air within specified range, and when requested to do so by the Engineer.
2. Do not use concrete that does not meet Specification requirements for air entrainment:
    a. Remove such concrete from project site.
3. Test air entrainment in concrete in accordance with ASTM C173.
4. The Engineer may at any time test percent of entrained air in concrete received on project site.

E. Enforcement of strength requirement:
1. Concrete is expected to reach a compressive strength (f'_c) equal to or greater than that the minimum specified in Table A.
2. Strength level of concrete will be considered acceptable if following conditions are satisfied:
    a. Averages of all sets of 3 consecutive strength test results is greater or equal to specified compressive strength(f'_c).
    b. No individual strength test (average of 2 cylinders) falls below specified compressive strength (f'_c) by more than 500 pounds per square inch.

3. Non-compliant strength tests:
    a. Mark non-compliant strength test reports to highlight that they contain non-complying results and immediately forward copies of test reports to all parties on the test report distribution list.
    b. Provide treatment of non-compliant concrete at no additional cost to Owner and with no additional time added to project schedule:
    c. Initial treatment may consist of additional curing and testing of the affected concrete.
        1) Provide additional curing of concrete using means and duration acceptable to the Engineer.
        2) Upon completion of the additional curing, provide additional testing designated by the Engineer.
            a) Obtain and test core samples for compression strength in accordance with ASTM C42, ACI 318, and ACI 350.
            b) Provide not less than 3 cores for each affected area. Obtain Engineer's acceptance of proposed coring locations before proceeding with that work.
            c) Submit report of compression strength testing for Engineer's review.
            d) If required by the Engineer, provide additional cores and obtain petrographic examination in accordance with ASTM C856. Submit report of petrographic analysis for Engineer's review.
        3) If additional curing does not bring average of 3 cores taken in affected area to at least the minimum specified compressive strength (f'_c), designate such concrete in affected area as defective.

3.04 ADJUSTING

A. Provide repair of defective concrete at no additional cost to Owner and with no additional time added to the project schedule:

B. Make repairs using approach and means acceptable to the Engineer:
    1. Provide repairs having strength equal to or greater than specified concrete for areas involved.
    2. Do not patch, repair, or cover defective work without inspection by the Engineer.
    3. Acceptable means may include, but are not limited to strengthening, repair, or removal and replacement.

C. Strengthening of defective concrete:
    1. By addition of concrete.
    2. By addition of reinforcing.
    3. By addition of both concrete and reinforcing.

D. Repairs:
    1. Methods of repair:
        a. Dry pack method:
            1) Use for holes having depth nearly equal to or greater than least surface dimension of hole, for cone-bolt holes, and for narrow slots cut for repair.
            2) Smooth holes: Clean and roughen by heavy sandblasting before repair.

b. Mortar replacement method:
    1) Use for holes too wide to dry pack and too shallow for concrete replacement.
    2) Comparatively shallow depressions, large or small, which extend no deeper than nearest surface reinforcement.
c. Concrete replacement method:
    1) Use when holes extend entirely through concrete section or when holes are more than 1 square foot in area and extend halfway or more through the section.

2. Preparation of concrete for repair:
    a. Chip out and key imperfections in the work and make them ready for repair.
    b. Obtain Engineer's acceptance of surface preparation methods and of prepared surfaces prior to repair.
    c. Surfaces of set concrete to be repaired: First coat with epoxy bonding agent as specified in Section 03071 - Epoxies.

E. Remove and replace defective concrete.

END OF SECTION

SECTION 03366

TOOLED CONCRETE FINISHING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Tooled concrete finishes.

1.02 QUALITY ASSURANCE

A. Mock-ups:
   1. Test panels for concrete finishes:
      a. Prepare test panels for F4 and F5 finishes and tie-hole repairs for review by Engineer.
      b. Accepted test panels serve as standard of quality and workmanship for project.
   2. Prepare test panel showing horizontal and vertical joints proposed for project for review by the Engineer. Refer to finishes specified in this Section.
   3. Test panels indicating methods for making concrete repairs: Prepare test panels for proposed repairs at beginning of project for review by Engineer:
      a. Accepted test panels serve as standard for repairs during the project.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Packing and shipping:
   1. Deliver and store packaged materials in original containers until ready for use.

PART 2 PRODUCTS

2.01 MIXES

A. Mortar mix for F4 finish: Consist of 1 part cement and 1-1/2 parts of fine sand passing Number 100 screen. Mix with enough water and emulsified bonding agent to have consistency of thick cream.

B. Mortar mix for F5 finish: Consist of 1 part cement to 1-1/2 parts of sand which passes Number 16 screen.

PART 3 EXECUTION

3.01 CONCRETE FINISHES

A. Cement for finishes:
   1. Addition of white cement may be required to produce finish which matches color of concrete to be finished.

B. Finish vertical concrete surfaces with one of the following finishes as indicated in the Finish Schedule:
   1. F1 finish: No special treatment other than repair defective work and fill depressions 1 inch or deeper and tie holes with mortar after removal of curing compound.
   2. F2 finish: No special treatment other than repair defective work, remove fins, fill depressions 1/2 inch or deeper and tie holes with mortar after removal of curing compound.
   3. F3 finish: Repair defective work, remove fins, offsets, and grind projections smooth. Fill depressions 1/4 inch or larger in depth or width and tie holes with mortar after removal of curing compound.
   4. F4 finish: Receive same finish as specified for F3 finish, and, in addition fill depressions and holes 1/16 inch or larger in width with mortar.
      a. "Brush-Off" sandblast surfaces prior to filling holes to expose all holes near surface of the concrete.
      b. Thoroughly wet surfaces and commence filling of pits, holes, and depressions while surfaces are still damp.
      c. Perform filling by rubbing mortar over entire area with clean burlap, sponge rubber floats, or trowels.
      d. Do not let any material remain on surfaces, except that within pits and depressions.
      e. Wipe surfaces clean and moist cure.
   5. F5 finish: Receive same finish as specified for F3 finish, and, in addition, receive special stoned finish, in accordance with following requirements:
      a. Remove forms and perform required repairs, patching, and pointing as specified in this Section.
      b. Wet surfaces thoroughly with brush and rub with hard wood float dipped in water containing 2 pounds of portland cement per gallon.
      c. Rub surfaces until form marks and projections have been removed.
      d. Spread grindings from rubbing operations uniformly over surface with brush in such manner as to fill pits and small voids.
      e. Moist cure brushed surfaces and allow to harden for 3 days:
         1) After curing, obtain final finish by rubbing with carborundum stone of approximately Number 50 grit until entire surfaces have smooth texture and are uniform in color.
         2) Continue curing for remainder of specified time.
      f. If any concrete surface is allowed to become too hard to finish in above specified manner, sandblast and wash related surfaces exposed to view, whether finished or not.
         1) While still damp, rub over surface, plastic mortar, as specified for brushed surfaces and handstoned with Number 60 grit carborundum stone, using additional mortar for brushed surfaces until surface is evenly filled without an excess of mortar.
         2) Continue stoning until surface is hard.
         3) After moist curing for 3 days, make surface smooth in texture and uniform in color by use of Number 50 or Number 60 grit carborundum stone.
         4) After stoning, continue curing until 7 day curing period is completed.

C. Finish horizontal concrete surfaces with one of the following finishes as indicated in the Finish Schedule after proper and adequate vibration and tamping:
   1. S1 finish: Screeded to grade and leave without special finish.

2. S2 finish: Smooth steel trowel finish.
3. S3 finish: Steel trowel finish free from trowel marks. Provide smooth finish free of all irregularities.
4. S4 finish: Steel trowel finish, without local depressions or high points, followed by light hairbroom finish. Do not use stiff bristle brooms or brushes. Perform brooming parallel to slab-drainage. Provide resulting finish that is rough enough to provide nonskid finish. Finish is subject to review and acceptance by the Engineer.
5. S5 finish: Nonslip abrasive: After concrete has been screeded level and hardened enough to support man standing on a board, sprinkle abrasive from shake screen into surface at uniform rate of 25 pounds for each 100 square feet of surface area, wood float into finish, then trowel abrasive into surface with steel trowel properly exposing abrasive in surface as required to provide nonslip surface.
6. S6 finish: Roughened finish: After concrete has been screeded to grade, apply a roughened finish by use of a jitterbug roller or similar device.

D. Finish concrete floor surfaces to which surfacing material is applied: Finish smooth with tolerance within 1/8 inch in 10 feet in any direction from lines indicated on the Drawings.

3.02 CONCRETE FINISH SCHEDULE

A. Finish concrete surfaces as follows:
1. F4 finish for following vertical surfaces:
   a. Concrete surfaces specified or indicated to be painted.
   b. Concrete surfaces, interior or exterior, exposed to view.
2. Surfaces in open channels, basins, and similar structures:
   a. F3 finish for vertical surfaces which are normally below water surface.
   b. F4 finish for vertical surfaces located above normal water surface and exposed to view.
   c. Remove fins and fill tie holes from concrete surfaces located in closed boxes or channels where there is normally no access or passageway.
3. S1 finish for following surfaces:
   a. Projecting footings which are to be covered with dirt.
   b. Slab surfaces which are to be covered with concrete fill.
4. S2 finish for following surfaces:
   a. Tops of corbels.
   b. Tops of walls and beams not covered above in this Section.
   c. Tops of slabs not covered above in this Section.
   d. All other surfaces not specified to be finished otherwise.
5. S3 finish for following surfaces:
   a. Building and machine room floors which are not covered with surfacing material: Provide floors that are free from trowel marks.
6. S4 finish for following surfaces:
   a. Exterior walkways.
   b. Tops of exterior walls or beams which are to serve as walkways.
   c. Tops of exterior walls or beams which are to support gratings.
   d. Top surface of slabs for basins, channels, digesters, and similar structures.

7. S6 finish for following surfaces:
    a. Basin bottoms, or other similar slab surfaces, over which layer of basin bottom grout will be applied.

END OF SECTION

SECTION 03565

BASIN BOTTOM GROUT

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Grouting basin bottom slabs.

1.02 REFERENCES

A. International Concrete Repair Institute (ICRI):
   1. 310.2 - Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays.

1.03 DEFINITIONS

A. Grout that has not bonded: Grout that, after placing and setting, has hollow sound when tapped with 4-foot long, nominal, 2-inch by 4-inch piece of lumber.

B. Jitterbug: An expanded metal or grate tamper designed for finishing concrete surfaces with a rough surface profile.

1.04 SUBMITTALS

A. Manufacturer's instructions:
   1. For equipment to be used in grouting basin bottom slabs:
      a. Submit grout placement instructions from manufacturer of equipment designated to operate in basin.
      b. Include in such instructions statements on limitations and precautions to be observed when using equipment for grout placement.

1.05 QUALITY ASSURANCE

A. Pre-installation conference for grouting basin bottom slabs: Schedule meeting with Engineer not less than 24 hours before planned grouting operations to discuss method of placement of grout.

PART 2 PRODUCTS

2.01 MATERIALS

A. Materials for grout:
   1. Cement, sand, and water: As specified in Section 03300 - Cast-in-Place Concrete.

2.02 MIXES

A. Grout mixture:
   1. 1 part portland cement and 4-1/2 parts sand, by weight.
   2. Water content:
      a. Sufficient to allow workability for spreading grout with screeds attached to arms of equipment mechanism.
      b. Not excessive, to prevent formation of surface water, laitance, segregation, and to allow grout to stay in place after screeding.
   3. Do not use admixtures.

PART 3 EXECUTION

3.01 PREPARATION

A. Surface preparation:
   1. Basin bottom slab surface preparation:
      a. Concrete slab surfaces shall have rough texture, suitable for bonding grout.
      b. During concrete placement: finish concrete surface with jitterbug. Do not provide a smooth troweled surface.
      c. Roughen top of slab surface to a ICRI 310.2 surface profile of CSP-5 or rougher using one of the following methods:
         1) Abrasive blasting.
         2) Steel shotblasting.
         3) Ultra high-pressure water jetting.
      d. Clean entire slab surface as required to remove dirt, oil, curing compound, laitance, dust, and other matter that may prevent proper grout bonding.
      e. Saturate concrete slabs with water for minimum of 3 days just before placing grout. At time grout is placed, concrete shall be saturated and surface damp.

B. Equipment preparation:
   1. Preparation of equipment for grouting basin bottom slabs:
      a. Setting the screeds:
         1) Bolt nominal 2-inch by 4-inch section of lumber blades on arms of equipment mechanism.
         2) Locate leading edge of lumber approximately 2 inches in front of blade and cut it parallel to centerline of arm.
         3) Securely nail nominal 2-inch by 6-inch screed board to ends of 2 by 4 lumber, in manner such that screed runs parallel to centerline of arm.
         4) Nail bent sheet metal to lower edge of screed board.
         5) Ensure that bottom of screed board is 1-1/2 inches below steel blades on arms of equipment mechanism.

3.02 APPLICATION

A. Grouting basin bottom slabs:
   1. Placement, general:
      a. Place grout in accordance with equipment manufacturer's instructions and in accordance with limitations and precautions given in such instructions.

b. Bring promptly to attention of the Engineer, conflicts between manufacturer's instructions and this Section.

2. Placing grout:
   a. Use grouting equipment to apply grout for basin bottom slabs.
   b. Perform grouting continuously without interruptions until basin slab is covered.
   c. Place ring of grout approximately 3 feet wide on outer edge of slab and gradually widened towards center following spiral pattern until basin bottom slab is covered.
   d. Unacceptable placing procedure: Following procedures will not be accepted:
      1) Grouting by circular sectors or "pie" sections.
      2) Grouting from center outward.
   e. Use finishing workers to control area immediately in front of screed boards in manner so that:
      1) Grout is installed to specified thickness.
      2) No low areas occur.
      3) No excessive amount of grout accumulates.
      4) Grout surface has uniform wood trowel finish without ridges, gouges, or other defect.
   f. Coordinate grout placement rate and number of finishing workers with travel speed of arms of equipment mechanism.
   g. Last grout area to be grouted in center may be finished by worker operating from 1 of the arms.
   h. Use misters or means acceptable to Engineer to keep grout from drying out before start of curing.
3. Following grout placement:
   a. After completion of slab grouting, allow mechanism to run continuously until there is no more danger that grout sloughing may occur.
   b. Prevent dry clumps of grout or rocks from being caught under screed board and gouging finish surface of grout.
4. Corrections:
   a. Before grout has set:
      1) Where sloughing has occurred, remove grout from sloughed areas and place grout in low areas.
      2) Repair gouges in grouted surface.
5. Curing:
   a. After grout has set, water cure grout for 7 days.
   b. Keep grout surface continuously wet for duration of curing period.

B. Tolerances:
1. For grouting basin bottom slabs:
   a. Tolerance in elevation of finished grout surface: Plus or minus 1/8 inch.
      1) Specified tolerance is more exacting than customary industry standards for slab finish.
      2) Tolerance is required for proper operation of equipment.
   b. Thickness of grout layer:
      1) Not less than 1 inch at any point.
      2) Provide average thickness of grout as indicated on the Drawings.

3.03 FIELD QUALITY CONTROL

A. Inspection:
   1. Verify grout elevation tolerance on basin bottom slabs as follows:
      a. After grout has set, operate grouting equipment with blades set to clear grout surface.
      b. Under these conditions, blades shall not clear grout surface by more than 1/4 inch at any point:
         1) Excess clearance: Correct as specified in article titled "Adjusting" in this Section.

3.04 ADJUSTING

A. Grouting basin bottom slabs:
   1. After grout has set:
      a. Where clearance between blades and grouted surface exceeds tolerance specified in this Section, grind high points in grout surface using terrazzo machine until specified tolerance is met.
      b. Grout that has not bonded to concrete slab is not acceptable. Remove and replace such grout.

END OF SECTION

SECTION 03600

GROUTING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Cement grout.
   2. Cement mortar.
   3. Dry-pack mortar.
   4. Epoxy grout.
   5. Grout.
   6. Non-shrink epoxy grout.
   7. Non-shrink grout.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. C109 - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (using 2-inch or cube specimens).
   2. C230 - Standard Specification for Flow Table for Use in Tests of Hydraulic Cement.
   3. C531 - Standard Test Method for Liner Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.
   4. C579 - Standard Test Method for Compressive Strength of Chemical-Resistant Mortars, Grouts, and Monolithic Surfacings and Polymer Concretes.
   5. C939 - Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method).
   6. C942 - Standard Test Method for Compressive Strength of Grouts for Preplaced-Aggregate Concrete in the Laboratory.
   7. C1107 - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-shrink).
   8. C1181 - Standard Test Methods for Compressive Creep of Chemical-Resistant Polymer Machinery Grouts.

B. International Concrete Repair Institute (ICRI):
   1. 310.2R - Selecting and specifying Concrete Surface Preparations for Sealers, Coatings, Polymer Overlays, and Concrete Repair.

1.03 SUBMITTALS

A. Cement grout:
   1. Mix design.
   2. Material submittals.

B. Cement mortar:
   1. Mix design.
   2. Material submittals.

C. Non-shrink epoxy grout:
   1. Manufacturer's literature.

D. Non-shrink grout:
   1. Manufacturer's literature.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to jobsite in their original, unopened packages or containers, clearly labeled with manufacturer's product identification and printed instructions.

B. Store materials in cool dry place and in accordance with manufacturer's recommendations.

C. Handle materials in accordance with the manufacturer's instructions.

PART 2 PRODUCTS

2.01 MANUFACTURED UNITS

A. Non-shrink epoxy grout:
   1. Manufacturers: One of the following or equal:
      a. Five Star Products, Inc., Five Star Epoxy Grout.
      b. BASF Construction Chemicals, Masterflow 648 CP Plus.
      c. L&M Construction Chemicals, Inc., EPOGROUT.
   2. Non-shrink epoxy grout shall be 100 percent solid, premeasured, prepackaged system containing 2-component thermosetting epoxy resin and inert aggregate.
   3. Maintain flowable consistency for at least 45 minutes at 70 degrees Fahrenheit.
   4. Shrinkage or expansion: Less than 0.0006 inches per inch when tested in accordance with ASTM C531.
   5. Minimum compressive strength: 10,000 pounds per square inch at 24 hours and 14,000 pounds per square inch at 7 days when tested in accordance with ASTM C579, Method B.
   6. Compressive creep: Not exceed 0.0027 inches/per inch when tested under 400 pounds per square inch constant load at 140 degrees Fahrenheit in accordance with ASTM C1181.
   7. Coefficient of thermal expansion: Not exceed 0.000018 inches per inch per degree Fahrenheit when tested in accordance with ASTM C531, Method B.

B. Non-shrink grout:
   1. Manufacturers: One of the following or equal:
      a. Five Star Products, Inc., Five Star Grout.
      b. BASF Construction Chemicals, Masterflow 928.
      c. L&M Construction Chemicals, Inc., CRYSTEX.
   2. In accordance with ASTM C1107.
   3. Preportioned and prepackaged cement-based mixture.
   4. Contain no metallic particles such as aluminum powder and no metallic aggregate such as iron filings.
   5. Require only addition of potable water.
   6. Water for pre-soaking, mixing, and curing: Potable water.

7. Free from emergence of mixing water from within or presence of water on its surface.
8. Remain at minimum flowable consistency for at least 45 minutes after mixing at 45 degrees Fahrenheit to 90 degrees Fahrenheit when tested in accordance with ASTM C230.
    a. If at fluid consistency, verify consistency in accordance with ASTM C939.
9. Dimensional stability (height change):
    a. In accordance with ASTM C1107, volume-adjusting Grade B or C at 45 degrees Fahrenheit to 90 degrees Fahrenheit.
    b. Have 90 percent or greater bearing area under bases.
10. Have minimum compressive strengths at 45 degrees Fahrenheit to 90 degrees Fahrenheit in accordance with ASTM C1107 for various periods from time of placement, including 5,000 pounds per square inch at 28 days when tested in accordance with ASTM C109 as modified by ASTM C1107.

2.02 MIXES

A. Cement grout:
    1. Use same sand-to-cementitious materials ratio for cement grout mix that is used for concrete mix.
    2. Use same materials for cement grout that are used for concrete.
    3. Use water-to-cementitious materials ratio that is no more than that specified for concrete.
    4. For spreading over surfaces of construction or cold joints.

B. Cement mortar:
    1. Use same sand-to-cementitious materials ratio for cement mortar mix that is used for concrete mix.
    2. Use same materials for cement mortar that are used for concrete.
    3. Use water-to-cementitious materials ratio that is no more than that specified for concrete being repaired.
    4. At exposed concrete surfaces not to be painted or submerged in water: Use sufficient white cement to make color of finished patch match that of surrounding concrete.

C. Dry-pack mortar:
    1. Proportions by weight: 1 part portland cement to 2 parts concrete sand.
        a. Portland cement: As specified in Section 03300 - Cast-in-Place Concrete.
        b. Concrete sand: As specified in Section 03300 - Cast-in-Place Concrete.

D. Epoxy grout:
    1. Consist of mixture of epoxy or epoxy gel and sand.
        a. Epoxy: As specified in Section 03071 - Epoxies.
        b. Epoxy gel: As specified in Section 03071 - Epoxies.
        c. Sand: Clean, bagged, graded, and kiln-dried silica sand.
    2. Proportioning:
        a. For horizontal work: Consist of mixture of 1 part epoxy with not more than 2 parts sand.
        b. For vertical or overhead work: Consist of 1 part epoxy gel with not more than 2 parts sand.

E. Grout:
   1. Mix in proportions by weight: 1 part portland cement to 4 parts concrete sand.
      a. Portland cement: As specified in Section 03300 - Cast-in-Place Concrete.
      b. Concrete sand: As specified in Section 03300 - Cast-in-Place Concrete.

F. Non-shrink epoxy grout:
   1. Mix in accordance with manufacturer's installation instructions.

G. Non-shrink grout:
   1. Mix in accordance with manufacturer's installation instructions such that resulting mix has flowable consistency and is suitable for placing by pouring.

PART 3 EXECUTION

3.01 EXAMINATION

A. Inspect concrete surfaces to receive grout or mortar and verify that they are free of ice, frost, dirt, grease, oil, curing compounds, paints, impregnations, and loose material or foreign matter likely to reduce bond or performance of grout or mortar.

3.02 PREPARATION

A. Surface preparation for grouting other baseplates:
   1. Remove grease, oil, dirt, dust, curing compounds, laitance, and other deleterious materials that may affect bond to concrete and bottoms of baseplates.
   2. Roughen concrete surfaces in contact with grout to ICRI CSP-6 surface profile or rougher.
      a. Remove loose or broken concrete.
   3. Metal surfaces in contact with grout: Grit blast to white metal surface.

3.03 INSTALLATION

A. Mixing:
   1. Cement grout:
      a. Use mortar mixer with moving paddles.
      b. Pre-wet mixer and empty out excess water before beginning mixing.
   2. Cement mortar:
      a. Use mortar mixer with moving paddles.
      b. Pre-wet mixer and empty out excess water before beginning mixing.
   3. Dry-patch mortar:
      a. Use only enough water so that resulting mortar will crumble to touch after being formed into ball by hand.
   4. Non-shrink epoxy grout:
      a. Keep temperature of non-shrink epoxy grout from exceeding manufacturer's recommendations.
   5. Non-shrink grout:
      a. May be drypacked, flowed, or pumped into place. Do not overwork grout.
      b. Do not retemper by adding more water after grout stiffens.

B. Placement:
   1. Cement grout:
      a. Exercise care in placing cement grout because it is required to furnish structural strength, impermeable water seal, or both.
      b. Do not use cement grout that has not been placed within 30 minutes after mixing.
   2. Cement mortar:
      a. Use mortar mixer with moving paddles.
      b. Pre-wet mixer and empty out excess water before beginning mixing.
   3. Epoxy grouts:
      a. Wet surfaces with epoxy for horizontal work or epoxy gel for vertical or overhead work prior to placing epoxy grout.
   4. Non-shrink epoxy grout:
      a. Mix in complete units. Do not vary ratio of components or add solvent to change consistency of mix.
      b. Pour hardener into resin and mix for at least 1 minute and until mixture is uniform in color. Pour epoxy into mortar mixer wheelbarrow and add aggregate. Mix until aggregate is uniformly wetted. Over mixing will cause air entrapment in mix.
   5. Non-shrink grout:
      a. Add non-shrink cement grout to premeasured amount of water that does not exceed the manufacturer's maximum recommended water content.
      b. Mix in accordance with manufacturer's instructions to uniform consistency.

C. Curing:
   1. Cement based grouts and mortars:
      a. Keep continuously wet for minimum of 7 days. Use wet burlap, soaker hose, sun shading, ponding, and in extreme conditions, combination of methods.
      b. Maintain above 40 degrees Fahrenheit until it has attained compressive strength of 3,000 pounds per square inch, or above 70 degrees Fahrenheit for minimum of 24 hours to avoid damage from subsequent freezing.
   2. Epoxy based grouts:
      a. Cure grouts in accordance with manufacturers' recommendations.
         1) Do not water cure epoxy grouts.
      b. Do not allow any surface in contact with epoxy grout to fall below 50 degrees Fahrenheit for minimum of 48 hours after placement.

D. Grouting equipment bases, baseplates, soleplates, and skids: As specified in Section 15050 - Common Work Results for Mechanical Equipment.

E. Grouting other baseplates:
   1. General:
      a. Use non-shrink grout as specified in this Section.
      b. Baseplate grouting shall take place from one side of baseplate to other in continuous flow of grout to avoid trapping air in grout.
      c. Maintain hydrostatic head pressure by keeping level of grout in headbox above bottom of baseplate. Fill headbox to maximum level and work grout down.
      d. Vibrate, rod, or chain non-shrink grout to facilitate grout flow, consolidate grout, and remove trapped air.

2. Forms and headboxes:
    a. Build forms using material with adequate strength to withstand placement of grouts.
    b. Use forms that are rigid and liquidtight. Caulk cracks and joints with elastomeric sealant.
    c. Line forms with polyethylene for easy grout release. Coating forms with 2 coats of heavy-duty paste wax is also acceptable.
    d. Headbox shall be 4 to 6 inches higher than baseplate and shall be located on one side of baseplate.
    e. After grout sets, remove forms and trim back grout at 45 degree angle from bottom edges of baseplate.

3.04 FIELD QUALITY CONTROL

A. Non-shrink epoxy grout:
    1. Test for 24-hour compressive strength in accordance with ASTM C579, Method B.

B. Non-shrink grout:
    1. Test for 24-hour compressive strength in accordance with ASTM C942.

END OF SECTION

SECTION 03923

CONCRETE REPAIR MORTAR

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Concrete repair mortar.

1.02 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO):
   1. T277 - Standard Method of Test for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration.

B. ASTM International (ASTM):
   1. C109 - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens).
   2. C293 - Standard Test Method for Flexural Strength of Concrete (Using Simple Beam With Center-Point Loading).
   3. C496 - Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens.
   4. C882 - Standard Test Method for Bond Strength of Epoxy-Resin Systems Used With Concrete By Slant Shear.

1.03 SYSTEM DESCRIPTION

A. General: Composed of pre-packaged polymer-modified portland cement mortar used to perform shallow repairs on horizontal, vertical, and overhead applications.

B. Design requirements:
   1. Provide material suitable for performing in environments subject to corrosive attack by chlorides and sulfates, freeze/thaw cycles, low permeability, and abrasion resistant.
   2. Capable of being poured in place or troweled in place to suit the conditions encountered.

1.04 SUBMITTALS

A. Product Data.

B. Manufacturer's Instructions.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle packaged materials in the manufacturer's original, sealed containers.

B. Clearly identify each container with the manufacturer's name, name and type of product, and batch numbers.

1. Remove all damaged material from the site.

C. Store and condition the specified product as recommended by the manufacturer.

D. Store materials subject to damage by dirt and moisture in a clean, dry location, off the ground and suitably protected.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The following or equal:
   1. Sika, SikaTop 123 Plus.

2.02 MATERIALS

A. Water: Potable, clean, and not detrimental to mortar.

2.03 MANUFACTURED UNITS

A. Component A shall be a liquid polymer emulsion with an acrylic copolymer base and additives:
   1. pH: 4.5 to 6.5.
   2. Film forming temperature: 73 degree Fahrenheit maximum.
   3. Tear strength: 950 pounds per square inch minimum.
   4. Elongation at break: 500 percent minimum.
   5. Particle size: Less than 0.1 micron.

B. Component A shall contain an organic, penetrating corrosion inhibitor that has been independently proven to reduce corrosion in concrete.
   1. The corrosion inhibitor shall not be calcium nitrite, and shall have a minimum of 5 years of independent field-testing to document performance on actual construction projects.

C. Component B shall be a blend of selected portland cements, specially graded aggregates, admixtures for controlling setting time, water reducers for workability, and an organic accelerator.

D. Materials shall be supplied as a factory-blended unit.

E. Placeable in 1/8 inch to 1-1/2 inch depth per lift for vertical applications and 1/8 inch to 1 inch in depth for overhead applications.

F. Typical properties of the mixed concrete repair mortar:
   1. Working time: Approximately 10 to 15 minutes.
   2. Finishing time: 20 to 60 minutes.
   3. Color: Concrete gray.

G. Properties of the cured concrete repair mortar:
   1. Compressive strength: In accordance with ASTM C109 modified:
      a. 1 day: 3,500 pounds per square inch minimum.
      b. 7 days: 6,000 pounds per square inch minimum.

c. 28 days: 7,000 pounds per square inch minimum.

2. Flexural strength: 2,000 pounds per square inch at 28 days in accordance with ASTM C293.
3. Splitting tensile strength: 900 pounds per square inch at 28 days in accordance with ASTM C496.
4. Bond strength: 2,200 pounds per square inch at 28 days in accordance with ASTM C882 modified.
5. Permeability: 500 coulombs in accordance with AASHTO T 277
6. Wet mix density: Approximately 132 pounds per cubic feet.
7. Shall not produce a vapor barrier.

PART 3 EXECUTION

3.01 INSTALLATION

A. Mix in accordance with manufacturer's instructions.

B. At the time of application, substrate shall be saturated surface dry with no standing water.

C. Install in accordance with manufacturer's installation instructions.

D. Apply only when ambient conditions of moisture, temperature, humidity, and wind are favorable for curing:
   1. Do not allow to dry out during placement.
   2. Use water misting when required to prevent material from drying out before curing is started.

E. Moist cure with wet burlap or a fine mist for 7 days.

F. During the curing process, protect from rain, wind, or freezing as required. Keep sufficient covering on hand at all times for protection.

END OF SECTION

SECTION 03926

STRUCTURAL CONCRETE REPAIR

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Repairing damaged structural concrete.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. C109 - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens).
   2. C293 - Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Center-Point Loading).
   3. C348 - Standard Test Method for Flexural Strength of Hydraulic-Cement Mortars).
   4. C666 - Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing.
   5. C882 - Standard Test Method for Bond Strength of Epoxy-Resin Systems Used With Concrete By Slant Shear.

1.03 SYSTEM DESCRIPTION

A. General: Structural repair concrete composed of cementitious material capable of being placed in formed vertical and overhead applications, and on horizontal surfaces.

B. Design requirements:
   1. Provide material suitable for performing in environments subject to corrosive attack by chlorides and sulfates, freeze/thaw cycles, low permeability, and abrasion resistant.
   2. Provide concrete repair mortar cement that is placeable from 1 inch in depth and extendable in greater depths.
   3. Concrete repair mortar shall be capable of being poured in place or troweled in place to suit the conditions encountered.

1.04 SUBMITTALS

A. Product data: Submit manufacturer's data completely describing structural repair concrete materials.

B. Certificates of Compliance.

C. Manufacturer's Instructions.

1.05 QUALITY ASSURANCE

A. Manufacturer qualifications: The manufacturer of the specified product shall have been in existence, for a minimum of 10 years.

B. Allowable tolerances: Deviation from plumb or level shall not exceed 1/8 inch within 10 feet in any direction, as determined with a 10-foot straight edge.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver the specified product in original, unopened containers with the manufacturer's name, labels, product identification, and batch numbers.

B. Store and condition the specified product as recommended by the manufacturer.

C. Deliver, store, and handle packaged materials in the manufacturer's original, sealed containers, each clearly identified with the manufacturer's name, and name and type of product.

D. Store materials subject to damage by dirt and moisture in a clean, dry location, off the ground, and suitably protected.

1.07 PROJECT CONDITIONS

A. Existing conditions:
   1. Hot weather: ACI 305.
   2. Cold weather: ACI 306.
   3. Do not place concrete repair mortar during precipitation, unless adequate protection is provided.

PART 2 PRODUCTS

2.01 MATERIALS

A. Structural repair concrete:
   1. Manufacturers: One of the following or equal:
      a. BASF, EMACO S66-CI.
      b. Sika Corp., SikaTop 123 Plus.
   2. Compressive strength: As follows in accordance with ASTM C109:
      a. 1 day: 2,500 pounds per square inch, minimum.
      b. 7 day: 6,000 pounds per square inch, minimum.
      c. 28 day: 7,000 pounds per square inch, minimum.
   3. Bond strength by slant shear: 2,200 pounds per square inch minimum at 28 days, in accordance with ASTM C882 modified.
   4. Flexural strength: 2,000 pounds per square inch minimum at 28 days, when tested in accordance with ASTM .C293, or 770 pounds per square inch minimum at 28 days when tested in accordance with ASTM C348.
   5. Rapid freeze/thaw durability: In accordance with ASTM C666; Procedure A.
      a. Relative durability factor at 300 cycles: 95 percent minimum.
   6. Working time: 30 to 40 minutes.
   7. Color: Concrete gray.

B. Water: Potable, clean, not detrimental to concrete.

C. Form materials:
   1. Smooth finish.
   2. Brace as required to maintain tolerances.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that concrete surfaces and exposed reinforcing are clean and free of contaminants.

3.02 PREPARATION

A. Prepare existing concrete by cleaning with steel brush and applying bonding agent in accordance with manufacturer's instructions.

B. Thoroughly clean reinforcement and other embedded items to remove loose rust and other objectionable matter.

C. Thoroughly wet wood forms, except coated plywood, and adjacent concrete at least 1 hour in advance of placing concrete; securely close cleanout end inspection ports; repeat wetting as necessary to keep forms damp.

D. Damaged concrete:
   1. Areas to be repaired shall be clean, sound, and free of contaminants.
      a. Remove all loose and deteriorated concrete by mechanical means acceptable to the Engineer.
      b. Saw cut perimeter 1/2-inch maximum.
   2. Chip concrete substrate to obtain a surface profile of 1/16 inch to 1/8 inch in depth with a new fractured aggregate surface.
      a. The area to be repaired shall be not less than 1 inch in depth.
   3. Concrete removal shall extend along the reinforcing steel to locations along the bar free of bond inhibiting corrosion, and where the bar is well bonded to surrounding concrete.

E. Use the following procedures where reinforcing steel with active corrosion is encountered:
   1. Sandblast reinforcing steel to remove all contaminants and rust.
   2. Determine section loss, splice new reinforcing steel where there is more than 15 percent loss as directed by the Engineer.
      a. If more than half the diameter of the reinforcing steel is exposed, chip out behind the reinforcing steel a minimum of 1/2 inch. The distance chipped behind the reinforcing steel must also equal or exceed the minimum placement depth of the accepted material.

F. Treat cracks in the substrate at the area of patching or overlay work as directed by the Engineer.

G. Extend existing control and expansion joints through any concrete repair.

H. Apply an epoxy-bonding agent to area to be repaired, as specified in Section 03071 - Epoxies, prior to patching concrete with polymer-modified portland cement mortar.

3.03 MIXING

A. Mix in accordance with manufacturer's mixing instructions.

3.04 INSTALLATION

A. Formed surface finishes:
   1. Smooth finish:
      a. Obtain by the use of plywood, sheet metal, or lined wood forms; no fins, pockmarks, or other irregularities shall be present in the exposed surfaces of concrete.
      b. Place no structural repair concrete without prior authorization of Engineer.

B. Verify that form materials are in place and ready to receive installation of concrete repair material.

C. Install in accordance with manufacturer's installation instructions.

D. In accordance with ACI recommendations, apply concrete repair material only when ambient conditions of moisture, temperature, humidity, and wind are favorable for curing.

E. Scrub mortar into substrate, filling all cracks, voids, and pores.

F. For new construction, finish of repaired area shall match required finish for concrete being repaired.

G. For existing concrete, finish of repair area shall match finish of concrete being repaired.

H. During the curing process, protect concrete repair from rain, wind, or freezing as required:
   1. Keep sufficient covering on hand at all times for protection of repair concrete.

3.05 CLEANING

A. Remove debris and excess material. Leave work site in a neat, clean condition.

END OF SECTION

SECTION 03931

EPOXY INJECTION SYSTEM

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Epoxy injection system.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. C881 - Standard Test Method for Epoxy-Resin-Base Bonding Systems for Concrete.
   2. C882 - Standard Test Method for Bond Strength of Epoxy-Resin Systems Used With Concrete by Slant Shear.
   3. D638 - Standard Test Method for Tensile Properties of Plastics.
   4. D648 - Standard Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position.
   5. D695 - Standard Test Method for Compressive Properties of Rigid Plastics.
   6. D790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

1.03 SUBMITTALS

A. General: Submit as specified in Section 01330 - Submittal Procedures.

B. Product data:
   1. Manufacturer's data completely describing epoxy injection system materials, and including test methods and results for strength in tension, flexure, compression and bond; flexural modulus of elasticity; coefficient of thermal expansion; and elongation.

C. Quality control submittals:
   1. Certificates of Compliance.
   2. Manufacturer's Instructions.

D. Special procedure submittals:
   1. Protection plan for surrounding areas and non-cementitious surfaces.

1.04 QUALITY ASSURANCE

A. Products:
   1. Provide materials that are new and use them within shelf life limitations set forth by manufacturer.

B. Qualifications:
   1. Installer:
      a. Minimum 5 years' experience in concrete repair, with focus on application of similar systems and products to projects of similar size and scope.

C. Pre-installation meeting:
   1. At least 1 week prior to commencing work of this Section, convene a meeting at the project site to review and discuss the following:
      a. Surface preparation.
      b. Substrate conditioning and pre-treatment.
      c. Installation procedures.
      d. Environmental conditions (including weather forecast) and curing requirements.
      e. Testing and inspection procedures.
      f. Protection of surrounding surfaces and equipment.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact. Labels shall include product identification, batch numbers, and shelf life information.

B. Store materials off the ground and away from moisture and direct sunlight, and at temperatures within manufacturer's recommended range.

C. Pre-condition materials to manufacturer's recommended temperatures before mixing and using.

1.06 PROJECT CONDITIONS

A. Take precautions to protect surfaces and equipment in the work area from damage and staining.

PART 2 PRODUCTS

2.01 MATERIALS

A. General:
   1. Repair materials shall be free of chlorides or alkalis (except for those attributed to water).
   2. To ensure compatibility of materials and methods, a single manufacturer shall produce and provide all products used together in a single area of concrete repair.

B. Manufacturers: One of the following or equal:
   1. BASF Building Systems, MasterInject 1500 (formerly Concresive Standard LVI).
   2. Sika Chemical Corp., Sikadur 35 Hi-Mod LV.

C. Epoxy:
   1. In accordance with ASTM C881, Types I, II and IV, Grade 1, Class C.

2. Water-insensitive 2-component low viscosity, epoxy adhesive material containing 100 percent solids and meeting or exceeding following characteristics when tested in accordance with standards specified:

Table 1 - Epoxy, Physical Properties		
Characteristic	Test Method	Required Results, minimum(1,2)
Viscosity (mixed)	--	250 - 375 centipoise
Tensile Strength	ASTM D638	7,500 pounds per square inch
Tensile Elongation at Break	ASTM D638	1 percent
Compressive Strength	ASTM D695	11,000 pounds per square inch
Compressive Modulus	ASTM D695	2.5×10^5 pounds per square inch.
Bond Strength, slant shear, hardened concrete to hardened concrete	ASTM C882	1500 pounds per square inch at 2 days at minimum 73 degrees Fahrenheit. Concrete shall fail before failure of epoxy.
Heat Deflection Temperature	ASTM D648	124 degrees Fahrenheit
Notes: 1) Properties for mixes with neat epoxy. 2) Results after 7-day cure at temperature between 72 and 78 degrees Fahrenheit, unless otherwise noted.		

2.02 EQUIPMENT

A. Injection pump:
   1. Use positive displacement injection pump with interlock to provide in-line mixing and metering system for 2 component epoxy.
   2. Use pressure hoses and injection nozzle designed to properly mix of 2 components of epoxy.
   3. Standby injection unit may be required.

PART 3 EXECUTION

3.01 PREPARATION

A. Surface preparation:
   1. Confirm that surface temperature and moisture conditions are within manufacturer's recommended limits. Condition surfaces to within those limits before commencing epoxy injection.
   2. Sweep or clean area in vicinity of cracks that will be injected with epoxy. Leave area in generally clean condition after epoxy injection is complete.
   3. Clean cracks so they are free from dirt, laitance, and other loose matter.

3.02 INSTALLATION

A. Install and cure epoxy materials in accordance with manufacturer's installation instructions.

B. Mixing:
   1. Mix epoxy in accordance with manufacturer's installation instructions.
   2. Do not use solvents to thin epoxy system materials introduced into cracks or joints.

C. Injection:
   1. Apply adequate surface seal to crack to prevent leakage of epoxy.
   2. Establish injection points at distance along crack not less than thickness of cracked member.
   3. Crack injection sequence:
      a. Inject epoxy into crack or joint at first port with sufficient pressure to advance epoxy to adjacent port. Start at lowest port along the injection line and work upwards.
      b. Seal original port and shift injection to next adjacent port where epoxy appears.
      c. Continue port-to-port injection until crack has been injected for its entire length.
      d. For small amounts of epoxy, or where excessive pressure developed by injection pump might further damage structure, premixed epoxy and use hand caulking gun to inject epoxy if acceptable to the Engineer.
      e. Seal ports, including adjacent locations where epoxy seepage occurs, as necessary to prevent drips or run out.
      f. After epoxy injection is complete, remove surface seal material, and refinish concrete in area where epoxy was injected to match existing concrete. Leave finished work and work area in a neat, clean condition.

3.03 FIELD QUALITY ASSURANCE

A. Provide Contractor quality control as specified in Section 01450 - Quality Control.

B. Field inspections and testing:
   1. Submit records of inspections and tests to Engineer within 24 hours after completion.

C. Manufacturer's services.
   1. Pre-installation meeting: Provide manufacturer's technical representative to attend pre-installation meeting specified in this Section.

3.04 FIELD QUALITY CONTROL

A. Provide Owner's quality assurance for the Work of this Section as specified in Section 01450 - Quality Control.

B. Special inspections special tests, and structural observation:
   1. Not required.

C. Field inspections:
   1. Preparation.

a. Review manufacturer's product data and installation instructions.

2. Required inspections.
   a. Observe surfaces to be injected for temperature and moisture conditions and for surface preparation.
   b. Observe conditioning and mixing of epoxy resin components.
   c. Observe injection procedures for filling cracks.
3. Records of inspections:
   a. Provide record of each inspection.
   b. Submit to Engineer upon request.

3.05 NON-CONFORMING WORK

A. Rework surface finishes that do not match surrounding concrete to the satisfaction of Engineer at no additional cost to Owner.

END OF SECTION

SECTION 04055

ADHESIVE BONDING REINFORCING BARS AND ALL THREAD RODS IN MASONRY

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Bonding reinforcing bars and all thread rods in masonry using injectable, 2-component adhesive.

1.02 REFERENCES

A. American National Standards Institute (ANSI):
   1. Standard B212.15 - Carbide Tipped Masonry Drills and Blanks for Carbide Tipped Masonry Drills.

B. ICC Evaluation Service, Inc. (ICC-ES):
   1. AC58 - Acceptance Criteria for Adhesive Anchors in Masonry Elements.

C. Society for Protective Coatings (SSPC):
   1. Surface Preparation Standards (SP).
      a. SP-1 - Solvent Cleaning.

1.03 DEFINITIONS

A. Evaluation Report: Report prepared by ICC-ES, or by other testing agency acceptable to the Engineer and to the Authority Having Jurisdiction, that documents testing and review of the adhesive product to confirm that it conforms to the requirements of ICC-ES AC58.

1.04 SUBMITTALS

A. Product data: Furnish technical data for adhesives, including:
   1. Independent testing laboratory results indicating allowable loads in tension and shear for masonry walls of the types included in the Work, with load modification factors for temperature, spacing, edge distance, and other installation variables.
   2. Handling and storage instructions.
   3. Installation instructions.

B. Quality control submittals:
   1. Special inspection: Detailed instructions for special inspection to comply with the building code specified in Section 01410 - Regulatory Requirements.
   2. Evaluation Report confirming that the product complies with the requirements of ICC-ES AC58.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Store and protect as follows, unless manufacturer has more stringent requirements:
   1. Store adhesive components on pallets or shelving in a covered-storage area protected from weather.
   2. Control temperature to maintain storage within manufacturer's recommended temperature range.
      a. If products are stored at temperatures outside manufacturer's recommended range, test components prior to use by methods acceptable to the Engineer to determine if the products still meet specified requirements.
   3. Dispose of products that have passed their expiration date.

1.06 PROJECT CONDITIONS

A. Seismic design category: As specified in Section 01610 - Project Design Criteria.

PART 2 PRODUCTS

2.01 GENERAL

A. Like items of materials: Use end products of one manufacturer to achieve structural compatibility and single-source responsibility.

2.02 ADHESIVE FOR SELF-CONTAINED CARTRIDGE SYSTEM

A. Adhesive shall have a current Evaluation Report demonstrating compliance with the requirements of ICC-ES AC58.

B. Materials:
   1. 2-component structural adhesive, insensitive to moisture, and gray in color.
   2. Cure temperature, pot life, and workability: Compatible with intended use and environmental conditions.

C. Packaging:
   1. Furnished in disposable, side-by-side cartridges with resin and hardener components isolated until mixing through manufacturer's static mixing nozzle.
      a. Nozzle designed to thoroughly blend the components, in the proper mixing ratio, for injection from the nozzle directly into prepared hole.
      b. Provide nozzle extensions as required to allow full-depth insertion and filling from the bottom of the hole.
   2. Container markings: Include manufacturer's name, product name, batch number, mix ratio by volume, product expiration date, ANSI hazard classification, and appropriate ANSI handling precautions.

D. For installation in solid masonry and solid-grouted masonry (concrete or brick):
   1. Manufacturers: One of the following or equal:
      a. Hilti, Inc., HY-70 Adhesive Anchor System.
      b. Simpson Strong-Tie Co., Inc., ET-HP Anchoring Adhesive.
      c. USP Structural Connectors, CIA-GEL 7000 Masonry Epoxy Adhesive.

2.03 ALL THREAD RODS

A. Materials: As specified in Section 05120 - Structural Steel.

2.04 REINFORCING BARS

A. As specified in Section 04090 - Masonry Accessories.

PART 3 EXECUTION

3.01 GENERAL

A. Unless otherwise required for “conditions of use” in the Evaluation Report submitted, prepare and install holes, adhesive, and inserts (all thread rods or reinforcing bars) in accordance with the manufacturer’s recommendations and this Section.
   1. In the event of conflicts, the more restrictive provisions shall govern.

B. Do not install adhesive-bonded all-thread rods or reinforcing bars in upwardly inclined and overhead applications.

3.02 PREPARATION

A. Prior to completing manufacturer’s on-site training specified in this Section, do not:
   1. Drill holes for reinforcing bars or all thread rods.
   2. Mix or install adhesive in holes.

B. Review manufacturer’s installation instructions and “conditions of use” stipulated in the Evaluation Report before beginning work.

C. Confirm that adhesive and substrate receiving adhesive are within manufacturer’s recommended temperature range, and will remain so during the cure time for the product.

3.03 HOLE LAYOUT AND INSTALLATION

A. Drilling holes:
   1. Determine location of reinforcing bars or other obstructions with a non-destructive indicator device. Mark locations with on the surface of the masonry using removable construction crayon, or other method acceptable to the Engineer.
   2. Do not damage or cut existing reinforcing bars, electrical conduits, or other items embedded in the masonry without prior acceptance by Engineer.

B. Hole drilling equipment:
   1. Electric or pneumatic rotary impact type.
      a. Set drill to “rotation only” mode, or to “rotation plus hammer” mode in accordance with manufacturer’s installation instructions and the requirements of the Evaluation Report.
   2. Where edge distances are less than 2 inches and “rotation plus hammer” mode is permitted, use lighter impact equipment to prevent micro-cracking and spalling from drilling.

3. Drill bits: Carbide-tipped in accordance with ANSI B212-15.
4. Hollow drill bits with flushing air systems are preferred. Air supplied to hollow drill bits shall be free of oil, water, or other contaminants that will reduce bond.

C. Hole diameter: As recommend in the manufacturer's installation instructions and the Evaluation Report.

D. Hole depth: As recommended by the manufacturer's installation instructions to provide minimum effective embedment indicated on the Drawings.

E. Obstructions in drill path:
1. If an existing reinforcing bar or other obstruction is hit while drilling hole, stop drilling and fill the hole with dry-pack mortar. Relocate the hole to miss the obstruction and drill to the required depth.
   a. Allow dry-pack mortar to cure to strength equal to that of the surrounding masonry before resuming drilling in that area.
   b. Epoxy grout may be substituted for dry-pack mortar when acceptable to the Engineer.
2. Avoid drilling an excessive number of adjacent holes that would weaken the structural member and endanger the stability of the structure. Obtain Engineer's acceptance of distance between abandoned and relocated holes.

F. Cleaning holes:
1. Insert air nozzle to bottom of hole and blow out loose dust.
   a. Use compressed air that is free of oil, water, or other contaminants.
   b. Provide minimum air pressure of 90 pounds per square inch for not less than 4 seconds.
2. Using a stiff bristle brush of diameter that provides contact around the full perimeter of the hole, vigorously brush the hole to dislodge compacted drilling dust.
   a. Insert brush to the bottom of the hole and withdraw using a simultaneous twisting motion.
   b. Repeat at least 4 times.
3. Repeat the preceding steps as required to remove drilling dust or other material that will reduce bond, and as required by the manufacturer and the Evaluation Report.
4. Leave prepared hole clean and dry.

3.04 INSTALLATION OF ADHESIVE AND INSERTS

A. Clean and prepare inserts:
1. Prepare embedded length of reinforcing bars and all thread rods by cleaning to bare metal. The inserts shall be free of oil, grease, paint, dirt, mill scale, rust, or other coatings that will reduce bond.
2. Solvent-clean prepared reinforcing bars and all thread rods over their embedment length in accordance with SSPC SP-1. Provide an oil and grease-free surface for bonding of adhesive to steel.

B. Fill holes with adhesive: Solid or solid-grouted masonry:
1. Starting at the bottom of the hole, fill hole with adhesive before inserting the reinforcing bar or all thread rod.
2. Fill hole without creating air voids as nozzle is withdrawn.

3. Fill hole with sufficient adhesive so that excess is extruded out of the hole when the reinforcing bar or all thread rod is inserted into the hole.
4. Where metal or plastic screens are required for use in masonry (units with hollow cells or holes, and multi-wythe brick walls), fill screen with adhesive and insert into hole in accordance with manufacturer's recommendations.

C. Install reinforcing bars and all thread rods:
1. Install to depth, spacing, and locations as indicated on the Drawings.
2. Insert bars and all thread rods into hole in accordance with manufacturer's recommended procedures. Confirm that insert has reached the designated embedment in the hole and that adhesive completely surrounds the embedded portion.
3. Clean excess adhesive from the mouth of the hole.

D. Curing and loading:
1. Provide curing conditions recommended by the adhesive manufacturer for the period required to fully cure the adhesive at the actual temperature of the masonry.
2. Do not disturb or load anchors until manufacturer's recommended cure time has elapsed.

3.05 FIELD QUALITY CONTROL

A. Contractor shall provide field quality control as specified in Section 01450 - Quality Control.

B. Manufacturers' services:
1. Before beginning installation, furnish adhesive manufacturer's representative to conduct on-site training in proper storage and handling of adhesive, drilling and cleaning of holes, and preparation and installation of reinforcing bars and all thread rods.
a. Provide notice of training to Engineer and Special Inspector not less than 10 working days before training occurs. Engineer and Special Inspector may attend training sessions.
2. Submit record, signed by the Engineer, listing Contractor's personnel who completed the training. Only qualified personnel who have completed manufacturer's on-site training shall perform installations.
3. Do not install holes or adhesive until training is complete.

3.06 FIELD QUALITY ASSURANCE

A. The Owner, or owner's authorized agent will provide on-site inspection and field quality assurance.

B. Special inspection:
1. As specified in Section 01455B - Special Tests and Inspections.
2. Unless otherwise indicated on the Drawings or in this Section, provide periodic special inspection as required by the "Conditions of Use" in the Evaluation Report for the product installed.
3. Provide a written record of each inspection using form acceptable to the Engineer and the Authority Having Jurisdiction.
4. Preparation:
a. Review drawings and specifications for the Work being observed.

b. Review adhesive manufacturer's recommended installation and evaluation report's special inspection procedures.

5. Provide an initial inspection by for each combination of masonry type and reinforcing bar or all thread rod being installed. During initial inspection, observe the following for compliance with installation requirements. Furnish report of inspection that includes the following items.
   a. Masonry construction: Type and thickness; whether fully or partially grouted; locations and types of voids and holes in units.
   b. Environment: Temperature and moisture conditions of masonry base material and work area.
   c. Holes: Locations, spacing, edge distances; verification of drill bit compliance with ANSI B212.15; cleaning equipment and procedures; cleanliness of hole. Before placing adhesive, confirm that depth and preparation of holes conforms to requirements of the Contract Documents, installation recommendations of the manufacturer, and "conditions of use" specified in the Evaluation Report.
   d. Adhesive: Product manufacturer and name; lot number and expiration date; temperature of product at installation; installation procedures. Note initial set times observed during installation.
   e. Embedded reinforcing bars and all thread rods: Material diameter and length; steel grade and/or strength; cleaning and preparation; cleanliness at insertion; minimum effective embedment.
6. Subsequent installations of the same reinforcing bars or threaded rods in the same masonry may be performed without the presence of the special inspector, provided that:
   a. There is no change in the personnel performing the installation, the type or details of the masonry receiving the insert, the adhesive or the reinforcing bars and all thread rods being used. Changes in any of these items shall require a new initial inspection.
   b. For ongoing installations over a period of time, the special inspector visits the site at least once per day during each day of installation to observe the work for compliance with material requirements and installation procedures.

END OF SECTION

SECTION 04090

MASONRY ACCESSORIES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Control joint filler.
   2. Reinforcing bars.

1.02 REFERENCES

A. American Welding Society (AWS):
   1. D1.4 - Structural Welding Code - Reinforcing Steel.

B. ASTM International (ASTM):
   1. A82 - Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
   2. A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   3. A615 - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
   4. A641 - Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.
   5. A951 - Standard Specification for Masonry Joint Reinforcement.
   6. D2000 - Standard Classification System for Rubber Products in Automotive Applications.
   7. D2287 - Standard Specification for Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds.

1.03 SYSTEM DESCRIPTION

A. The Drawings contain general notes concerning amount of reinforcement and placing, details of reinforcement at wall corners and intersections, and details of extra reinforcement around openings in masonry.

1.04 SUBMITTALS

A. Reinforcing bars:
   1. Changes to reinforcing steel contract drawing requirements:
      a. Indicate in separate letter submitted with shop drawings any changes of requirements indicated on the Drawings for reinforcing steel.
      b. Such changes will not be acceptable unless the Engineer has accepted such changes in writing.
      c. Reinforcement detail drawings:
         1) Review of reinforcement shop drawings by the Engineer will be limited to general compliance with the Contract Documents.
      d. Welding procedures.

B. Product data.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Packing and shipping:
   1. Deliver bars bundled and tagged with identifying tags.

PART 2 PRODUCTS

2.01 MANUFACTURED UNITS

A. Anchor bolts:
   1. Cast-in/built-in steel anchors: As specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.
      a. Includes: anchor bolts, anchor rods, deformed bar anchors, and welded studs).
   2. Post-installed steel anchors: As specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.
      a. Includes concrete anchors for concrete masonry, and screw anchors for concrete masonry.

B. Control joint filler: The key shall be of the width and shape as indicated on the Drawings. In accordance with ASTM D2000 or ASTM D2287.
   1. Manufacturers: One of the following or equal:
      a. Hohmann & Barnard, VS Standard.
      b. Wire-Bond, No. 2901.
      c. Southern Metals and Plastics, No. CJ1.

C. Reinforcing bars:
   1. Deformed bars in accordance with ASTM A615, Grade 60.
   2. Provide reinforcing steel that is of quality specified, free from excessive rust or scale or any defects affecting its usefulness.

2.02 FABRICATION

A. Reinforcing bars:
   1. Cut and bend bars in accordance with building code as specified in Section 01410 - Regulatory Requirements.
   2. Bend bars cold.
   3. Provide bars free from defects and kinks and from bends not indicated on the Drawings.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of conditions:
   1. Reinforcing bars:
      a. Verify that bars are new stock free from rust scale, loose mill scale, excessive rust, dirt, oil, and other coatings which adversely affect bonding capacity when placed in the work.

3.02 PREPARATION

A. Reinforcing bars:
   1. Thin coating of red rust resulting from short exposure will not be considered objectionable. Thoroughly clean any bars that have rust scale, loose mill scale, or thick rust coat.
   2. Remove concrete or other deleterious coatings from dowels and other projecting bars by wire brushing or sandblasting before bars are embedded in subsequent masonry placement.

3.03 INSTALLATION

A. Reinforcing bars:
   1. No field bending of bars will be allowed.
   2. Welding:
      a. Weld reinforcing bars where indicated on the Drawings or acceptable to the Engineer.
      b. Perform welding in accordance with AWS D1.4.
      c. Submit welding procedures.
      d. Do not tack weld reinforcing bars.

B. Placing reinforcing bars:
   1. Accurately place bars and adequately secure them in position.
   2. Overlap bars at splices as indicated on the Drawings or specified.
   3. If not indicated on the Drawings, lap splice bars in masonry in accordance with the building code as specified in Section 01410 - Regulatory Requirements.

END OF SECTION

SECTION 04100

MORTAR AND MASONRY GROUT

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Mortar and grout for masonry construction.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. C144 - Standard Specification for Aggregate for Masonry Mortar.
   2. C150 - Standard Specification for Portland Cement.
   3. C207 - Standard Specification for Hydrated Lime for Masonry Purposes.
   4. C270 - Standard Specification for Mortar for Unit Masonry.
   5. C404 - Standard Specification for Aggregates for Masonry Grout.
   6. C476 - Standard Specification for Grout for Masonry.
   7. C780 - Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry.
   8. C1019 - Standard Test Method for Sampling and Testing Grout.

1.03 DEFINITIONS

A. Alkali: Sum of sodium oxide and potassium oxide calculated as sodium oxide.

1.04 PERFORMANCE REQUIREMENTS

A. Compressive strength:
   1. Grout: Minimum 2,000 pounds per square inch at 28 days.

B. Mortar color:
   1. To match existing buildings nearby on site.

1.05 SUBMITTALS

A. Product data.

B. Shop drawings.

C. Mortar color samples.

D. Design Mixes for mortar and grout.

E. Test reports:
   1. Mortar Strength Test Results.
   2. Grout Strength Test Results.

1.06 QUALITY ASSURANCE

A. Materials for mortar and grout: Do not change source of materials which will affect the appearance of finished work after the work has started unless acceptable to Engineer.

1.07 PROJECT CONDITIONS

A. Environmental requirements:
   1. Cold weather requirements:
      a. Cold Weather Construction: In accordance with the building code as specified in Section 01410 - Regulatory Requirements.
      b. Provide adequate equipment for heating mortar and grout materials when air temperature is below 40 degrees Fahrenheit.
         1) Temperatures of separate materials, including water, shall not exceed 140 degrees Fahrenheit when placed in mixer.
         2) Maintain mortar temperature on boards above freezing.
   2. Hot weather requirements:
      a. Wet mortar board before loading and cover mortar to retard drying when not being used.

PART 2 PRODUCTS

2.01 MATERIALS

A. Portland cement:
   1. Type II, low alkali, containing maximum 0.6 percent total alkali in accordance with ASTM C150.

B. Hydrated lime:
   1. Type S in accordance with ASTM C207.

C. Aggregate for mortar:
   1. Fine aggregate: Sand in accordance with ASTM C144.

D. Aggregate for grout:
   1. Fine aggregate: Size Number 2 in accordance with ASTM C404.
   2. Coarse aggregate: Size Number 8 in accordance with ASTM C404.

E. Admixtures:
   1. Mortar color admixture:
      a. Containing maximum 15 percent lime proof, inorganic compounds, unless recommended otherwise by manufacturer.
      b. Maximum 3 percent carbon black by weight of cement.
      c. Factory blend for full color saturation of mortar joint.
      d. Packaging for unitized jobsite mixing at ratio of 1 unit of color per sack of portland cement.
   2. Grout admixture:
      a. Manufacturers: One of the following or equal:
         1) Sika Corp., Sika Grout Aid, Type II.
         2) Concrete Emulsions, Grout Aid GA-II.

3. Mortar water repellent admixture:
    a. Manufacturers: One of the following or equal:
        1) Sika Corp., Sikaproof 85.
        2) W.R. Grace, Dry Block Mortar.
        3) BASF, Rheopel Plus Mortar Admixture.
4. Other admixtures:
    a. Prohibited, unless accepted by the Engineer.

F. Water: Clean, clear, potable, free of oil, soluble salts, chemicals, and other deleterious substances.

G. Other materials:
1. Prohibited, unless acceptable to Engineer.

2.02 MIXES

A. Mortar mix:
1. Portland cement-lime mortar.
2. Mortar mix proportions by volume: As indicated in the following table:

MORTAR TYPE	PARTS BY VOLUME OF PORTLAND CEMENT	PARTS BY VOLUME OF HYDRATED LIME	AGGREGATE MEASURED IN A DAMP LOOSE CONDITION
S	1	Greater than 1/4 to 1/2	Not less than 2-1/4 and not more than 3 times the sum of the separate volumes of cementitious materials

3. Mortar mixing:
    a. Mix on jobsite in accordance with ASTM C270.
    b. Mix in mechanical mixer and only in quantities needed for immediate use.
    c. Mix for minimum 3 minutes, and maximum of 5 minutes after materials have been added to mixer.
4. Measurement by volume: Measurement of constituents shall be accomplished by the use of a container of known capacity.
5. Water shall be mixed with the dry ingredients in sufficient amount to provide a workable mixture which will adhere to the vertical surfaces of masonry units.
    a. Use no mortar which has been standing for more than 1 hour after being mixed.
6. Whenever 90 minutes has elapsed since last batch was mixed, completely empty mixer drum of materials and wash down before placing next batch of materials.

B. Grout mix:
1. Grout mix proportions by property: see grout Performance Requirements in Section 1.04.
2. Grout mixing:
    a. Mix on jobsite or in a transit mix in accordance with ASTM C476
    b. Slump: 8 to 11 inches, unless otherwise accepted by the Engineer.
    c. Use within 90 minutes after addition of mixing water.

d. Mix for minimum of 5 minutes after ingredients are added and until uniform mix is attained. Grout shall have sufficient water added to produce pouring consistency without segregation.

3. Use coarse grout for hollow cell masonry units with minimum 4-inch cell dimensions in both horizontal directions.
   a. Calculate cell dimension for this criterion by subtracting diameter(s) of any horizontal reinforcement crossing the cell from clear cell dimensions of the masonry unit.

PART 3 EXECUTION

3.01 FIELD QUALITY CONTROL

A. Testing of grout and mortar:
   1. During progress of construction, the Owner will have tests made to determine whether the grout and mortar, as being produced, complies with Specifications.
   2. Compressive strength test for grout: In accordance with ASTM C1019.
   3. The Engineer will make and deliver test specimens to the laboratory and testing expense will be borne by the Owner.
   4. Required number of tests:
      a. At least 2 test specimens of grout will be made per week.
      b. At least 2 test specimens of grout will be made for each floor level of masonry laid.
   5. Do not use grout and mortar that does not meet specification.
      a. Remove such mortar and grout from Project site.
   6. Make provisions for and furnish grout and mortar for test specimens, and provide manual assistance to the Engineer in preparing test specimens.
   7. Assume responsibility for care of and providing proper curing conditions for test specimens.

3.02 ADJUSTING

A. Repair of defective masonry:
   1. Remove and replace or repair defective work.
   2. Do not patch, repair, or cover defective work without inspection by the Engineer.
   3. Provide repairs having strength equal to or greater than specified strength for areas involved.

END OF SECTION

SECTION 04220

CONCRETE UNIT MASONRY

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Concrete masonry units and accessories.

1.02 REFERENCES

A. American Concrete Institute (ACI):
   1. ACI 530.1 - Specification for Masonry Structures.

B. ASTM International (ASTM):
   1. C90 - Standard Specification for Loadbearing Concrete Masonry Units.
   2. C140 - Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.
   3. C426 - Standard Test Method for Linear Drying Shrinkage of Concrete Masonry Units.

1.03 DEFINITIONS

A. Mortar Smears: Mortar paste smeared across the permanent masonry construction during construction and absorbed into the masonry pores.

B. Mortar Splash: Mortar dropped splashed onto the permanent masonry construction at the base of the wall or off the scaffolding.

C. Mortar Tag: Excess mortar between masonry units worked out of the joints during tooling or striking.

D. Mortar Stains: Mortar paste left after mortar tags are removed.

1.04 SUBMITTALS

A. Product data:
   1. Submit manufacturer’s product data for split face block, if used.
   2. Submit manufacturer’s product data for proposed cleaning agent.

B. Samples: Include samples of stretcher units in sufficient quantity to illustrate color range.

C. Test reports:
   1. Compressive strength.
   2. Linear shrinkage.
   3. Moisture content as a percentage of total absorption.
   4. Total absorption.
   5. Unit weight.

D. Manufacturer's instructions:
   1. Submit printed or written recommendations from the masonry unit manufacturer of the cleaning procedures and cleaning agents appropriate for each type of masonry unit included in the work.

E. Quality assurance submittals:
   1. If requested by the Engineer, submit a record of the Installer's evidence of qualifications.
   2. If requested by the Engineer, submit a record of the Masonry Cleaner's evidence of qualifications.

1.05 QUALITY ASSURANCE

A. Qualifications:
   1. Installer qualifications:
      a. The mason shall hold an appropriate contractor's license in the State where the work will be constructed.
      b. The mason shall have not less than 5 years' experience and completed a minimum of 20 projects and at least 5 of which included the type of masonry units specified for this Work.
   2. Masonry cleaner qualifications:
      a. The masonry cleaner shall have not less than 5 years' experience and completed a minimum of 20.

B. Mock-up:
   1. A minimum 2 weeks to starting construction of masonry, construct minimum 4 foot inches by 4 foot inches square mock-up. The mock-up shall be constructed by the mason who will be performing the Work.
   2. Mock-up is intended for use as the project standard of workmanship, construction, quality, appearance, and material selection.
   3. Use accepted materials containing each different kind and color of concrete masonry units to illustrate wall design.
   4. The mock-up shall be constructed by the mason who will be performing the work.
   5. The mock-up shall be cleaned with the exact equipment, products, and methods submitted and cleaned by the individual who will perform the Work.
   6. When accepted, mock-up will be standard of comparison for remainder of masonry work.
      a. The mock-up may be accepted by the Engineer with exceptions that will not be accepted in the final construction.
         1) In such cases, those areas of the mock-up not accepted will be clearly identified by the Engineer.
   7. When not accepted by the Engineer, construct another mock-up.
   8. Upon completion of Project, dispose of mock-ups in legal manner at offsite location.

C. Pre-installation conference: Conduct as specified in Section 01312 - Project Meetings.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Transport and handle concrete masonry units as required to prevent discoloration, chipping, and breakage.

B. Store masonry units off the ground in a dry location, covered and protected from absorbing moisture.
   1. Locate storage piles, stacks, and bins to protect materials from heavy traffic.
   2. If masonry units are delivered in shrink-wrapped packaging and condensation develops, remove shrink-wrap packaging.

C. Remove chipped, cracked, and otherwise defective units from jobsite upon discovery.

1.07 ENVIRONMENTAL REQUIREMENTS

A. Cold weather requirements:
   1. In accordance with building code as specified in Section 01410 - Regulatory Requirements, provide adequate equipment for heating masonry materials when air temperature is below 40 degrees Fahrenheit.

B. Hot weather requirements:
   1. In accordance with building code as specified in Section 01410 - Regulatory Requirements, when ambient air temperature exceeds 100 degrees Fahrenheit, or when ambient air temperature exceeds 90 degrees Fahrenheit and wind velocity is greater than 8 miles per hour, implement hot weather protection procedures.
   2. Wet mortarboard before loading and cover mortar to retard drying when not being used.
   3. Do not spread mortar beds more than 48 inches ahead of placing masonry units.
   4. Place masonry units within one minute of spreading mortar.

1.08 SEQUENCING AND SCHEDULING

A. Order concrete masonry units well before start of installation to ensure adequate time for manufacturing and minimum 28 days for curing and drying before start of installation. Protect from weather after curing period to avoid moisture increase.

PART 2 PRODUCTS

2.01 MANUFACTURED UNITS

A. Hollow load bearing concrete masonry units:
   1. Class: Class 1 in accordance with ASTM C90, with minimum compressive strength of 2,000 pounds per square inch.
   2. Surface texture: To match nearby existing buildings on site.
   3. Color: Integral, Match existing.
   4. Typical size: 8 inches wide by 8 inches high by 16 inches long, or other sizes as needed to minimize cutting.
   5. Special sizes and shapes: As required for window and door openings, bond beams, piers, lintels, control joints, and other special applications to minimize cutting.
   6. Manufacturers: As necessary to provide construction similar to on-site buildings.

B. Anchor bolts: As specified in Section 05120 - Structural Steel.

C. Steel reinforcement: As specified in Section 04090 - Masonry Accessories.

D. Wall ties: As specified in Section 04090 - Masonry Accessories.

E. Wire joint reinforcement: As specified in Section 04090 - Masonry Accessories.

F. Loose fill insulation: As specified in Section 04090 - Masonry Accessories.

PART 3 EXECUTION

3.01 PREPARATION

A. Protection:
1. Protect adjacent construction with appropriate means from mortar droppings and other effects of laying of concrete masonry units.

B. Surface preparation:
1. Thoroughly clean foundations of laitance, grease, oil, mud, dirt, mortar droppings, and other matter that will reduce bond.

3.02 INSTALLATION

A. Forms and shores:
1. Where required, construct forms to the shapes indicated on the Drawings:
    a. Construct forms sufficiently rigid to prevent deflection which may result in cracking or other damage to supported masonry and sufficiently tight to prevent leakage of mortar and grout.
    b. Do not remove supporting forms or shores until the supported masonry has acquired sufficient strength to support safely its weight and any construction loads to which it may be subjected.
        1) Wait at least 24 hours after grouting masonry columns or walls before applying uniform loads.
2. Wait at least 72 hours before applying concentrated loads.

B. Concrete masonry units:
1. Comply with the requirements of ACI 530.1 unless more restrictive requirements are contained in this Section.
2. Lay concrete masonry units dry.
3. Lay units in uniform and true courses, level, plumb, and without projections or offset of adjacent units.
4. Lay units to preserve unobstructed vertical continuity of cells to be filled with grout or insulation.
5. Align vertical cells to be filled with grout to maintain clear, unobstructed continuous vertical cell measuring not less than 2 by 3 inches.
6. Place mortar with full coverage of joints at webs of all cells and face shells.
7. Butter vertical head joints for thickness equal to face shell thickness of units, and shove joints tightly together so that mortar bonds to both masonry units.
8. Solidly fill joints from face of units to inside face of cells.
9. Lay units to desired height with joints of uniform thickness.
10. Bond shall be plumb throughout.
11. Lay units to avoid formation of cracks when units are placed. Keep cells of units as free of mortar as possible as masonry wall height increases.

12. When positions of units shift after mortar has stiffened, bond is broken, or cracks are formed, relay units in new mortar.
13. Remove mortar, mortar droppings, debris, and other obstructions and materials from inside of cell walls.
14. Remove mortar tags and smears daily with a non-metallic tool.
    a. Mortar tags and smears shall be removed after they initially set, but shall not be permitted to remain more than 24 hours.
15. Where practical, protect completed work from mortar splash by placing thin plastic sheeting around the base of walls.
    a. Place sand, straw, sawdust or other similar material on the floor around the base of walls to protect floors and walls.
16. Turn scaffold planks over at the end of the workday to avoid mortar splashes from wet weather.
    a. Cover tops of walls at the end of the workday and other work stoppages to prevent entry of water into the partially completed masonry.
17. Seal cleanouts after inspection and before grouting.

C. Bond pattern:
    1. Lay concrete masonry units in running bond pattern, unless otherwise indicated on the Drawings.

D. Mortar joints:
    1. Make joints straight, clean, smooth, and uniform in thickness.
    2. Tool exposed joints, slightly concave. Strike concealed joints flush.
    3. Make vertical and horizontal joints 3/8-inch thick.
    4. Where fresh masonry joins totally or partially set masonry, clean and roughen set masonry before laying new units.
    5. Remove mortar that protrudes more than 1/2 inch into the cells of units that are to be grouted.

E. Grouting and reinforcement:
    1. Where horizontal and vertical bars are spliced and adjacent lap splices are separated by more than 3 inches, the lap splice length shall be 72 bar diameters. Where adjacent lap splices are separated by 3 inches or less, the lap splice length shall be increased by 1.3 times or the lap splices shall be staggered at least 24 bar diameters with no increase in length.
    2. Hold vertical reinforcing bars in position at top and bottom and at intervals not exceeding 200 bar diameters. Use steel wire bar positioners to position bars. Tie reinforcing bars to dowels with wire ties.
    3. Obtain acceptance of reinforcement placement before grouting.
    4. Fill all spaces and cells solidly with grout.
        a. Low-lift grouting:
            1) Hollow unit masonry to be grouted by the low lift method shall be constructed and grouted in lifts not exceeding 5 feet.
            2) Slushing with mortar will not be permitted.
        b. High-lift grouting:
            1) Hollow unit masonry shall be allowed to cure at least 24 hours before grouting.
            2) Grout shall be placed in lifts not to exceed 6 feet in depth.
            3) Each lift shall be allowed to set for 10 minutes after initial consolidation of grout before successive lift is placed.
            4) The full height of each section of wall shall be grouted in 1 day.

5. Grout in cells shall have full contact with surface of concrete footings.
6. When grouting stops for 1 hour or longer, form horizontal construction joints by stopping grout placement 1-1/2 inches below top of uppermost unit containing grout.
7. After placement, consolidate grout using mechanical immersion vibrators designed for consolidating grout.
8. Placement:
    a. Use a hand bucket, concrete hopper, or grout pump.
    b. Place grout in final position within 1-1/2 hours after mixing. Place grout so as to completely fill the grout spaces without segregation of the aggregates.
    c. Do not insert vibrators into lower grout placements that are in a semi-solidified state.
    d. Remove grout spills immediately by hand washing with a bucket and brush.

F. Bond beams:
1. Starting courses at bottom of walls shall be bond beams.
2. Other bond beam locations and spacing shall be as indicated on the Drawings.

G. Cutting concrete masonry units:
1. When possible, use full units of the proper size in lieu of cut units. Cut units as required to form chases, openings, for anchorage, and for other appurtenances.
2. Cut and fit units with power-driven carborundum or diamond disc blade saw.

H. Control joints:
1. Provide in masonry walls at locations indicated on the Drawings.
2. Make full height and continuous in appearance.
3. Run bond beams and bond beam reinforcing bars continuously through control joints.
4. Insert control joint filler in joints as wall is constructed.
5. Apply sealant as specified in Section 07900 - Joint Sealants.

I. Openings and lintels:
1. Place horizontal reinforcement in fully grouted bond beam units.
2. Use lintel block units where underside of lintel will be exposed.
3. Provide minimum of 8-inch bearing at each end of lintel.
4. Embed reinforcing bars minimum 24 inches or 48 bar diameters, whichever is longer, into wall past edges of openings or as indicated on the Drawings:
    a. At corners, provide 90-degree bend with equivalent total embedment.

J. Steel door frames:
1. Anchor and fully grout jambs and head of steel doorframes connected to concrete unit masonry.
2. Fill frames with grout as each 2 feet of concrete unit masonry is laid.

K. Anchor bolts:
1. Hold anchor bolts in place with template during grouting to ensure precise alignment.
2. Do not cut or ream members being anchored or use other means to accommodate misaligned anchor bolts in roof deck support angles.

L. Enclosures:
   1. Where concrete masonry units enclose conduit, pipes, stacks, ducts, and similar items, construct chases, cavities, and similar spaces as required, whether or not such spaces are indicated on the Drawings.
   2. Point openings around flush mounted electrical outlet boxes with mortar, including flush joints above boxes.
   3. Do not cover enclosures until inspected and when appropriate, tested.

M. Other embedded items:
   1. Build in wall plugs, accessories, flashings, pipe sleeves, and other items required to be built-in as the masonry work progresses.

N. Patching:
   1. Patch exposed concrete masonry units at completion of the Work and in such manner that patching will be indistinguishable from similar surroundings and adjoining construction.

O. Water curing:
   1. Protect concrete masonry units from drying too rapidly by frequently fogging or sprinkling so walls will always be visibly damp for minimum 3 days.

P. Miscellaneous:
   1. Build in required items, such as anchors, flashings, sleeves, frames, structural steel, lintels, anchor bolts, and metal fabrications, as required for complete installation.

Q. Water repellent:
   1. Apply water repellent as specified in Section 07190 - Water Repellents.

R. Grouting equipment:
   1. Grout pumps:
      a. Do not pump grout through aluminum tubes.
      b. Operate pumps to produce a continuous stream of grout without air pockets.
      c. Upon completion of each days pumping, eject grout from pipeline without contamination or segregation of the grout:
         1) Remove waste materials and debris from the equipment.
         2) Dispose of waste materials, debris, and all flushing water outside the masonry.
   2. Vibrators:
      a. Internal vibrators shall maintain a speed of not less than 5,000 impulses per minute when submerged in the grout.
      b. Maintain at least 1 spare vibrator, at the site at all times.
      c. Apply vibrators at uniformly spaced points not further apart than the visible effectiveness of the machine.
      d. Limit duration of vibration to time necessary to produce satisfactory consolidation without causing segregation.

3.03 CONSTRUCTION

A. Site tolerances: Lay masonry plumb, true to line, and with courses level. Keep bond pattern plumb throughout. Lay masonry within the following tolerances:
   1. Maximum variation from the plumb in the lines and surfaces of columns, walls, and in the flutes and surfaces of fluted or split faced blocks:
      a. In adjacent masonry units: 1/8 inch.
      b. In 10 feet: 1/4 inch.
      c. In any story or 20 feet maximum: 3/8 inch.
      d. In 40 feet or more: 1/2 inch.
   2. Maximum variations from the plumb for external corners, expansion joints, and other conspicuous lines:
      a. In any story or 20 feet maximum: 1/4 inch.
      b. In 40 feet or more: 1/2 inch.
   3. Maximum variations from the level or grades indicated on the Drawings for exposed lintels, sills, parapets, horizontal grooves, and other conspicuous lines:
      a. In any bay or 20 feet maximum: 1/4 inch.
      b. In 40 feet or more: 1/2 inch.
   4. Maximum variations of the linear building lines from established position in plan and related portion of columns, walls, and partitions:
      a. In any bay or 20 feet maximum: 1/2 inch.
      b. In 40 feet or more: 3/4 inch.
   5. Maximum variation in cross sectional dimensions of columns and in thickness of walls:
      a. Minus: 1/4 inch.
      b. Plus: 1/2 inch.

3.04 FIELD QUALITY CONTROL

A. Site tests:
   1. Owner will have tests performed by an independent laboratory.
   2. Have minimum 3 concrete masonry units of each type proposed for Project tested in accordance with ASTM C90, C140, and C426 to verify conformance to Specifications.
   3. Tests shall include compressive strength, linear shrinkage, moisture content as percent of total absorption, total absorption, and unit weight.

B. Special inspection:
   1. Special inspection shall be as specified in Section 01455B - Special Tests and Inspections.
   2. Owner will employ a qualified masonry special inspector for continuous special inspection of the masonry work. Acceptance by a state or municipality having a program of examining and certifying masonry inspectors will be considered adequate qualifications. The masonry inspector shall be at the site during all masonry construction and perform the following duties:
      a. Review Drawings and Specifications and meet with the Contractor to discuss requirements before work commences.
      b. Before masonry work commences, Contractor and the Contractor's Quality Control Representative shall attend meeting with Engineer to review the requirements for surveillance and quality control of the masonry work.

c. Check brand and type of cement, lime (if used), and source of sand.
d. Verify that foundation is clean, rough, and ready to receive units.
e. Check reinforcing steel dowels for correct location, straightness, proper alignment, spacing, size, and length.
f. Observe field proportioning of mortar. Visually check aggregate to determine uniformity of grading, cleanliness, and moisture.
g. Verify that joints are full of mortar and kept tight during work. Inspect grout cells to verify that fins will not interfere with grouting. Verify that masons keep grout cells clean of mortar droppings and inspect to determine compliance.
h. Continuously observe placing of grout.
i. Perform or supervise performance of required sampling and testing.

3. Keep complete record of inspections. Report daily to the Building Official, Contractor's Quality Control Representative, Engineer, and Owner the progress of the masonry inspection.

3.05 FINAL CLEANING

A. General:
1. Final cleaning shall be performed within 7 to 14 days after construction of masonry work.
2. Protect adjacent materials and equipment that may be damaged by cleaning.
3. Pre-wet masonry before applying cleaning agent, but do not saturate masonry.
4. Remove mortar stains, smears, and splash, efflorescence, and grout stains on exposed surfaces with the submitted cleaning agent as directed by the masonry unit manufacturer’s recommendations.
5. Do not use muriatic acid as cleaning agent.
6. Cleaning agents shall be applied when the masonry surface and air temperatures are at least 50 degrees Fahrenheit.
   a. Dilute cleaning agents in accordance with manufacturer’s recommendations.
   b. Do not allow cleaning agents to dry on the masonry.
7. Clean wall from the top to the bottom, without overlapping areas being cleaned for consistency.
8. If pressure cleaning equipment is used, the following limitations shall be observed:
   a. Apply cleaning agent to pre-wetted wall with low pressure (less than 50 pounds per square inch).
   b. Use a 25 degree to 50 degree flared-tip nozzle (not a pointed tip).
   c. Maintain a consistent distance from the spray nozzle to the masonry surface no closer than 12 inches.
      1) Masonry cleaner shall use a combination of pressure, nozzle, and distance from tip to masonry that does not damage the masonry surface.
9. Rinse cleaning agents off the wall with potable water.
10. Dispose of debris, refuse, and surplus material offsite legally.

3.06 PROTECTION

A. Provide temporary protection for exposed masonry corners subject to damage.

B. Bracing:
   1. Unless wall is adequately supported by permanent supporting elements so wall will not overturn or collapse, adequately brace masonry walls over 8 feet in height to prevent overturning and to prevent collapse.
   2. Keep bracing in place until permanent supporting elements of structure are in place.

C. Limited access zone:
   1. Establish limited access zone prior to start of masonry wall construction.
   2. Zone shall be immediately adjacent to wall and equal to height of wall to be constructed plus 4 feet by entire length of wall on unscaffolded side of wall.
   3. Limit access to zone to workers actively engaged in constructing wall. Do not permit other persons to enter zone.
   4. Keep zone in place until wall is adequately supported or braced by permanent supporting elements to prevent overturning and collapse.

END OF SECTION

SECTION 05120

STRUCTURAL STEEL

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Structural steel shapes and plate.
   2. Fasteners and structural hardware:
      a. All thread rods.
      b. All thread rods, high-strength.
      c. High-strength bolts.
   3. Welding.
   4. Bolting.

1.02 REFERENCES

A. American Institute of Steel Construction (AISC):
   1. 303 - Code of Standard Practice for Steel Buildings and Bridges.
   2. 360 - Specification for Structural Steel Buildings.

B. American Iron and Steel Institute (AISI):
   1. Steel and stainless steel alloys (“types”) as indicated.

C. American Welding Society (AWS):
   1. A5.1 - Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding.
   2. A5.17 - Specification for Carbon Steel Electrodes and Fluxes for Submerged Arc Welding.
   3. A5.20 - Specification for Carbon Steel Electrodes for Flux Cored Arc Welding.
   4. D1.1 - Structural Welding Code - Steel.
   5. D1.6 - Structural Welding Code - Stainless Steel.

D. ASTM International (ASTM):
   1. A6 - Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling.
   2. A36 - Standard Specification for Carbon Structural Steel.
   3. A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded, and Seamless.
   4. A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   5. A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   6. A194 - Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
   7. A240 - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
   8. A276 - Standard Specification for Stainless Steel Bars and Shapes.

9. A325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
10. A380 - Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
11. A489 - Standard Specification for Carbon Steel Lifting Eyes.
12. A500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
13. A501 - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
14. A563 - Standard Specification for Carbon and Alloy Steel Nuts.
15. A992 - Standard Specification for Structural Steel Shapes.
16. F436 - Standard Specification for Hardened Steel Washers.
17. F959 - Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners.
18. F1554 - Standard Specification for Anchor Bolts, Steel, 36, 55, and 105 ksi Yield Strength.
19. F2329 - Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners.

E. Research Council on Structural Connections (RCSC):
1. Specification for Structural Joints Using High-Strength Bolts (RCSC Specification).

1.03 DEFINITIONS

A. Snug-tight: At bolted joints, the tightness attained with a few impacts of an impact wrench, or by the full effort of an ironworker using a spud wrench to bring the connected plies into firm contact.

B. Stainless steel related terms:
1. Descaling: Removal of heavy, tightly adherent oxide films resulting from hot-forming, heat-treatment, welding, and other high-temperature operations.
2. Pickling: Chemical descaling of stainless steel using aqueous solutions of nitric and hydrofluoric acid, or various proprietary formulations as specified.
3. Passivation: Chemical treatment of stainless steel with a mild oxidant for the purpose of enhancing the spontaneous formation of the steel’s protective passive film.

1.04 SUBMITTALS

A. Product data:
1. Welding electrodes: Electrode manufacturer's data.
2. Stainless steel: Fabricator name and qualifications, member dimensions and structural section properties, and specifications and procedures used for pickling and passivating members.

B. Shop drawings:
1. Fabrication and erection drawings.

C. Quality control submittals:
1. Welding procedure specifications (WPS) in accordance with AWS D1.1 and D1.6.

a. Submit WPS for each type of welded joint used, whether prequalified or qualified by testing.
    1) State electrode manufacturer and specific electrodes used.
    2) Indicate required AWS qualification for joint.
b. Submit WPS with shop drawings that indicate those welds.
c. Submit Procedure Qualification Record (PQR) in accordance with AWS D1.1 and D1.6 for welding procedures qualified by testing.

2. Welder qualifications: For each welding process and position:
    a. Welder's qualification certificates.
    b. Contractor's statement that certificate will be "in effect" at the time(s) welding will be performed based on the "Period of Effectiveness" provisions of AWS D1.1 and D1.6.

D. Test reports:
1. Certified copies of mill tests and analyses made in accordance with applicable ASTM standards, or reports from a recognized commercial laboratory, including chemical and tensile properties of each shipment of structural steel or part thereof having common properties.

1.05 QUALITY ASSURANCE

A. Welding:
1. Perform welding of structural metals in accordance with AWS D1.1 and D1.6 using welders who have current AWS qualification certificate for the process, position, and joint configuration to be welded.
2. Make Welding Procedure Specifications available at the locations where welding is performed.
3. Notify Engineer at least 24 hours before starting shop or field welding.
4. Engineer may check materials, equipment, and qualifications of welders.
5. Remove welders performing unsatisfactory Work, or require requalification.
6. Engineer may use gamma ray, magnetic particle, dye penetrant, trepanning, or other aids to visual inspection to examine any part of welds or all welds.
7. Contractor shall bear costs of retests on defective welds.
8. Contractor shall also bear costs in connection with qualifying welders.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Packing and shipping: Deliver structural steel free from mill scale, rust, and pitting.

B. Storage and protection: Until erection and painting, protect from weather items not galvanized or protected by a shop coat of paint.

PART 2 PRODUCTS

2.01 MATERIALS

A. Unless otherwise specified or indicated on the Drawings, materials shall conform to the following:

Item	ASTM Standard	Class, Grade, Type, or Alloy Number
Carbon Steel		
Plate, bars, rolled shapes (except W and WT shapes), and miscellaneous items	A36	--
Rolled W and WT shapes	A992	Grade 50
Hollow structural sections (HSS): Round, square, or rectangular	A500	Grade B
Round HSS	A500	Grade B
Steel pipe	A53	Grade B
Stainless steel		
Plate, sheet, and strip	A240	Type 304* or 316**
Bars and shapes	A276	Type 304* or 316**
* Use Type 304L (low-carbon stainless steel) if material will be welded.		
** Use Type 316L (low carbon stainless steel) if material will be welded.		

2.02 FASTENERS AND STRUCTURAL HARDWARE

A. General:
   1. Materials: Of domestic manufacture.
   2. Where fasteners and hardware are specified to be galvanized, galvanize in accordance with ASTM A153 or ASTM F2329.

B. All thread rods:
   1. Carbon steel:
      a. In accordance with ASTM A36 unless otherwise indicated on the Drawings.
      b. High strength all thread rods: In accordance with ASTM F1554, Grade 55.
      c. Nuts: ASTM A194.
      d. Washers: ASTM F436.
   2. Galvanized carbon steel:
      a. In accordance with ASTM A36 unless otherwise indicated on the Drawings, and hot dip galvanized in accordance with ASTM A153.
      b. High strength galvanized all thread rods: In accordance with ASTM F1554, Grade 55, and galvanized in accordance with ASTM F2329.
      c. Nuts: ASTM A194, hot-dip galvanized in accordance with ASTM A153.
      d. Washers: ASTM F436, hot-dip galvanized in accordance with ASTM A153.

3. Stainless steel:
    a. Units descaled, pickled, and passivated as specified in “Fabrication” in this Section.
    b. Threaded rods and nuts to be the products of a single manufacturer/fabricator to ensure proper fit without galling. Ship all thread rods with properly fitting nuts attached.
    c. Alloy Type 304 or Type 316 as indicated on the Drawings.
    d. Type 304:
        1) Rod: ASTM F593, Group 1, Condition CW, coarse threads.
        2) Nuts: ASTM F594. Match alloy of rod (group and UNS designation).
        3) Washers: Type 304 stainless steel.
    e. Type 316:
        1) Rod: ASTM F593, Group 2, Condition CW, coarse threads.
        2) Nuts: ASTM F594. Match alloy of rod (group and UNS designation).
        3) Washers: Type 316 stainless steel.

C. Anchor bolts, anchor rods, and post-installed steel anchors: As indicated on the Drawings and as specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.

D. High-strength bolts:
1. Provide high-strength bolt assembly, with nuts, hardened flat washers, and compressible-washer-type direct tension indicators. Provide uncoated components unless galvanized coating is indicated on the Drawings.
2. Carbon steel - Uncoated:
    a. Bolts: Plain heavy hex structural bolts in accordance with ASTM A325 Type 1.
    b. Nuts: Heavy hex nuts in accordance with ASTM A563, Grade C.
    c. Washers: Flat:
        1) Adjacent to normal, oversized, and short-slotted holes: Circular and square or rectangular beveled washers in accordance with ASTM F436.
        2) Adjacent to long slotted holes: 5/16-inch thick plate washer fabricated from steel in accordance with ASTM A36.
    d. Washers: Tension indicating: In accordance with ASTM F959.
3. Carbon steel - Galvanized:
    a. Bolt and nut assemblies fabricated, galvanized, tested for rotational capacity, and shipped accordance with the provisions ASTM A325 and the RCSC Specification.
    b. Bolts, nuts, and washers: Hot-dip galvanized and in accordance with ASTM A153, Class C or ASTM F2329.
    c. Bolts: Plain heavy hex structural bolts in accordance with ASTM A325 Type 1 and galvanized as specified.
    d. Nuts: Heavy hex nuts in accordance with ASTM A563, Grade DH, galvanized as specified, and lubricated in accordance with ASTM A563, Supplementary Requirement S1 to minimize galling.
    e. Washers:
        1) Adjacent to normal, oversized, and short-slotted holes: Circular and square or rectangular beveled washers in accordance with ASTM F436 and galvanized as specified.

2) Adjacent to long slotted holes: 5/16-inch thick plate washer fabricated from steel in accordance with ASTM A36, and galvanized in accordance with ASTM A123.

E. Stainless steel bolts (for use in stainless steel structures):
   1. General:
      a. Bolts and nuts shall be the products of a single manufacturer/fabricator to ensure proper fit without galling. Ship bolts with properly fitting nuts attached.
      b. Units descaled, pickled and passivated as specified in “Fabrication."
   2. Alloy: Type 304 or Type 316 to match alloy of structural members being connected.
   3. Type 304:
      a. Bolts: ASTM F593, Group 1, Condition CW, coarse threads.
      b. Nuts: ASTM F594. Match alloy (group and UNS designation) and threads of bolts.
      c. Washers: Type 304 stainless steel.
   4. Type 316:
      a. Bolts: ASTM F593, Group 2, Condition CW, coarse threads.
      b. Nuts: ASTM F594. Match alloy (group and UNS designation) and threads of bolts.
      c. Washers: Type 316 stainless steel.
   5. Welded studs: As indicated on the Drawings and as specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.

2.03 ISOLATING SLEEVES AND WASHERS

A. As indicated on the Drawings and as specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.

2.04 GALVANIZED SURFACE REPAIR

A. Manufacturers: One of the following or equal:
   1. Galvinox.
   2. Galvo-Weld.

2.05 THREAD COATING

A. Manufacturers: One of the following or equal:
   1. Never Seez Compound Corp., Never-Seez.
   2. Oil Research, Inc., WLR No. 111.

2.06 SUPPLEMENTARY PARTS

A. Furnish as required for complete structural steel erection, whether or not such parts and Work are specified or indicated on the Drawings.

2.07 FABRICATION

A. Shop assembly:
   1. Fabricate structural steel in accordance with AISC 360 and AISC 303 unless otherwise specified or modified by applicable regulatory requirements.

2. Where anchors, connections, or other details of structural steel are not specifically indicated on the Drawings or specified, their material, size and form shall be equivalent in quality and workmanship to items specified.
3. Round off sharp and hazardous projections and grind smooth.
4. Take measurements necessary to properly fit work in the field. Take responsibility for and be governed by the measurements and proper working out of all the details.
5. Take responsibility for correct fitting of metalwork.
6. Welded connections:
    a. Comply with AWS requirements for the metals to be welded.
    b. Weld only in accordance with approved Welding Procedure Specifications.
    c. Keep Welding Procedure Specifications readily available for welders and inspectors during fabrication processes.

B. Stainless steel shapes and assemblies:
1. For structural members such as W shapes, S shapes, channels, angles, and similar rolled shapes not available in quantity, size, and type of stainless steel specified or indicated on the Drawings:
    a. Fabricate shapes using laser-fused, full penetration welds between pieces of plate to attain same or higher section modulus and moment of inertia as that of members indicated on the Drawings.
    b. Fabricate shapes from dual grade stainless steel.
    c. Fabricate beams and channels to ASTM A6 tolerances.
    d. Manufacturers: The following or equal:
        1) Stainless Structurals, LLC.
2. Cleaning and passivation:
    a. Following shop fabrication of stainless steel members and bolts, clean and passivate fabrications at point of manufacture.
    b. Finish requirements: Remove free iron, heat tint oxides, weld scale and other impurities, and obtain a bright passive finished surface with no etching, pitting, frosting, or discoloration.
    c. Provide quality control testing to verify effectiveness of cleaning agents and procedures and to confirm that finished surfaces are clean and passivated.
        1) Conduct sample runs using test specimens with proposed cleaning agents and procedures as required to avoid adverse effects on surface finishes and base materials.
    d. Pre-clean, chemically de-scale (“pickle”), passivate, and final-clean fabrications in accordance with the requirements of ASTM A380.
        1) If degreasing is required before cleaning (pickling) to remove scale or iron oxide, cleaning with citric acid treatments is permissible; however, such treatments shall be followed inorganic cleaners.
        2) Pickle and passivate stainless steel using a nitric acid solution in accordance with ASTM A380, Annex A2, Table A2.1, Part II.
        3) Pickling by citric acid treatment or sulfuric acid treatment is not considered to satisfy the requirements of this Section.
    e. Inspect after cleaning using methods specified for “gross inspection” in ASTM A380.
    f. Improperly or poorly cleaned and passivated materials shall not be shipped and will not be accepted at the site.

C. Galvanized carbon steel:
   1. Where galvanizing is required, hot-dip structural steel after fabrication in accordance with ASTM A123:
   2. Do not electro-galvanize or mechanically-galvanize unless specified or accepted by Engineer.
   3. Re-straighten galvanized items that bend or twist during galvanizing.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of conditions: Examine Work in place to verify that it is satisfactory to receive the Work of this Section. If unsatisfactory conditions exist, do not begin this Work until such conditions have been corrected.

3.02 ERECTION

A. General:
   1. Fabricate structural and foundry items to true dimensions without warp or twist.
   2. Form welded closures neatly, and grind off smooth where weld material interferes with fit or is unsightly.
   3. Install structural items accurately and securely, true to level, plumb, in correct alignment and grade, with all parts bearing or fitting structure or equipment for which intended.
   4. Do not shift out of alignment, re-drill, re-shape, or force fit fabricated items.
   5. Place anchor bolts or other anchoring devices accurately and make surfaces that bear against structural items smooth and level.
   6. Rigidly support and brace structural items needing special alignment to preserve straight, level, even, and smooth lines. Keep structural items braced until concrete, grout, or dry pack mortar has hardened for 48 hours minimum.
   7. Erect structural steel in accordance with AISC 303 unless otherwise specified or modified by applicable regulatory requirements.
   8. Where anchors, connections, and other details of structural steel erection are not specifically indicated on the Drawings or specified, form, locate, and attach with equivalent in quality and workmanship to items specified.
   9. Round off sharp or hazardous projections and grind smooth.
   10. Paint or coat steel items as specified in Sections 09910 - Painting and 09960 - High-Performance Coatings.

B. Stainless steel. Take all necessary precautions to avoid iron contamination of stainless steel during delivery, storage, and handling.
   1. Segregate stainless steel from iron.
   2. Tools and handling devices.
      a. Do not use iron tools clamps, chokes, working surfaces, or brushes when fabricating, handling, and erecting stainless steel.
      b. Do not use tools that have been contaminated by contact with iron.
      c. Use stainless steel, polymer coated, or wood tools and handling equipment. Do not use tools that have been contaminated by contact with iron or steel.

C. Welding: General:
   1. Make welds full penetration type, unless otherwise indicated on the Drawings.

2. Remove backing bars and weld tabs after completion of weld. Repair defective welds observed after removal of backing bars and weld tabs.

D. Welding: Carbon steel:
   1. General: In accordance with AWS D1.1:
      a. Weld ASTM A36 and A992 structural steel, ASTM A500 and A501 structural tubing, and ASTM A53 pipe with electrodes in accordance with AWS A5.1, using E70XX electrodes; AWS A5.17, using F7X-EXXX electrodes; or AWS A5.20, using E7XT-X electrodes.
      b. Field repair cut or otherwise damaged galvanized surfaces to equivalent original condition using a galvanized surface repair.

E. Welding: Stainless steel:
   1. General: In accordance with AWS D1.6.
   2. Field welding of stainless steel will not be permitted.
   3. Passivation of field-welded surfaces:
      a. Provide cleaning, pickling and passivating as specified under “Fabrications” of this Section. Clean using Derustit Stainless Steel Cleaner, or equal.

F. Interface with other products:
   1. Where steel members and fasteners come in contact with dissimilar metals (aluminum, stainless steel, etc.), separate or isolate the dissimilar metals with isolating sleeves and washers as specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.

G. Fasteners: General:
   1. Install bolts to project 2 threads minimum, but 1/2 inch maximum beyond nut.
   2. Anchor bolts and anchor rods: Install as specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.
      a. Unless otherwise specified, tighten nuts on anchor bolts and anchor rods specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry to the "snug-tight" condition.
   3. All thread rods in drilled holes bonded to concrete with adhesive: Install as specified in Section 03055 - Adhesive-Bonded Reinforcing Bars and All Thread Rods in Concrete.
   4. All thread rods in drilled holes bonded to masonry with adhesive: Install as specified in Section 04055 - Adhesive Bonding Reinforcing Bars and All Thread Rods in Masonry.

H. Fasteners: High-strength carbon steel bolts:
   1. Connections with high-strength bolts shall in accordance with RCSC Specification for Structural Joints Using High-Strength Bolts.
   2. Provide snug-tight joints at bolted connections, unless otherwise indicated on the Drawings.
   3. Joints: Slip-critical.
      a. Confirm that faying surfaces at connections are free of dirt and other foreign material, have been blast cleaned, and are free of coatings and inadvertent overspray in accordance with RCSC Specification.
      b. Furnish hardened flat washers in accordance with ASTM F436:
         1) On outer plies with slotted holes.

2) When 1 or more plies of the connected material has a yield strength less than 40 ksi.
3) Under element, nut, or bolt head, turned in tightening.

c. Install tension indicator washers, placed in accordance with ASTM F959 Figure X1, to confirm adequate tightening of bolts.
d. Tighten bolts to full pretension.

5. Joints: Snug-tight:
   a. Install bolts with washers where required in accordance with RCSC Specification.
   b. Tighten bolts to bring the connected plies into firm contact. Tightening shall progress systematically beginning with the most rigid part of the joint. More than 1 cycle through the bolt pattern may be required to achieve this condition.
   c. Verify adequate tightening of bolts by visual observation to confirm that washers have been installed at locations required in accordance with RCSC Specification, and that the plies of the connected parts have been brought into firm contact.

I. Fasteners: Stainless steel bolts:
   1. Connections shall be snug-tight joints unless otherwise indicated on the Drawings.
   2. Prior to installing nuts, coat threads of stainless steel fasteners with thread coating to prevent galling of threads.
   3. Rotate nuts using a slow, smooth action without interruptions. Avoid overtightening.

3.03 FIELD QUALITY CONTROL

A. Provide quality control as specified in Section 01450 - Quality Control.

3.04 FIELD QUALITY ASSURANCE

A. Provide quality assurance as specified in Section 01450 - Quality Control.

B. Special inspections, special tests, and structural observation:
   1. Provide as specified in Section 01455B - Special Tests and Inspections.

END OF SECTION

SECTION 05140

STRUCTURAL ALUMINUM

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Structural aluminum products, including sheet, pipe, extrusions, and associated accessories.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
   2. B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
   3. B308 - Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.

B. American Welding Society (AWS):
   1. A5.10 - Specification for Bare Aluminum and Aluminum-Alloy Welding Electrodes and Rods.
   2. D1.2 - Structural Welding Code - Aluminum.

1.03 SUBMITTALS

A. Quality control submittals:
   1. Test Reports: Certified copies of mill tests or reports from a recognized commercial laboratory including chemical and tensile properties of each shipment of structural metal or part thereof having common properties. Tests and analyses shall be made in accordance with applicable ASTM Standards.
   2. Welder’s certificates.

1.04 QUALITY ASSURANCE

A. Qualifications:
   1. Perform welding of structural metals with welders who have current AWS certificate for the type of welding to be performed.
   2. Notify Engineer 24 hours minimum before starting shop or field welding.
   3. Engineer may check materials, equipment, and qualifications of welders.
   4. Remove welders performing unsatisfactory work, or require to requalify.
   5. Engineer may use gamma ray, magnetic particle dye penetrant, or other aids to visual inspection to examine any part of welds or all welds.
   6. Contractor shall bear costs of retests on defective welds.
   7. Contractor shall bear costs in connection with qualifying welders.

PART 2 PRODUCTS

2.01 MATERIALS

A. Structural sheet aluminum: ASTM B209, Alloy 6061-T6.

B. Structural aluminum: ASTM B308, Alloy 6061-T6.

C. Extruded aluminum: ASTM B221, Alloy 6063-T42.

D. Isolating sleeves and washers:
   1. As indicated on the Drawings and as specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.

E. Miscellaneous materials:
   1. Furnish supplementary parts necessary to complete each item even where such work is neither definitely indicated on the Drawings nor specified.
   2. Size, form, attachment, and location shall conform to the best of current practice.
   3. Conform to applicable ASTM Standards for materials not otherwise specified.

2.02 FABRICATION

A. Aluminum layout:
   1. Center punch hole centers, and punch or scribe cutoff lines, except where marks would remain on fabricated material.
   2. Apply temperature correction where necessary in layout of critical dimensions. Use a coefficient of expansion of 0.000013 per degree of Fahrenheit.

B. Cutting aluminum:
   1. Material 1/2-inch thick or less: Shear, saw, or cut with a router.
   2. Material more than 1/2-inch thick: Saw or rout.
   3. Make cut edges true and smooth, free from excessive burrs or ragged breaks.
   4. Avoid reentrant cuts wherever possible. Where used, fillet by drilling prior to cutting.
   5. Do not flame cut aluminum alloys.
   6. Punch or drill rivet or bolt holes to finished size before assembly:
      a. Make finished diameter of holes for bolts 1/16-inch maximum larger than nominal bolt diameter.
      b. Make holes cylindrical and perpendicular to principal surface.
      c. Do not permit holes to drift in a manner to distort metal.

C. Aluminum forming and assembly:
   1. Do not heat structural aluminum, except as follows:
      a. Heat aluminum to 400 degrees Fahrenheit for 30 minutes maximum, to facilitate bending or welding.
      b. Heat only when proper temperature controls and supervision can ensure that limitations on temperature and time are observed.

D. Before assembly, remove chips lodged between contacting surfaces.

E. Welding aluminum:
   1. Perform welding of aluminum in accordance with AWS D1.2.

2. Weld aluminum in accordance with the following:
    a. Preparation:
        1) Remove dirt, grease, forming or machining lubricants, and organic materials from areas to be welded by cleaning with a suitable solvent or by vapor degreasing.
        2) Additionally, etch or scratch brush to remove oxide coating just prior to welding when inert gas tungsten arc welding method is used.
        3) Oxide coating may not need to be removed if welding is performed by automatic or semi-automatic inert gas shielded metal arc.
        4) Suitably prepare edges to ensure 100 percent penetration in butt welds by sawing, chipping, machining, or shearing. Do not cut with oxygen.
    b. Filler metal: Aluminum alloys conforming to the requirements of AWS A5.10 and AWS classification ER 4043, ER 5654, ER 5554, ER 5183, ER 5356, or ER 5556.
    c. Perform welding of structures which are to be anodized using filler alloys which will not discolor when anodized, AWS ER 5654, ER 5554, ER 5183, ER 5356, or ER 5556.
    d. Perform welding by using a non-consumable tungsten electrode with filler metal in an inert gas atmosphere (TIG) or using a consumable filler metal electrode in an inert gas atmosphere (MIG).
    e. Do not use welding process that requires use of a welding flux.
    f. Neatly make welded closures.
    g. Where weld material interferes with fit or is unsightly in appearance, grind it smooth.
    h. Make welds full penetration welds unless otherwise indicated on the Drawings.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of conditions: Examine Work in place to verify that it is satisfactory to receive the Work of this Section. If unsatisfactory conditions exist, do not begin this Work until such conditions have been corrected.

3.02 INSTALLATION

A. Install structural aluminum products as indicated on the Drawings and specified.

B. Install structural aluminum products accurately and securely, true to level, plumb, in correct alignment and grade, with all parts bearing or fitting structure or equipment for which intended.

C. Do not cock out of alignment, redrill, reshape, or force fit fabricated items.

D. Place anchor bolts or other anchoring devices accurately and make surfaces that bear against structural items smooth and true to level.

E. Rigidly support and brace structural products needing special alignment to preserve straight, level, even, smooth lines, and keep braced until concrete, grout, or dry pack mortar has hardened for a minimum 48-hour period.

F. Interface with other products:
   1. Where aluminum comes in contact with dissimilar metals, use stainless steel bolts or anchors and separate or isolate the dissimilar metals with isolating sleeves and washers as specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.
   2. Coat those parts of aluminum that will be cast into concrete or that will be in contact with concrete, grout, masonry, wood, or other materials that will cause the aluminum to corrode, as specified in Section 09960 - High-Performance Coatings.

END OF SECTION

SECTION 05190

MECHANICAL ANCHORING AND FASTENING TO CONCRETE AND MASONRY

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Cast-in anchors and fasteners:
      a. Anchor bolts.
      b. Concrete inserts.
      c. Deformed bar anchors.
      d. Welded studs.
   2. Post-installed steel anchors and fasteners:
      a. Concrete anchors.
      b. Sleeve anchors.
      c. Screw anchors.
      d. Undercut concrete anchors.
   3. Appurtenances for anchoring and fastening:
      a. Anchor bolt sleeves.
      b. Isolating sleeves and washers.
      c. Thread coating for threaded stainless steel fasteners.

1.02 REFERENCES

A. American Concrete Institute (ACI):
   1. 355.2 - Qualification of Post-Installed Mechanical Anchors in Concrete & Commentary.

B. American National Standards Institute (ANSI):
   1. B212.15 - Cutting Tools - Carbide-tipped Masonry Drills and Blanks for Carbide-tipped Masonry Drills.

C. American Welding Society (AWS):
   1. D1.1 - Structural Welding Code - Steel.
   2. D1.6 - Structural Welding Code - Stainless Steel.

D. ASTM International (ASTM):
   1. A29 - Standard Specification for Steel Bars, Carbon and Alloy, Hot-Wrought, General Requirements for.
   2. A36 - Standard Specification for Carbon Structural Steel.
   3. A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   4. A108 - Standard Specification for Steel Bars, Carbon and Alloy, Cold Finished.
   5. A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   6. A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

7. A240 - Standard Specification for Chromium and Chromium Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
8. A380 - Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
9. A496 - Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement.
10. A563 - Standard Specification for Carbon and Alloy Steel Nuts.
11. B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
12. B695 - Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel.
13. E488 - Standard Test Methods for Strength of Anchors in Concrete Elements.
14. F436 - Standard Specification for Hardened Steel Washers.
15. F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws and Studs.
16. F594 - Standard Specification for Stainless Steel Nuts.
17. F1554 - Standard Specification for Anchor Bolts, Steel, 36, 55 and 105-ksi Yield Strength.
18. F2329 - Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners.

E. International Code Council Evaluation Service, Inc. (ICC-ES):
1. AC01 - Acceptance Criteria for Expansion Anchors in Masonry Elements.
2. AC106 - Acceptance Criteria for Predrilled Fasteners (Screw Anchors) in Masonry.
3. AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements.

1.03 DEFINITIONS

A. Built-in anchor: Headed bolt or assembly installed in position before filling surrounding masonry units with grout.

B. Cast-in anchor: Headed bolt or assembly installed in position before placing plastic concrete around.

C. Overhead installations: Fasteners installed on overhead surfaces where the longitudinal axis of the fastener is more than 60 degrees above a horizontal line so that the fastener resists sustained tension loads.

D. Passivation: Chemical treatment of stainless steel with a mild oxidant for the purpose of enhancing the spontaneous formation of the steel’s protective passive film.

E. Post-installed anchor: Fastener or assembly installed in hardened concrete or finished masonry construction, typically by drilling into the structure and inserting a steel anchor assembly.

F. Terms relating to structures or building environments as used with reference to anchors and fasteners:
    1. Corrosive locations: Describes interior and exterior locations as follows:
        a. Locations used for delivery, storage, transfer, or containment (including spill containment) of chemicals used for plant treatment processes.
        b. Exterior and interior locations at the following treatment structures:
            1) Wastewater treatment facilities: Liquids stream:
                a) Raw wastewater delivery and holding structures.
                b) Headworks and grit facilities.
                c) Primary clarifiers and primary clarifier flow splitting boxes.
                d) Chlorine contact structures.
            2) Wastewater treatment facilities: Solids stream:
                a) Sludge holding and thickening tanks.
                b) Digesters.
                c) Dewatering facilities.
    2. Wet and moist locations: Describes locations, other than “corrosive locations,” that are submerged, are immediately above liquid containment structures, or are subject to frequent wetting, splashing, or wash down. Includes:
        a. Exterior portions of buildings and structures.
        b. Liquid-containing structures:
            1) Locations at and below the maximum operating liquid surface elevation.
            2) Locations above the maximum operating liquid surface elevation and:
                a) Below the top of the walls containing the liquid.
                b) At the inside faces and underside surfaces of a structure enclosing or spanning over the liquid (including walls, roofs, slabs, beams, or walkways enclosing the open top of the structure).
        c. Liquid handling equipment:
            1) Bases of pumps and other equipment that handles liquids.
        d. Indoor locations exposed to moisture, splashing, or routine wash down during normal operations, including floors with slopes toward drains or gutters.
        e. Other locations indicated on the Drawings.
    3. Other locations:
        a. Interior dry areas where the surfaces are not exposed to moisture or humidity in excess of typical local environmental conditions.

1.04 SUBMITTALS

A. General:
    1. Submit as specified in Section 01330 - Submittal Procedures.
    2. Submit information listed for each type of anchor or fastener to be used.

B. Action submittals:
    1. Product data:
        a. Cast-in anchors:
            1) Manufacturer’s data including catalog cuts showing anchor sizes and configuration, materials, and finishes.

b. Post-installed anchors:
    1) For each anchor type, manufacturer's data including catalog cuts showing anchor sizes and construction, materials and finishes, and load ratings.
2. Samples:
    a. Samples of each type of anchor, including representative diameters and lengths, if requested by the Engineer.
3. Certificates:
    a. Cast-in anchors:
        1) Mill certificates for steel anchors that will be supplied to the site.
    b. Post-installed anchors:
        1) Manufacturer's statement or certified test reports demonstrating that anchors that will be supplied to the site comply with the materials properties specified.
4. Test reports:
    a. Post-installed anchors: For each anchor type used for the Work:
        1) Current ICC-ES Report (ESR) demonstrating:
            a) Acceptance of that anchor for use under the building code specified in Section 01410 - Regulatory Requirements.
5. Manufacturer's instructions:
    a. Requirements for storage and handling.
    b. Recommended installation procedures including details on drilling, hole size (diameter and depth), hole cleaning and preparation procedures, anchor insertion, and anchor tightening.
    c. Requirements for inspection or observation during installation.

1.05 QUALITY ASSURANCE

A. Qualifications:
    1. Post installed anchors shall be in accordance with building code specified in Section 01410 - Regulatory Requirements.

B. Special inspection:
    1. Provide special inspection of post-installed anchors as specified in Section 01455B - Special Tests and Inspections and this Section.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver post-installed anchors in manufacturer's standard packaging with labels visible and intact. Include manufacturer's installation instructions.

B. Handle and store anchors and fasteners in accordance with manufacturer's recommendations and as required to prevent damage.

C. Protect anchors from weather and moisture until installation.

1.07 PROJECT CONDITIONS

A. As specified in Section 01610 - Project Design Criteria.

B. Seismic Design Category (SDC) for structures is indicated on the Drawings.

PART 2 PRODUCTS

2.01 MANUFACTURED UNITS

A. General:
   1. Furnish threaded fasteners with flat washers and hex nuts fabricated from materials corresponding to the material used for threaded portion of the anchor.
      a. Cast-in anchors: Provide flat washers and nuts as listed in the ASTM standard for the anchor materials specified.
      b. Post-installed anchors: Provide flat washers and nuts supplied for that product by the manufacturer of each anchor.
   2. Size of anchors and fasteners, including diameter and length or minimum effective embedment depth: As indicated on the Drawings or as specified in this Section. In the event of conflicts, contact Engineer for clarification.
   3. Where anchors and connections are not specifically indicated on the Drawings or specified, their material, size and form shall be equivalent in quality and workmanship to items specified.

B. Materials:
   1. Provide and install anchors of materials as in this Section.

2.02 CAST-IN ANCHORS AND FASTENERS

A. Anchor bolts:
   1. Description:
      a. Straight steel rod having one end with an integrally forged head, and one threaded end. Embedded into concrete with the headed end cast into concrete at the effective embedment depth indicated on the Drawings or specified, and with the threaded end left to project clear of concrete face as required for the connection to be made.
      b. Furnish anchor bolts with heavy hex forged head or equivalent acceptable to Engineer.
         1) Rods or bars with angle bend for embedment in concrete (i.e., “L” or “J” shaped anchor bolts) are not permitted in the Work.
   2. Materials:
      a. Type 316 stainless steel:
         1) Bolts: ASTM F593, Group 2, Condition CW, coarse threads.
         2) Nuts: ASTM F594. Match alloy (group and UNS designation) and threads of bolts.
         3) Washers: Type 316 stainless steel.
      b. Type 304 stainless steel:
         1) Bolts: ASTM F593, Group 1, Condition CW, coarse threads.
         2) Nuts: ASTM F594. Match alloy (group and UNS designation) and threads of bolts.
         3) Washers: Type 304 stainless steel.
      c. Galvanized steel:
         1) Hot-dip galvanized coating in accordance with ASTM F2329.
         2) Bolt: ASTM F1554, Grade 36 heavy hex, coarse thread.
         3) Nuts: ASTM A563, Grade A heavy hex, threads to match bolt.
         4) Washers: ASTM F436, Type 1.

3. Materials:
    a. Stainless steel: Type 316:
        1) Rod: ASTM F593, Group 2, Condition CW, coarse threads.
        2) Nuts: ASTM F594. Match alloy (group and UNS designation) and threads of rods.
        3) Washers: Type 316 stainless steel.
        4) Plates (embedded): ASTM A240.
    b. Stainless steel: Type 304:
        1) Rod: ASTM F593, Group 1, Condition CW, coarse threads.
        2) Nuts: ASTM F594. Match alloy (group and UNS designation) and threads or rods.
        3) Washers: Type 304 stainless steel.
        4) Plates (embedded): ASTM A240.
    c. Galvanized: steel:
        1) Hot-dip galvanized with coating in accordance with ASTM F2329.
        2) Rod: ASTM F1554, Grade 36, coarse thread.
        3) Nuts: ASTM A563, Grade A, threads to match rod.
        4) Washers: ASTM F436, Type 1.
        5) Plates (embedded): ASTM A36.

B. Deformed bar anchors:
    1. Description: Steel rod with rebar-like deformations along its length and welding ferrule at one end for attachment to structural steel members (plates or shapes).
    2. Manufacturers: One of the following or equal:
        a. Nelson Stud Welding Co., D2L Deformed Bar Anchors (D2L-DBA).
        b. Stud Welding Products, Inc., Deformed Anchor Studs.
    3. Materials:
        a. Galvanized steel:
            1) Hot-dip galvanized coating in accordance with ASTM A153 where indicated on the Drawings.
            2) Steel: ASTM A496 wire deformed for concrete reinforcement.

C. Welded studs:
    1. Description: Anchor with forged head for embedment into concrete on one end, and welding ferrule for attachment to steel on the other. Welded to steel members or plates to provide anchorage for steel connections to concrete.
    2. Acceptance criteria:
        a. Welded studs in accordance with AWS D1.1, Type B.
    3. Manufacturers: One of the following or equal:
        a. Nelson Stud Welding Co., H4L Concrete Anchors or S3L Shear Connectors as indicated on the Drawings.
        b. Stud Welding Products, Headed Concrete Anchors (HCA) or Headed Shear Connectors (HSC) as indicated on the Drawings.
    4. Materials:
        a. Stainless steel: Type 316L:
        b. Stainless steel: Type 304L:
        c. Galvanized steel:
            1) Hot-dip galvanized after fabrication with coating in accordance with ASTM A123.

2) Steel: Carbon steel in accordance with ASTM A108 with 50,000 pounds per square inch minimum yield strength, and 60,000 pounds per square inch minimum tensile strength.

D. Steel plates or shapes for fabrications including assemblies with welded studs or deformed bar anchors:
   1. Stainless steel: Type 316L or Type 304L:
      a. Plates (embedded): ASTM A240.
   2. Galvanized steel:
      a. Hot dip galvanized in accordance with ASTM A123.
      b. Steel: ASTM A36.

2.03 POST-INSTALLED ANCHORS AND FASTENERS - ADHESIVE

A. Epoxy bonding of reinforcing bars, all thread rods, and threaded inserts in concrete: As specified in Section 03055 - Adhesive-Bonded Reinforcing Bars and All Thread Rods in Concrete.

B. Epoxy bonding of reinforcing bars, all thread rods, and threaded inserts in masonry: As specified in Section 04055 - Adhesive Bonding Reinforcing Bars and All Thread Rods in Masonry.

2.04 POST-INSTALLED ANCHORS AND FASTENERS - MECHANICAL

A. General:
   1. Post-installed anchors used for the Work shall hold a current ICC Evaluation Service Report demonstrating acceptance for use under the building code specified in Section 01410 - Regulatory Requirements.
      a. Conditions of use: The acceptance report shall indicate acceptance of the product for use under the following conditions:
         1) In regions of concrete where cracking has occurred or may occur.
         2) To resist short-term loads due to wind forces.
         3) To resist short-term loading due to seismic forces for the Seismic Design Category of the structure where the product will be used.
   2. Substitutions: When requesting product substitutions, submit calculations, indicating the diameter, effective embedment depth and spacing of the proposed anchors, and demonstrating that the substituted product will provide load resistance that is equal to or greater than that provided by the anchors listed in this Section.
      a. Calculations shall be prepared by and shall bear the signature and seal of a Structural Engineer licensed in the State of Utah.
      b. Decisions regarding the acceptability of proposed substitutions shall be at the discretion of the Engineer.

B. Concrete anchors:
   1. Description. Post-installed anchor assembly consisting of a threaded stud and a surrounding wedge expansion sleeve that is forced outward by torquing the center stud to transfer loads from the stud to the concrete through bearing, friction, or both. (Sometimes referred to as “expansion anchors” or “wedge anchors.”)
      a. Do not use slug-in, lead cinch, and similar systems relying on deformation of lead alloy or similar materials to develop holding power.

2. Concrete anchors for anchorage to concrete:
    a. Acceptance criteria:
        1) Concrete anchors shall have a current ICC-ES Report demonstrating that the anchors have been tested and qualified for performance in both cracked and un-cracked concrete, and for short-term loading due to wind and seismic forces for Seismic Design Categories A through F in accordance with ACI 355.2 and with ICC-ES AC193 (including all mandatory tests and optional tests for seismic tension and shear in cracked concrete).
        2) Concrete anchor performance in the current ICC-ES Report shall be "Category 1" as defined in ACI 355.2.
    b. Manufacturers: One of the following or equal:
        1) Hilti, Kwik Bolt TZ Expansion Anchor.
        2) Powers Fasteners, PowerStud+ SD2.
        3) Simpson Strong-Tie, Strong Bolt 2 Wedge Anchor.
    c. Materials. Integrally threaded stud, wedge, washer, and nut:
        1) Stainless steel: Type 316.
            a) Type 304 stainless steel acceptable for use at wet and moist locations when accepted in writing by the Engineer.
        2) Galvanized: Carbon steel, zinc plated in accordance with ASTM B633, minimum 5 microns (Fe/Zn 5).
3. Concrete anchors for anchorage to concrete masonry (fully grouted cells):
    a. Acceptance criteria: Concrete anchors shall have a current ICC-ES Report demonstrating that the anchors have been tested and qualified in accordance with ICC-ES AC01, including all mandatory tests and optional seismic tests.
    b. Manufacturers: One of the following or equal:
        1) Hilti, Kwik Bolt 3 Expansion Anchor.
        2) Powers Fasteners, Power-Stud+ SD1.
        3) Simpson Strong-Tie, Wedge-All Anchor.
    c. Materials. Integrally threaded stud, wedge, washer, and nut:
        1) Stainless steel: Type 316.
            a) Type 304 stainless steel acceptable for use at wet and moist locations when accepted in writing by the Engineer.
        2) Galvanized: Carbon steel, zinc plated in accordance with ASTM B633, minimum 5 microns (Fe/Zn 5) or mechanically galvanized in accordance with ASTM B695, Class 55, Type 1.

C. Flush shells:
1. Description: Post-installed anchor assembly consisting of an internally threaded mandrel that is forced into a pre-drilled concrete hole with a setting tool until the top of the anchor is flush with the face of the concrete. Once installed, a removable threaded bolt is installed in the mandrel.
2. Flush shell anchors are not permitted in the Work.

D. Sleeve anchors:
1. Description: Post-installed, torque-controlled anchor assembly consisting of an externally threaded stud with a spacer sleeve near the surface of the base material, and an expansion sleeve on the lower part of the stud. The expansion sleeve is forced outward by torquing of the center stud to transfer load.

a. Do not use slug-in, lead cinch, and similar systems relying on deformation of lead alloy or similar materials in order to develop holding power.

2. Sleeve anchors for anchorage to concrete:
   a. Acceptance criteria:
      1) Sleeve anchors shall have a current ICC-ES Report demonstrating that the anchors have been tested and qualified for performance in both cracked and un-cracked concrete, and for short-term loading due to wind and seismic forces for Seismic Design Categories A through F in accordance with ACI 355.2 and with ICC-ES AC193 (including all mandatory tests and optional tests for seismic tension and shear in cracked concrete).
      2) Sleeve anchor performance in the current ICC-ES Report shall be "Category 1" as defined in ACI 355.2.
   b. Manufacturers: One of the following or equal:
      1) Hilti, HSL-3 Heavy Duty Expansion (sleeve) Anchor.
      2) Powers Fasteners, Power Bolt+ Heavy Duty Sleeve Anchor.
   c. Materials:
      1) Galvanized steel: Carbon steel, zinc plated in accordance with ASTM B633, minimum 5 microns (Fe/Zn 5).
3. Sleeve anchors for anchorage to concrete masonry (fully grouted only):
   a. Acceptance criteria: Sleeve anchors shall have a current ICC-ES Report demonstrating that anchors have been tested and qualified for performance in masonry, including short-term loading due to wind and seismic forces in accordance with ICC-ES AC01.
   b. Materials:
      1) Galvanized steel: Carbon steel, zinc plated in accordance with ASTM B633, minimum 5 microns (Fe/Zn 5).

E. Screw anchors:
1. Description: Post-installed concrete anchor that develops tensile strength from mechanical interlock provided by creating a helical "key" that is larger than the diameter of the bolt itself along the length of the anchor shaft.
2. Screw anchors for anchorage to concrete:
   a. Acceptance criteria:
      1) Screw anchors shall have a current ICC-ES Report demonstrating that the anchors have been tested and qualified for performance in both cracked and un-cracked concrete, and for short-term loading due to wind and seismic forces for Seismic Design Categories A through F in accordance with ACI 355.2 and ICC ES AC193 (including all mandatory tests and optional tests for seismic tension and shear in cracked concrete).
      2) Screw anchor performance in the current ICC-ES Report shall be "Category 1" as defined in ACI 355.2.
   b. Manufacturers: Screw anchor: One of the following or equal:
      1) Hilti, Hex head, HUS-EZ Screw Anchor:
         a) With internally threaded head: HUS-EZ I Hanger Anchor.
      2) Powers Fasteners, Wedge-Bolt+:
         a) With internally threaded head: Vertigo+ Rod Hanging System.
      3) Simpson Strong-Tie, Titen® HD Screw Anchor:
         a) With internally threaded head: Titen® HD Rod Hanger.

c. Materials:
1) Galvanized steel: Carbon steel, zinc plated in accordance with ASTM B633, minimum 5 microns (Fe/Zn 5) or equal.

3. Screw anchors for anchorage to concrete masonry (fully grouted only):
a. Acceptance criteria:
1) Acceptance criteria. Screw anchors shall have a current ICC-ES Report demonstrating that anchors have been tested and qualified for performance in masonry, including short-term loading due to wind and seismic forces in accordance with ICC-ES AC106.
b. Manufacturers: One of the following or equal:
1) Hilti, HUS-EZ Screw Anchor.
2) Simpson Strong-Tie, Titen® HD Screw Anchor.
c. Materials:
1) Galvanized steel: Carbon steel. Zinc plated in accordance with ASTM B633, minimum 5 microns (Fe/Zn 5); or mechanically galvanized in accordance with ASTM B695; Class 55, Type I.

F. Undercut concrete anchors:
1. Description: Post-installed concrete anchor that develops tensile strength from mechanical interlock provided by creation of an undercut “key” at the embedded end of the anchor. The undercut may be achieved with a special drill before anchor installation, or by the anchor itself during installation.
2. Acceptance criteria:
a. Acceptance criteria:
1) Undercut concrete anchors shall have a current ICC-ES Report demonstrating that the anchors have been tested and qualified for performance in both cracked and un-cracked concrete, and for short-term loading due to wind and seismic forces for Seismic Design Categories A through F in accordance with ACI 355.2 and ICC ES AC193 (including all mandatory tests and optional tests for seismic tension and shear in cracked concrete).
2) Undercut anchor performance in the current ICC-ES Report shall be “Category 1” as defined in ACI 355.2.
b. Use pre-setting units.
3. Manufacturers: One of the following or equal:
a. Hilti, HDA (carbon steel) or HAD-R (stainless steel) Undercut Anchor.
b. Powers Fasteners, Atomic+ Undercut Anchor.
c. Simpson Strong-Tie, Torq-Cut Anchor.
d. USP Structural Connectors, DUC-L Undercut Anchors.
4. Materials:
a. Stainless steel: Corrosive, wet, and moist and locations: Type 316.
b. Galvanized: Carbon steel, zinc plated in accordance with ASTM B633, minimum 5 microns (Fe/Zn 5).

2.05 APPURTENANCES FOR ANCHORING AND FASTENING

A. Anchor bolt sleeves:
1. Having inside diameter approximately 2 inches greater than bolt diameter and minimum 10-bolt diameters long.
2. Plastic sleeves:
a. High-density polyethylene, corrugated sleeve, threaded to provide adjustment of location on the anchor bolt.

3. Fabricated steel sleeves: Construct as specified in Section 05500 - Metal Fabrications:
    a. At galvanized carbon steel anchor bolts, provide galvanized carbon steel sleeves.
    b. At stainless steel anchor bolts, provide stainless steel sleeves of same Type (304 or 316) as bolt, except that sleeves shall be constructed from low carbon stainless steel for welding (Type 304L or 316L.
4. Fabricated steel sleeves:
    a. Fabricate to the following dimensions unless otherwise indicated on the Drawings:
        1) Inside diameter: At least 2 inches greater than bolt diameter.
        2) Inside length: Not less than 10 bolt diameters.
        3) Bottom plate:
            a) Square plate with dimensions equal to the outside diameter of the sleeve plus 1/2 inch each side.
            b) Thickness equal to or greater than one-half of the anchor bolt diameter.
    b. Carbon steel anchor bolts:
        1) Fabricated from ASTM A36 plate and ASTM A53, Grade B pipe.
        2) Welded connections: Conform to requirements of AWS D1.1.
        3) Hot dip galvanized in accordance with ASTM A153.
    c. Stainless steel anchor bolts:
        1) Fabricated from ASTM A240 plate and pipe. Type 304L or Type 316L to match Type of the anchor bolt.
        2) Welded connections: In accordance with AWS D1.6.

B. Isolating sleeves and washers:
1. Manufacturers: One of the following or equal:
    a. Central Plastics Co.
    b. Corrosion Control Products PSI, Inc.
2. Sleeves: Mylar, 1/32-inch thick, 4,000 volts per mil dielectric strength, of proper size to fit bolts and extending half way into both steel washers.
3. One sleeve required for each bolt.
4. Washers: The inside diameter of all washers shall fit over the isolating sleeve, and both the steel and isolating washers shall have the same inside diameter and outside diameter.
    a. Proper size to fit bolts.
    b. Two 1/8-inch thick steel washers for each bolt.
    c. G3 Phenolic: 2 insulating washers are required for each bolt:
        1) Thickness: 1/8 inch.
        2) Base material: Glass.
        3) Resin: Phenolic.
        4) Water absorption: 2 percent.
        5) Hardness (Rockwell): 100.
        6) Dielectric strength: 450 volts per mil.
        7) Compression strength: 50,000 pounds per square inch.
        8) Tensile strength: 20,000 pounds per square inch.
        9) Maximum operating temperature: 350 degrees Fahrenheit.

C. Coating for repair of galvanized surfaces:
1. Manufacturers: One of the following or equal:
    a. Galvinox.

b. Galvo-Weld.

D. Thread coating: For use with threaded stainless steel fasteners:
1. Manufacturers: One of the following or equal:
a. Never Seez Compound Corp., Never-Seez.
b. Oil Research, Inc., WLR No. 111.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine Work in place to verify that it is satisfactory to receive the Work of this Section. If unsatisfactory conditions exist, do not begin this Work until such conditions have been corrected.

3.02 INSTALLATION: GENERAL

A. Where anchors and fasteners are not specifically indicated on the Drawings or specified, make attachments with materials specified in this Section.

B. Substitution of anchor types:
1. Post-installed anchors may not be used as an alternative to cast-in/built-in anchors at locations where the latter are indicated on the Drawings.
2. Cast-in/built-in anchors may be used as an alternative to post-installed mechanical anchors at locations where the latter are indicated on the Drawings.

C. Protect products from damage during installation. Take special care to protect threads and threaded ends.

D. Accurately locate and position anchors and fasteners:
1. Unless otherwise indicated on the Drawings, install anchors perpendicular to the surfaces from which they project.
2. Install anchors so that at least 2 threads, but not more than 1/2 inch of threaded rod, projects past the top nut.

E. Interface with other products:
1. Where steel anchors come in contact with dissimilar metals (aluminum, stainless steel, etc.), use stainless steel anchors and separate or isolate dissimilar metals using isolating sleeves and washers.
2. Prior to installing nuts, coat threads of stainless steel fasteners with thread coating to prevent galling of threads.

3.03 INSTALLATION: CAST-IN ANCHORS

A. General:
1. Accurately locate cast-in and built-in anchors.
a. Provide anchor setting templates to locate anchor bolts and anchor rods. Secure templates to formwork.
b. Brace or tie off embedments as necessary to prevent displacement during placement of plastic concrete or of surrounding masonry construction.

c. Position and tie cast-in and built-in anchors in place before beginning placement of concrete or grout. Do not “stab” anchors into plastic concrete, mortar, or grout.
d. Do not allow cast-in anchors to touch reinforcing steel. Where cast-in anchors are within 1/4 inch of reinforcing steel, isolate the metals by wrapping the anchors with a minimum of 4 wraps of 10-mil polyvinyl chloride tape in area adjacent to reinforcing steel.

2. For anchoring at machinery bases subject to vibration, use 2 nuts, with 1 serving as a locknut.
3. Where anchor bolts or anchor rods are indicated on the Drawings as being for future use, thoroughly coat exposed surfaces that project from concrete or masonry with non-oxidizing wax. Turn nuts down full length of the threads, and neatly wrap the exposed thread and nut with a minimum of 4 wraps of 10-mil waterproof polyvinyl tape.

B. Anchor bolts:
1. Minimum effective embedment: 10-bolt diameters, unless a longer embedment is indicated on the Drawings.
2. Where indicated on the Drawings, set anchor bolts in plastic, galvanized steel or stainless steel sleeves to allow for adjustment. Seal top of sleeve to prevent grout from filling sleeve.

C. Deformed bar anchors:
1. Butt weld to steel fabrications with automatic stud welding gun as recommended by manufacturer.
2. Ensure that butt weld develops the full strength of the anchor.

D. Welded studs:
1. Butt weld to steel fabrications with automatic stud welding gun as recommended by the manufacturer.
2. Ensure that butt weld develops full strength of the stud.

3.04 INSTALLATION: POST-INSTALLED ADHESIVE ANCHORS

A. Epoxy and acrylic adhesive bonding of reinforcing bars, all thread rods, and internally threaded inserts in concrete: As specified in Section 03055 - Adhesive-Bonded Reinforcing Bars and All Thread Rods in Concrete.

B. Epoxy and acrylic adhesive bonding of reinforcing bars, all thread rods, and internally threaded inserts in masonry: As specified in Section 04055 - Adhesive Bonding Reinforcing Bars and All Thread Rods in Masonry.

3.05 INSTALLATION: POST-INSTALLED MECHANICAL ANCHORS

A. General:
1. Install anchors in accordance with the manufacturer’s instructions, ACI 355.2, the anchor’s ICC-ES Report. Where conflict exists between the ICC-ES Report and the requirements in this Section, the requirements of the ICC-ES Report shall control.
2. Where anchor manufacturer recommends the use of special tools and/or specific drill bits for installation, provide and use such tools.

3. After anchors have been positioned and inserted into concrete or masonry, do not:
    a. Remove and reuse/reinstall anchors.
    b. Loosen or remove bolts or studs.

B. Holes drilled into concrete and masonry:
1. Do not drill holes in concrete or masonry until the material has achieved its minimum specified compression strength (f'c or f'm).
2. Accurately locate holes:
    a. Before drilling holes, use a reinforcing bar locator to identify the position of all reinforcing steel, conduit, and other embedded items within a 6-inch radius of each proposed hole.
    b. If the hole depth exceeds the range of detection for the rebar locator, the Engineer may require radiographs of the area designated for investigation before drilling commences.
3. Exercise care to avoid damaging existing reinforcement and other items embedded in concrete and masonry.
    a. If embedments are encountered during drilling, immediately stop work and notify the Engineer. Await Engineer's instructions before proceeding.
4. Unless otherwise indicated on the Drawings, drill holes perpendicular to the concrete surface into which they are placed.
5. Drill using anchor manufacturer's recommended equipment and procedures:
    a. Unless otherwise recommended by the manufacturer, drill in accordance with the following:
        1) Drilling equipment: Electric or pneumatic rotary type with light or medium impact. Where edge distances are less than 2 inches, use lighter impact equipment to prevent micro-cracking and concrete spalling during drilling process.
        2) Drill bits: Carbide-tipped in accordance with ANSI B212-15. Hollow drills with flushing air systems are preferred.
6. Drill holes at manufacturer's recommended diameter and to depth required to provide the effective embedment indicated.
7. Clean and prepare holes as recommended by the manufacturer and as required by the ICC-ES Report for that anchor.
    a. Unless otherwise recommended by anchor manufacturer, remove dust and debris using brushes and clean compressed air.
    b. Repeat cleaning process as required by the manufacturer's installation instructions.
    c. When cleaning holes for stainless steel anchors, use only stainless steel or non-metallic brushes.

C. Insert and tighten (or torque) anchors in full compliance with the manufacturer's installation instructions.
1. Once anchor is tightened (torque), do not attempt to loosen or remove its bolt or stud.

D. Concrete anchors: Minimum effective embedment lengths unless otherwise indicated on the Drawings:

Concrete Anchors			
Nominal Diameter	**Minimum Effective Embedment Length**		**Minimum Member Thickness**
	In Concrete	**In Grouted Masonry**	
3/8 inch	2 1/2 inch	2 5/8 inch	8 inch
1/2 inch	3 1/2 inch	3 1/2 inch	8 inch
5/8 inch	4 1/2 inch	4 1/2 inch	10 inch
3/4 inch	5 inch	5 1/4 inch	12 inch

E. Flush shell anchors:
1. Flush shell anchors are not permitted in the Work.
2. If equipment manufacturer's installation instructions recommend the use of flush shell anchors, contact Engineer for instructions before proceeding.

F. Sleeve anchors:
1. Minimum effective embedment lengths unless otherwise indicated on the Drawings:

Sleeve Anchors			
	Minimum Effective Embedment Length		**Minimum Member Thickness**
Nominal Diameter	**In Concrete**	**In Grouted Masonry**	
M8 (1/2 inch)	70 mm (2 3/4 inch)	Not accepted	100 mm (8 inch)
M10 (5/8 inch)	76 mm (3 inch)	Not accepted	250 mm (10 inch)
M12 (3/4 inch)	80 mm (3 1/4 inch)	Not accepted	300 mm (12 inch)

2. Install with the sleeve fully engaged in the base material.

G. Screw anchors:
1. Minimum effective embedment lengths unless otherwise indicated on the Drawings:

Screw Anchors			
	Minimum Effective Embedment Length		**Minimum Member Thickness**
Nominal Diameter	**In Concrete**	**In Grouted Masonry**	
3/8 inch	2 1/2 inch	3 1/4 inch	8 inch
1/2 inch	3 1/4 inch	4 1/2 inch	8 inch
5/8 inch	4 inch	5 inch	10 inch
3/4 inch	5 1/2 inch	6 1/4 inch	12 inch

2. Install screw anchors using equipment and methods recommended by the manufacturer. Continue driving into hole until the washer head is flush against the item being fastened.

H. Undercut concrete anchors:
1. Minimum effective embedment lengths unless otherwise indicated on the Drawings:

Undercut Anchors			
Nominal Diameter (bolt)	**Minimum Effective Embedment Length**		**Minimum Member Thickness(1)**
	In Concrete	**In Grouted Masonry**	
M10 (3/8 inch)	100 mm (4 inch)	Not accepted	200 mm (8 inch)
M12 (1/2 inch)	125 mm (5 inch)	Not accepted	350 mm (14 inch)
M16 (5/8 inch)	190 mm (7 1/2 inch)	Not accepted	460 mm (18 inch)
M20 (7/8 inch)	250 mm (10 inch)	Not accepted	510 mm (20 inch)
Notes: (1) Thickness indicated is for pre-set units. If through-set units are accepted, obtain minimum member thickness requirements from the Engineer.			

2. Installations of undercut anchors shall not be allowed where edge distances are less than 12 times the nominal diameter of the anchor stud.
3. Undercut bottom of hole using cutting tools manufactured for this purpose by the manufacturer of the undercut anchors being placed.

3.06 FIELD QUALITY CONTROL

A. Contractor shall provide quality control over the Work of this Section as specified in Section 01450 - Quality Control.
1. Expenses associated with work described by the following paragraphs shall be paid by the Contractor.

B. Cast-in and built-in anchors:
1. Verify position and orientation of anchors prior to casting in.

C. Post-installed anchors:
1. Review anchor manufacturer's installation instructions and requirements of the Evaluation Service Report (hereafter referred to as "installation documents") for each anchor type and material.
2. Observe hole-drilling and cleaning operations for conformance with the installation documents.
3. Certify in writing to the Engineer that the depth and location of anchor holes, and the torque applied for setting the anchors conforms to the requirements of the installation documents.

3.07 FIELD QUALITY ASSURANCE

A. Owner or Owner's Representative will provide on-site observation and field quality assurance for the Work of this Section.

1. Expenses associated with work described by the following paragraphs shall be paid by the Owner.

B. Field inspections and special inspections:
   1. Required inspections: Observe construction for conformance to the approved Contract Documents, the accepted submittals, and manufacturer's installation instructions for the products used.
   2. Record of inspections:
      a. Maintain record of each inspection.
      b. Submit copies to Engineer upon request.
   3. Statement of special inspections: At the end of the project, prepare and submit to the Engineer and the authority having jurisdiction inspector's statement that the Work was constructed in general conformance with the approved Contract Documents, and that deficiencies observed during construction were resolved.

C. Special inspections: Anchors cast into concrete and built into masonry.
   1. Provide special inspection during positioning of anchors and placement of concrete or masonry (including mortar and grout) around the following anchors:
      a. Anchor bolts.
      b. Deformed bar anchors.
      c. Welded studs.
   2. During placement, provide continuous special inspection at each anchor location to verify that the following elements of the installation conform to the requirements of the Contract Documents.
      a. Anchor:
         1) Type and dimensions.
         2) Material: Galvanized steel, Type 304 stainless steel, or Type 316 stainless steel as specified in this Section or indicated on the Drawings.
         3) Positioning: Spacing, edge distances, effective embedment, and projection beyond the surface of the construction.
         4) Reinforcement at anchor: Presence, positioning, and size of additional reinforcement at anchors indicated on the Drawings.
   3. Following hardening and curing of the concrete or masonry surrounding the anchors, provide periodic special inspection to observe and confirm the following:
      a. Base material (concrete or grouted masonry):
         1) Solid and dense concrete or grouted masonry material within required distances surrounding anchor.
         2) Material encapsulating embedment is dense and well-consolidated.

D. Special Inspections: Post-installed mechanical anchors placed in hardened concrete and in grouted masonry.
   1. Provide special inspection during installation of the following anchors:
      a. Concrete anchors.
      b. Sleeve anchors.
      c. Screw anchors.
      d. Undercut concrete anchors.
   2. Unless otherwise noted, provide periodic special inspection during positioning, drilling, placing, and torquing of anchors.

a. Provide continuous special inspection for post-installed anchors in "overhead installations" as defined in this Section.

3. Requirements for periodic special inspection:
   a. Verify items listed in the following paragraphs for conformance to the requirements of the Contract Documents and the Evaluation Report for the anchor being used. Observe the initial installation of each type and size of anchor, and subsequent installation of the same anchor at intervals of not more than 4 hours.
      1) Any change in the anchors used, in the personnel performing the installation, or in procedures used to install a given type of anchor shall require a new "initial inspection."
   b. Substrate: Concrete or masonry surfaces receiving the anchor are sound and of a condition that will develop the anchor's rated strength.
   c. Anchor:
      1) Manufacturer, type, and dimensions (diameter and length).
      2) Material (galvanized, Type 304 stainless steel, or Type 316 stainless steel).
   d. Hole:
      1) Positioning: Spacing and edge distances.
      2) Drill bit type and diameter.
      3) Diameter, and depth.
      4) Hole cleaned in accordance with manufacturer's required procedures. Confirm multiple repetitions of cleaning when recommended by the manufacturer.
      5) Anchor's minimum effective embedment.
      6) Anchor tightening/installation torque.
4. Requirements for continuous special inspection:
   a. The special inspector shall observe all aspects of anchor installation, except that holes may be drilled in his/her absence provided that he/she confirms the use of acceptable drill bits before drilling, and later confirms the diameter, depth, and cleaning of drilled holes.

E. Field tests:
1. Owner or Owner's Representative may, at any time, request testing to confirm that materials being delivered and installed conform to the requirements of the Specifications.
   a. If such additional testing shows that the materials do not conform to the specified requirements, the Contractor shall pay the costs of these tests.
   b. If such additional testing shows that the materials do conform to the specified requirements, the Owner shall pay the costs of these tests.

3.08 SCHEDULES

A. Stainless steel. Provide and install stainless steel anchors at the following locations:
1. "Corrosive locations" as defined in this Section: Type 316 stainless steel
2. "Wet and moist locations" as defined in this Section: Type 316 stainless steel.
3. "Other locations:"
   a. For connecting stainless steel members to concrete or masonry: Type 304 stainless steel.
   b. For connecting aluminum members to concrete or masonry.
   c. For connecting fiber-reinforced plastic (FRP) members to concrete or masonry.

4. At locations indicated on the Drawings.

B. Galvanized: Provide and install galvanized carbon steel anchors at the following locations:
   1. Locations not requiring stainless steel.
   2. At locations indicated on the Drawings.

END OF SECTION

SECTION 05500

METAL FABRICATIONS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Aluminum grating stair tread.
   2. Aluminum stair nosing.
   3. Cast iron stop plank grooves.
   4. Concrete inserts.
   5. Handrails and guardrails.
   6. Ladders.
   7. Manhole frames and covers.
   8. Manhole steps.
   9. Metal gratings.
   10. Metal tread plate.
   11. Preformed channel pipe supports.
   12. Stairs.
   13. Miscellaneous metals.
   14. Associated accessories to the above items.

1.02 REFERENCES

A. Aluminum Association (AA):
   1. DAF-45: Designations from Start to Finish.
      a. M12-C22-A41.

B. American Association of State Highway and Transportation Officials (AASHTO):
   1. Standard Specifications for Highway Bridges.

C. ASTM International (ASTM):
   1. A36 - Standard Specification for Carbon Structural Steel.
   2. A48 - Standard Specification for Gray Iron Castings.
   3. A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded, and Seamless.
   4. A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   5. A240 - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels for General Applications.
   6. A276 - Standard Specification for Stainless Steel Bars and Shapes.
   7. A307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
   8. A325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
   9. A380 - Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
   10. A489 - Standard Specification for Carbon Steel Lifting Eyes.

11. A490 - Standard Specification for Structural Bolts, Alloy Steel, Heat-Treated, 150 ksi Minimum Tensile Strength.
12. A500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
13. A501 - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
14. A635 - Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Alloy, Carbon, Structural, High-Strength Low-Alloy, and High-Strength Low-Alloy with Improved Formability, General Requirements for.
15. A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
16. A992 - Standard Specification for Structural Steel Shapes.
17. B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
18. B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
19. B308 - Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.
20. B429 - Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
21. F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws and Studs.

D. American Welding Society (AWS):
   1. A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination.

E. National Association of Architectural Metal Manufacturers (NAAMM):
   1. Metal Finishes Manual.

F. Occupational Safety and Health Administration (OSHA).

1.03 DEFINITIONS

A. Passivation: Removal of exogenous iron or iron compounds from the surface of a stainless steel by means of chemical dissolution resulting from treatment with an acid solution that removes the surface contamination but does not significantly affect the stainless steel itself.

1.04 SUBMITTALS

A. Product Data:
   1. Aluminum grating stair tread.
   2. Aluminum stair nosing.
   3. Cast iron stop plank grooves.
   4. Handrails and guardrails.
   5. Manhole frames and covers.
   6. Manhole steps.
   7. Metal grating.

B. Shop drawings:
   1. Handrails and guardrails:
      a. Including details on connection attachments, gates, kick plates, ladders, and angles.
      b. Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories.
      c. Include erection drawings, elevations, and details where applicable.
      d. Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths.
   2. Ladders.
   3. Metal grating.
   4. Metal tread plate.
   5. Stairs.
   6. Miscellaneous metals.

C. Samples:
   1. Guardrails with specified finishes.

D. Quality control submittals:
   1. Design data.
   2. Test reports:
      a. Guardrails: 3 copies of certified tests performed by an independent testing laboratory certifying that guardrails meet current State and OSHA strength requirements.
      b. Gratings:
         1) Grating manufacturers' calculations showing that gratings will meet specified design load, stress, and deflection requirements for each size grating for each span.
         2) Reports of tests performed.

PART 2 PRODUCTS

2.01 MATERIALS

A. General: Unless otherwise specified or indicated on the Drawings, structural and miscellaneous metals in accordance with the standards of the ASTM, including the following:

Item	ASTM Standard No.	Class, Grade Type or Alloy No.
Cast Iron		
Cast Iron	A48	Class 40B
Steel		
Galvanized sheet iron or steel	A653	Coating G90
Coil (plate)	A635	--

Item	ASTM Standard No.	Class, Grade Type or Alloy No.
Structural plate, bars, rolled shapes, and miscellaneous items (except W shapes).	A36	--
Rolled W shapes	A992	Grade 50
Standard bolts, nuts, and washers	A307	--
High strength bolts, nuts, and hardened flat washers	A325 A490	--
Eyebolts	A489	Type 1
Tubing, cold-formed	A500	--
Tubing, hot-formed	A501	--
Steel pipe	A53	Grade B
Stainless Steel		
Plate, sheet, and strip	A240	Type 304* or 316**
Bars and shapes	A276	Type 304* or 316**
Bolts (Type 304)	F593	Group 1 Condition CW
Bolts (Type 316)	F593	Group 2 Condition CW
Aluminum		
Flashing sheet aluminum	B209	Alloy 5005-H14, 0.032 inches minimum thickness
Structural sheet aluminum-	B209	Alloy 6061-T6
Structural aluminum	B209 B308	Alloy 6061-T6
Extruded aluminum	B221	Alloy 6063-T42
* Use Type 304L if material will be welded. ** Use Type 316L if material will be welded.		

1. Stainless steels are designated by type or series defined by ASTM.

2. Where stainless steel is welded, use low-carbon stainless steel.

2.02 MANUFACTURED UNITS

A. Aluminum grating stair tread:
   1. Manufacturers: One of the following or equal:
      a. IKG Borden Ind., Aluminum Grating Stair Tread with Mebac® nosing.
      b. McNichols Co., Type A-Standard with Corrugated Angle Nosing.
   2. Material: Welded aluminum grating tread with non-slip nosing and integral end plates for bolt on attachment to stair stringers.
   3. Size:
      a. Tread width: To equal tread spacing plus 1 inch minimum.
      b. Tread length: Length to suit stringer-to-stringer dimension on the Drawings.
      c. Depth: 1-3/4 inches.
   4. Bolts: Type 316 stainless steel.

B. Aluminum stair nosing:
   1. Manufacturers: One of the following or equal:
      a. Wooster Products, Inc., Type 101 Nosing.
      b. American Safety Tread Co., Inc., Style 801 Nosing.
   2. Material: Cast aluminum abrasive nosings with aluminum oxide granules integrally cast into metal, forming permanent, nonslip, long-wearing surface.
   3. For installation in cast-in-place stairs.
   4. Configuration: 4 inches wide, fabricated with integrally cast stainless steel anchors at approximately 12-inch centers. Length to extend within 3 inches of stair edge on each side.

C. Cast iron stop plank grooves:
   1. Manufacturers: One of the following or equal:
      a. Neenah Foundry Co., R-7500 Series, Type A.
      b. McKinley Iron Works, Type L.
   2. Size: 2-inch wide groove opening by 1-1/2 inch deep, unless otherwise indicated on the Drawings.
   3. Recess groove with the cast iron surface of the groove set flush with the concrete surface.

D. Concrete inserts:
   1. Concrete inserts for supporting pipe and other applications are specified in Section 15061 - Pipe Supports.

E. Handrails and guardrails:
   1. General:
      a. Design and fabricate assemblies to conform to current local, State, and OSHA standards and requirements.
      b. Coordinate layout of assemblies and post spacings to avoid conflicts with equipment and equipment operators:
         1) Indicate on the shop drawings locations of such equipment.
         2) Highlight locations where railings cannot be made continuous, and obtain Engineer’s directions on how to proceed before fabricating or installing railings.

2. Aluminum handrails and guardrails (nonwelded pipe):
    a. Rails, posts, and fitting-assembly spacers:
        1) In accordance with ASTM B429, 6005, 6063 or 6105, minimum Schedule 40, extruded aluminum pipe of minimum 1.89-inch outside diameter and 0.14-inch wall thickness.
    b. Kick plates: 6061 or 6105 aluminum alloy.
    c. Fastenings and fasteners: As recommended or furnished by the manufacturer.
    d. Other parts: 6063 extruded aluminum, or F214 or F514.0 aluminum castings:
        1) Fabrications: In accordance with ASTM B209 or ASTM B221 extruded bars:
            a) Bases: 6061 or 6063 extruded aluminum alloy.
        2) Plug screws or blind rivets: Type 305 stainless steel.
            a) Other parts: Type 300 series stainless steel.
    e. Finish of aluminum components:
        1) Anodized finish, 0.7 mil thick, applied to exposed surfaces after cutting. Aluminum Association Specification M12-C22-A41, mechanical finish non specular as fabricated, chemical finish-medium matte, anodic coating-clear Class I Architectural.
        2) Pretreat aluminum for cleaning and removing markings before anodizing.
    f. Fabrication and assembly:
        1) Fabricate posts in single, unspliced pipe length.
        2) Perform without welding.
        3) Do not epoxy bond the parts.
        4) Maximum clear opening between assembled railing components as indicated on the Drawings.
    g. Manufacturers: One of the following or equal:
        1) Moultrie Manufacturing Co., Wesrail.
        2) Golden Railings, Riveted System.
        3) Craneveyor Corp. Enerco Metals, C-V Rail.
3. Steel pipe handrails and guardrails:
    a. Schedule 40 black steel pipe with minimum 1.9-inch outside diameter, or larger where indicated on the Drawings.
    b. Fabricate posts in single, unspliced pipe length.
    c. Kick plates: Galvanized steel.
    d. Attachment devices: Provide clip angles and other fasteners necessary for securing handrails and guardrails to other construction as indicated on the Drawings.
    e. Continuously weld joints and grind smooth.
    f. Bend rails to profile indicated on the Drawings, without sharp bends or flat spots. Rails shall be round after bending.
    g. Neatly weld intersection of rails and posts, and grind surfaces smooth.
4. Guardrail gates:
    a. Supplied by guardrail manufacturer:
        1) Of same material, quality, and workmanship as specified for guardrail system in which they will be installed.
        2) Of design similar to that of handrail or railing system in which they will be installed.

b. Components: Gate frame, stainless steel self-closing device, hinges, gate stops, and durable self-locking type latch. Fabricate components in conformance with OSHA minimum strength requirements.

5. Fastenings and fasteners: As recommended or furnished by guardrail manufacturer for use with this system.

F. Ladders:
1. General:
a. Type: Safety type conforming to local, State, and OSHA standards as minimum. Furnish guards for ladder wells.
b. Size: 18 inches wide between side rails of length, size, shape, detail, and location indicated on the Drawings.
2. Aluminum ladders:
a. Materials: 6063-T5 aluminum alloy.
b. Rungs:
1) 1-inch minimum solid square bar with 1/8-inch grooves in top and deeply serrated on all sides.
2) Capable of withstanding 1,000 pound load without failure.
c. Side rails: Minimum 4-inch by 1/2-inch flat bars.
d. Finish of aluminum components:
1) Anodized finish, 0.7 mil thick, applied to exposed surfaces after cutting. Aluminum Association Specification M12-C22-A41, mechanical finish non specular as fabricated, chemical finish-medium matte, anodic coating-clear Class I Architectural.
2) Pretreat aluminum for cleaning and removing markings before anodizing.
e. Fabrication:
1) Welded construction, of size, shape, location, and details indicated on the Drawings.
2) For ladders over 20 feet high, furnish standard ladder cages or fall prevention system designed in accordance with State and OSHA requirements.
f. Fall prevention system: Include but not limit to railing, brackets, clamps, 2 sleeves, and 2 belts, satisfying OSHA safe climbing requirements:
1) Manufacturers: One of the following or equal:
a) North Consumer Products, Saf-T-Climb.
b) Swager Communications, Climbers Buddy System.

G. Manhole frames and covers:
1. Material: Gray iron castings, in accordance with ASTM A48, Class 30-B.
2. Type: Heavy-duty traffic type, with combined minimum set weight of 265 pounds.
3. Machine horizontal and vertical bearing surfaces to fit neatly, with easily removable cover bearing firmly in frame without rocking.
4. Frame:
a. Bottom flange type.
b. Approximately 4-1/2 inches frame height.
c. Dimensions as indicated on the Drawings.
1) Minimum inside clear dimension may not be smaller than nominal diameter minus 2 inches.

5. Cover:
    a. Skid-resistant grid pattern design stamped with name of utility service provided by manhole, such as "ELECTRICAL," "SEWER," "TELEPHONE," or "WATER."
    b. Solid type without ventilation holes.
6. Finish: Unpainted.

H. Manhole steps:
1. Type 316 stainless steel, of size, shape, and spacing indicated on the Drawings.

I. Metal gratings:
1. General:
    a. Fabricate grating to cover areas indicated on the Drawings.
    b. Unless otherwise indicated on the Drawings, grating over an opening shall cover entire opening.
    c. Make cutouts in grating where required for equipment access or protrusion, including valve operators or stems, and gate frames.
    d. Band ends of grating and edges of cutouts in grating:
        1) End banding: 1/4 inch less than height of grating, with top of grating and top edge of banding flush.
        2) Cutout banding: Full-height of grating.
        3) Use banding of same material as grating.
        4) Panel layout: Enable installation and subsequent removal of grating around protrusions or piping.
        5) Openings 6 inches and larger: Lay out grating panels with edges of 2 adjacent panels located on centerline of opening.
        6) Openings smaller than 6 inches: Locate opening at edge of single panel.
        7) Where an area requires more than 1 grating section to cover area, clamp adjacent grating sections together at 1/4-points with fasteners acceptable to Engineer.
        8) Fabricate steel grating sections in units weighing not more than 75 pounds each.
        9) Fabricate aluminum grating sections in units of weighing not more than 50 pounds each.
        10) Gaps between adjacent grating sections shall not be more than the clear spacing between bearing bars.
    e. When requested by Engineer, test 1 section of each size grating for each span length involved on the job under full load:
        1) Furnish a suitable dial gauge for measuring deflections.
    f. Grating shall be aluminum, unless otherwise specified or indicated on the Drawings.
2. Aluminum grating:
    a. Material for gratings, shelf angles, and rebates: 6061-T6 or 6063-T6 aluminum alloy, except crossbars may be 6063-T5 aluminum alloy.
    b. Shelf angle concrete anchors: Type 304 or Type 316 stainless steel.
    c. Grating rebate rod anchors: 6061-T6 or 6063-T6 aluminum alloy.
    d. Bar size and spacing: As determined by manufacturer to enable grating to support design load.

e. Design live load: A minimum of 100 pounds per square foot uniform live load on entire grating area, but not less than the live load indicated on the Drawings for the area where grating is located.
f. Maximum fiber stress for design load: 12,000 pounds per square inch.
g. Maximum deflection due to design load: 1/240 of grating clear span.
h. Maximum spacing of main grating bars: 1-1/8 inches clear between bars.
i. Minimum grating height: 1-1/2 inches.
j. Manufacturers: One of the following or equal:
1) IKG Borden Ind., Grooved aluminum I-bar.
2) Brodhead Steel Products, Inc., Grooved aluminum I-bar.

3. Steel gratings:
a. Hot-dip galvanized in accordance with ASTM A123.
b. Bar size and spacing: As determined by the manufacturer to support design load.
c. Design live load: A minimum of 100 pounds per square foot uniform live load on the entire area of the grating area, but not less than the live load indicated on the Drawings for the area where the grating is located.
d. Maximum fiber stress for design load: 18,000 pounds per square inch.
e. Maximum deflection under design load: 1/240 of grating clear span.
f. Bar spacing: Maximum of 1-1/8 inches clear between bars.
g. Manufacturers: One of the following or equal:
1) IKG Borden Ind., IKG Weldforged.
2) Brodhead Steel Products, Inc., Type 19 W 4.

4. Heavy-duty steel grating:
a. Heavy-duty type, fabricated from structural steel and designed in accordance with AASHTO Standard Specifications for Highway Bridges, using H-20 loading.
b. Hot-dip galvanized after fabrication in accordance with ASTM A123.
c. Manufacturers: One of the following or equal:
1) Reliance Steel Products Co., Heavy-Duty Steel Grating.
2) Seidelhuber Metal Products, Inc., equivalent product.

J. Metal tread plate:
1. Plate having a raised figured pattern on 1 surface to provide improved traction.

K. Preformed channel pipe supports:
1. Preformed channel pipe supports for pipe supports and other applications are specified in Section 15062 - Preformed Channel Pipe Support System.

L. Stairs:
1. Aluminum stairs:
a. Stringers: 6061-T6 aluminum alloy.
b. Stair treads:
1) Aluminum of same type specified under Aluminum Grating.
2) Of sizes indicated on the Drawings, and 1-3/4 inch minimum depth with cast abrasive type safety nosings.
c. Handrails and guardrails: Aluminum pipe specified under Aluminum Handrails and Guardrails (Nonwelded Pipe).
d. Fasteners: Type 304 or Type 316 stainless steel.

M. Miscellaneous aluminum:
    1. Fabricate aluminum products, not covered separately in this Section, in accordance with the best practices of the trade and field assemble by riveting or bolting.
    2. Do not weld or flame cut.

N. Miscellaneous cast iron:
    1. General:
        a. Tough, gray iron, free from cracks, holes, swells, and cold shuts.
        b. Quality such that hammer blow will produce indentation on rectangular edge of casting without flaking metal.
        c. Before leaving the foundry, clean castings and apply 16-mil dry film thickness coating of coal-tar epoxy, unless otherwise specified or indicated on the Drawings.

O. Miscellaneous stainless steel:
    1. Provide miscellaneous stainless steel items not specified in this Section as indicated on the Drawings or specified elsewhere.
        a. Fabricate and install in accordance with the best practices of the trade.
    2. Cleaning and passivation:
        a. Following shop fabrication of stainless steel members, clean and passivate fabrications.
        b. Finish requirements: Remove free iron, heat tint oxides, weld scale and other impurities, and obtain a passive finished surface.
        c. Provide quality control testing to verify effectiveness of cleaning agents and procedures and to confirm that finished surfaces are clean and passivated.
            1) Conduct sample runs using test specimens with proposed cleaning agents and procedures as required to avoid adverse effects on surface finishes and base materials.
        d. Pre-clean, chemically descale (pickle), and final clean fabrications in accordance with the requirements of ASTM A380 to remove deposited contaminants before shipping.
            1) Passivation by citric acid treatment is not allowed.
                a) If degreasing is required before cleaning to remove scale or iron oxide, cleaning (pickling) treatments with citric acid are permissible; however, these treatments shall be followed by inorganic cleaners such as nitric-hydrofluoric acid.
            2) Provide acid descaling (pickling) in accordance with Table A1.1 of Annex A1 of ASTM A380.
            3) After pickling, final cleaning of stainless steel shall conform to Part II of Table A2.1 of Annex A2 of ASTM A380.
        e. After cleaning, inspect using methods specified for “gross inspection” in ASTM A380.
        f. Improperly or poorly cleaned and passivated materials shall not be shipped and will not be accepted at the job site.

P. Miscellaneous structural steel:
    1. Provide miscellaneous steel items not specified in this Section as indicated on the Drawings or specified elsewhere.
        a. Fabricate and install in accordance with the best practices of the trade.

Q. Isolating sleeves and washers:
   1. As indicated on the Drawings and as specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of conditions:
   1. Examine work in place to verify that it is satisfactory to receive the work of this Section.
   2. If unsatisfactory conditions exist, do not begin this work until such conditions have been corrected.

3.02 INSTALLATION

A. General:
   1. Install products as indicated on the Drawings, and in accordance with shop drawings and manufacturer's printed instructions, as applicable except where specified otherwise.
   2. Interface between materials:
      a. Dissimilar metals: Where steel comes in contact with dissimilar metals (aluminum, stainless steel, etc.), separate or isolate the dissimilar metals.
         1) Make application so that the isolating or protective barrier is not visible in the completed construction.
         2) Isolating sleeves and washers: As specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.
      b. Aluminum in contact with concrete or masonry: Coat aluminum surfaces as specified in Section 09960 - High Performance Coatings.
      c. Aluminum in contact with concrete or masonry.

B. Aluminum stair nosing:
   1. Install stair nosings on treads of concrete stairs, including top tread on upper concrete slab.
   2. Omit stair nosings where concrete is submerged.
   3. Cast stair nosings in fresh concrete, flush with tread and riser faces. Install nosing in center of step approximately 3 inches from each stair edge.

C. Cast iron stop plank grooves:
   1. Recess stop plank grooves with cast iron surfaces of groove set flush with concrete surface.

D. Handrails and guardrails:
   1. General:
      a. Fasten pipe rails to fittings with Series 300 stainless steel pop rivets or flush set screws.
      b. Make pipe cuts clean and straight, free of burrs and nicks, and square and accurate for minimum joint-gap.
      c. Drill and countersink holes to proper size, as required for a tight flush fit of screws and other component parts.
      d. Space attachment brackets as indicated in the manufacturer's instructions.

2. Aluminum pipe handrails and guardrails:
    a. During construction, keep exterior surfaces of handrails and guardrails covered with minimum 0.4 millimeters of heat shrink polyethylene film.
    b. Do not remove protective film before handrails and guardrails have been accepted by Engineer nor before other work in proximity of handrails and guardrails has been completed.
    c. Discontinue handrails and guardrails at lighting fixtures.
    d. Provide 1/8-inch diameter weep hole at base of each post.
    e. Space posts as indicated on the Drawings.
    f. Anchor posts into concrete by grouting posts into formed holes in concrete, into stainless steel sleeves cast in concrete; or bracket mount to face of concrete surfaces as specified and indicated on the Drawings.
    g. Space rails as indicated on the Drawings.
    h. Make adequate provision for expansion and contraction of kick plates and rails.
        1) Make provisions for removable sections where indicated on the Drawings.
    i. Make lower rails a single, unspliced length between posts, or continuous.
    j. Make top rails continuous whenever possible, and attach single, unspliced lengths to 3 posts minimum.
    k. Draw up fasteners tight with hand wrench or screw driver.
    l. Space attachment brackets as indicated on shop drawings or in manufacturer's installation instructions.
    m. Completed installation shall have handrails and railings rigid and free of play at joints and attachments.
    n. Protect handrail and guardrail finish from scratches, gouges, dents, stains, and other damage.
    o. Replace damaged or disfigured handrails and guardrails with new.
    p. Shortly before final acceptance of the work, and after removal of protective polyethylene film, clean handrails and guardrails with mild detergent or with soap and water.
        1) After cleaning, thoroughly rinse handrails and guardrails and wipe with soft cloth.
    q. Erect guardrail straight, level, plumb, and true to the positions as indicated on the Drawings. Correct deviations from true line of grade, which are visible to the eye.
3. Stainless steel pipe handrails and guardrails:
    a. During construction, keep exterior surfaces of handrails and guardrails covered with minimum 0.4 millimeters of heat shrink polyethylene film.
    b. Do not remove protective film before handrails and guardrails have been accepted by Engineer nor before other work in proximity of handrails and guardrails has been completed.
    c. Discontinue handrails and guardrails at lighting fixtures.
    d. Provide 1/8-inch diameter weep hole at base of each post.
    e. Space posts as indicated on the Drawings.
    f. Anchor posts into concrete by grouting posts into formed holes in concrete, into stainless steel sleeves cast in concrete; or bracket mount to face of concrete surfaces as specified and indicated on the Drawings.
    g. Space rails as indicated on the Drawings.
    h. Make adequate provision for expansion and contraction of kick plates and rails.

1) Make provisions for removable sections where indicated on the Drawings.

i. Make lower rails a single, unspliced length between posts, or continuous.

j. Make top rails continuous whenever possible, and attach single, unspliced lengths to 3 posts minimum.

k. Draw up fasteners tight with hand wrench or screw driver.

l. Space attachment brackets as indicated on shop drawings or in manufacturer's installation instructions.

m. Completed installation shall have handrails and railings rigid and free of play at joints and attachments.

n. Protect handrail and guardrail finish from scratches, gouges, dents, stains, and other damage.

o. Replace damaged or disfigured handrails and guardrails with new.

p. Shortly before final acceptance of the work, and after removal of protective polyethylene film, clean handrails and guardrails with mild detergent or with soap and water.

1) After cleaning, thoroughly rinse handrails and guardrails and wipe with soft cloth.

q. Erect guardrail straight, level, plumb, and true to the positions as indicated on the Drawings.

1) Correct deviations from true line of grade that are visible to the eye.

4. Steel pipe handrail and guardrail:

a. Anchor posts into concrete by grouting posts into galvanized steel sleeves embedded in concrete as indicated on the Drawings.

1) Do not cut reinforcing bars in concrete.

2) Where required to fasten guardrail to other construction, fasten as indicated on the Drawings.

5. Guardrail gates:

a. Install gate to be a vertical plane with the guardrail when in the closed position.

b. Install hinges so that each gate can swing 180 degrees from the closed position to the fully open position.

c. Install so that the gates swing to the walkway side of the guardrail only.

1) Install gate stops on the stationary railing posts to prohibit gates from swinging in the wrong direction.

d. Install gate frames, hinges, stops, and latches in conformance with OSHA minimum strength requirements.

E. Ladders:

1. Secure to supporting surface with bent plate clips providing minimum 8 inches between supporting surface and center of rungs.

2. Where exit from ladder is forward over top rung, extend side rails 3 feet 3 inches minimum above landing, and return the rails with a radius bend to the landing.

3. Where exit from ladder is to side, extend ladder 5 feet 6 inches minimum above landing and rigidly secure at top.

4. Erect rail straight, level, plumb, and true to position indicated on the Drawings:

a. Correct deviations from true line or grade which are visible to the eye.

F. Manhole frames and covers:

1. Installation: As specified in Section 02084 - Precast Drainage Structures.

G. Manhole steps:
   1. Space as indicated on the Drawings.

H. Metal gratings:
   1. General:
      a. Allow 1/8-inch maximum clearance between ends of grating and inside face of vertical leg of shelf angles.
      b. Horizontal bearing leg of shelf angles shall be 2 inches minimum.
      c. Install aluminum plate or angles where necessary to fill openings at changes in elevation and at openings between equipment and grating.
      d. Install angle stops at ends of grating.
      e. Installed grating shall not slide out of rebate or off support.
      f. Weld stops in place, unless otherwise specified or indicated on the Drawings.
      g. Top surfaces of grating sections adjacent to each other shall lie in same plane.
   2. Aluminum grating:
      a. Aluminum grating: Support on aluminum shelf angles or rebates.
   3. Steel grating:
      a. Support on hot-dip galvanized structural steel shelf angles or rebates.
   4. Heavy-duty steel grating:
      a. Support on hot-dip galvanized structural steel rebates embedded and anchored in concrete.
      b. Use for roadways, traffic areas, and where indicated on the Drawings.

I. Stairs:
   1. General:
      a. Install guard railings around stair wells as indicated on the Drawings or specified.

J. Stainless Steel:
   1. Welding:
      a. Passivate field-welded surfaces:
         1) Provide cleaning, pickling and passivating as specified in this Section.
         2) Clean using Derustit Stainless Steel Cleaner, or equal.

END OF SECTION

SECTION 06100

ROUGH CARPENTRY

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Carpentry normally not exposed to view, related metal items, and connectors.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. B18.2.1 - Square and Hex Bolts and Screws.
   2. B18.6.1 - Wood Screws.

B. American Softwood Lumber Standard (ASLS):
   1. PS 20 - Softwood Lumber, Product Standard.

C. ASTM International (ASTM):
   1. D226 - Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing.
   2. F1667 - Standard Specification for Driven Fasteners: Nails, Spikes, and Staples.

D. California Redwood Association (CRA):
   1. Standard Specification for Grades of California Redwood Lumber.
   2. Redwood Inspection Service (RIS).

E. U.S. Department of Commerce (DOC):
   1. Voluntary Product Standard PS 1-07 - Structural Plywood.

F. West Coast Lumber Inspection Bureau (WCLIB):
   1. Standard No. 17 - Grading Rules for West Coast Lumber.

G. Western Wood Products Association (WWPA):
   1. Western Lumber Grading Rules.

1.03 SUBMITTALS

A. Shop drawings.

B. Product Data.

1.04 QUALITY ASSURANCE

A. Grade lumber in accordance with following:
   1. Douglas fir and Larch Lumber:
      a. WCLIB Grading Rules.
      b. WWPA Grading Rules.

c. ASLS PS 20.

2. Redwood Lumber: CRA and RIS grading rules.

B. Stamp each piece of lumber with grade, species, and size.

C. Identify each panel of softwood plywood with appropriate APA grade-trademark. Plywood shall meet requirements DOC PS 1-07.

D. Grade lumber 2 inches, 3 inches, and 4 inches thick in accordance with ASLS PS 20. Identify with grade name and species only without reference to paragraph numbers.

E. Grade lumber 6 inches and larger under provisions of WWPA. Identify with grade, species, and size. Equivalent members graded by WCLIB will be accepted unless specifically excluded.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Cover products for protection from damage and moisture.

B. Stack lumber to permit good air drying. Position separators at each layer and between soil and first layer.

PART 2 PRODUCTS

2.01 WOOD

A. Minimum lumber grade requirements for framing and sheathing:

Classification	Nominal Size	Species and Minimum Grade
Studs	2 by 3, 2 by 4	DF-L Number 2 or construction
	2 by 6, 2 by 8	DF-L Number 2
Roof Joists	2 by 6 through 2 by 14	DF-L Number 2
Floor Joists and Planking	2 by 6 through 2 by 14	DF-L Number 2
Headers, Beams, and Stringers	4 by 4 through 4 by 14	DF-L Number 1
	6 by 6 through 6 by 14	DF-L Number 1 (WWPA 70-11)
Posts and Timbers	6 by 6 and larger	DF-L Number 1
Boards	1 by	DF-L Construction
Framing Lumber	All sizes	DF-L Number 2
Blocking and Bridging	2 by 3 through 2 by 14	DF-L Number 3
Miscellaneous	All sizes	DF-L Number 2
DF-L = Douglas fir - Larch (North) Grouping		

B. Species shall be as specified, or any combination of species allowed by grading rules.

C. Lumber 4 inches thick and less: Seasoned or kiln-dried with maximum 19 percent moisture.

D. Lumber thicker than 4 inches: Seasoned to minimize warping and twisting.

E. Lumber surfaces: Surfaced four sides (S4S), unless otherwise specified or indicated on the Drawings.

F. Lumber shall be free of bow, warp, or twist. Pieces with serious defects will be discarded regardless of grading.

G. Sills, cants, and nailers for fascia for roofing: Preservative pressure-treated Number 2 or better Douglas fir.

H. Roof nailers: Use preservative pressure-treated Number 2 or better Douglas fir nailers for gravel stops at edges of roof and at roof expansion joints. Match thickness of nailers and roof insulation.

I. Redwood:
   1. Redwood for baffles and stop logs: Select Heart.

2.02 PLYWOOD

A. Plywood:
   1. DOC PS 1-09 for structural plywood.

B. Plywood with edges or surfaces permanently exposed to weather: Exterior type with exterior type glue, Grade A-C.

C. Plywood roof sheathing: Exterior type with exterior type glue, of thickness and grade as indicated on the Drawings.

D. Plywood sheathing exposed at overhangs: Exterior type plywood with exterior type glue, Grade A-C or better.

E. Miscellaneous plywood: Exterior type plywood of thickness indicated on the Drawings, Grade A-C, or as otherwise indicated on the Drawings.

F. Plywood for roof diaphragms and shear walls: As indicated on the Drawings.

2.03 ROUGH HARDWARE

A. Fasteners:
   1. Nails: ASTM F1667 common wire nails or spikes with full head.
   2. Bolts, nuts, and studs: ASME B18.2.1, hot-dip galvanized.
   3. Washers: Hot-dip galvanized square or round steel plate washers, or malleable iron washers with following dimensions:
      a. Hot-dip galvanized square steel washers:

Bolt Diameter	Washer Dimensions
1/2 inch	2-1/2 by 2-1/2 by 1/4 inches
5/8 inch	2-1/2 by 2-1/2 by 1/4 inches

Bolt Diameter	Washer Dimensions
3/4 inch	2-3/4 by 2-3/4 by 5/16 inches
7/8 inch	3-1/4 by 3-1/4 by 5/16 inches
1 inch	3-3/4 by 3-3/4 by 3/8 inches

b. Hot-dip galvanized round steel washers:

Bolt Diameter	Washer Dimensions
1/2 inch	2-1/2 inch diameter by 1/4 inch
5/8 inch	2-3/4 inch diameter by 1/4 inch
3/4 inch	3 inch diameter by 5/16 inch
7/8 inch	3-1/2 inch diameter by 3/8 inch
1 inch	4 inch diameter by 7/16 inch

c. Round malleable iron washers:

Bolt Diameter	Washer Dimensions
1/2 inch	2-1/2 inch diameter by 1/4 inch
5/8 inch	2-3/4 inch diameter by 5/16 inch
3/4 inch	3 inch diameter by 7/16 inch
7/8 inch	3-1/2 inch diameter by 7/16 inch
1 inch	4 inch diameter by 1/2 inch

4. Lag screws: ASME B18.2.1, hot-dip galvanized.
5. Wood screws: ASME B18.6.1.
6. Nails, screws, bolts, plates, and other fasteners exposed to weather or on building exteriors shall be hot-dip galvanized or of Series 300 stainless steel.
7. Anchor bolts, concrete anchors, flush shells, and powder actuated fasteners: As specified in Section 05120 - Structural Steel.
8. Sheet metal connectors:
   a. Manufacturers: One of the following or equal:
      1) Simpson Strong-Tie Co., Inc.
      2) USP Structural Connectors.
   b. Material: Sheet steel, hot-dip galvanized after fabrication.
   c. Model numbers: As indicated on the Drawings.
   d. Nails, typical: Common, hot-dip galvanized.
   e. Nails, joist hanger: Special, hot-dip galvanized, providing full building code as specified in Section 01410 - Regulatory Requirements, lateral load resistance values for common nails.

B. Miscellaneous hardware:
   1. Clamps, expansion screws, anchors, and plates: Standard products of established manufacturers of proper size and strength to adequately fasten, support, and maintain members in place.
   2. Hardware exposed to weather or on building exteriors: Hot-dip galvanized.

C. Building paper: ASTM D226; unperforated; No. 15 unless otherwise indicated.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that conditions are satisfactory for installation of products as specified in Section 01600 - Product Requirements.

3.02 GENERAL

A. Notch, cope, and miter meeting members so meeting members have full bearing without overcutting or undercutting.

B. Accurately cut, fit, and frame lumber.

3.03 SILLS AND PLATES

A. Install 2 layers of building paper under sills and members fasten to concrete or masonry.

B. Secure sills to foundation as indicated on the Drawings. When not indicated on the Drawings, anchor sills with 1/2-inch diameter hot-dip galvanized anchor bolts at 4-foot centers and within a minimum of 6 inches from each end of each member.

C. Set plates on top of masonry and concrete walls level and in same plane.

D. Anchor plates to masonry or concrete with anchor bolts of size and spacing indicated on the Drawings. Install anchor bolt within 6 inches of member ends.

E. Use cement grout, when necessary, to ensure full bedding and leveling of plates.

3.04 WALLS

A. Erect walls plumb and true to line.

B. Frame walls and partitions with studs of sizes and spacing indicated on the Drawings and at not greater than 16 inches on center.

C. Provide double studs at openings and triple studs at corners.

D. Provide double plates at top of wall studs, arranging to form continuous horizontal ties. Splice individual plates and stagger ends of double plates.

E. Provide two 2-by-6 lintels for openings up to 48 inches and two 2-by-8 lintels for openings from 48 inches to 72 inches.

F. Frame openings for large pipes and ducts and for receiving recessed Work in partitions without cutting structural members.

G. Place nailing blocks and backing necessary for attachment of ground, trim, fixtures, and miscellaneous items. Cut, fur, and install backing required for plumbing and heating pipes, fixtures, and electrical work.

H. Provide fire retardant pressure-treated wood within metal-framed partitions and furring.

I. Provide blocking for attaching paneling, trim, and similar items to framing.

J. Do not cut wood beams or joists and plates in bearing walls for passage of pipes.

K. Coordinate requirements for sleepers for mechanical equipment and curb openings with work of other Sections for locations and sizes.

L. Firestopping:
   1. Where required by governing codes, install continuous row of fire stop blocking in stud walls and partitions at ceilings and floor levels and at maximum 10 feet spacing. Form complete and effective separation for entire width of wall or partition.
   2. Use fire stop blocking with minimum 2 inches nominal thickness and same width as studs.

3.05 ROUGH HARDWARE

A. Provide nailing as indicated on the Drawings or in accordance with Fastening Schedule specified in building code, as specified in Section 01410 - Regulatory Requirements, whichever is more stringent. Do not use box and sinker nails.

B. Install bolts and other fastenings as indicated on the Drawings or in accordance with building code as specified in Section 01410 - Regulatory Requirements, whichever is more stringent.

C. Prebore nail holes where required to avoid splitting of wood members. Remove and replace split pieces.

D. Prebore holes for screws and lag screws, then screw into place. When wood screws and lag screws are defective because they have been driven into place with hammer, replace wood members involved with new members.

E. Drill holes for bolts 1/32-inch larger than bolt shank unless otherwise indicated on the Drawings.

F. Perform final bolting after structural members have been properly aligned.

G. Place washers under heads of bolts and nuts and heads of lag screws bearing on wood. Align exposed bolts.

H. Power nailing will be permitted where nails are as specified and provided installation does not mar or damage wood members. Nails shall have full head. Do not overdrive nails.

I. Drive nail heads for plywood diaphragms flush with plywood surface. Where nails have been overdriven in plywood panel, remove and replace plywood, nails, and damaged supporting members.
   1. Use common nails unless otherwise indicated on the Drawings.

END OF SECTION

SECTION 06608

FIBERGLASS REINFORCED PLASTIC

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: General fabrication and design requirements for fiberglass reinforced plastic fabrications.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. RTP-1 - Reinforced Thermoset Plastic Corrosion Resistant Equipment.

B. ASTM International (ASTM):
   1. C582 - Standard Specification for Contact-Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion-Resistant Equipment.
   2. D883 - Standard Terminology Relating to Plastics.
   3. D2563 - Standard Practice for Classifying Visual Defects in Glass-Reinforced Plastic Laminate Parts.
   4. D2583 - Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor.
   5. D2584 - Standard Test Method for Ignition Loss of Cured Reinforced Resins.
   6. D3299 - Standard Specification for Filament-Wound Glass Fiber Reinforced Thermoset Resin Corrosion-Resistant Tanks.
   7. D4097 - Standard Specification for Contact-Molded Glass-Fiber-Reinforced Thermoset Resin Corrosion-Resistant Tanks.

1.03 DEFINITIONS

A. The terminology of this specification is in accordance with ASTM D883. Fabricators using this specification are responsible for correct interpretation.

B. Fiberglass reinforced plastic: Fiberglass Reinforced Plastic or glass fiber and resin fabrication consisting of approximately 35 to 55 percent glass fiber reinforcement by weight for hand lay-up structural laminates and 55 to 70 percent glass for filament wound structural laminates, unless otherwise specified.

C. Equipment: The fiberglass reinforced plastic equipment, including ancillary equipment, work, and materials as described in this specification.

D. Fabrication drawings: Those drawings produced by the Fabricator or Contractor, with the intention of providing the necessary information to construct or install the equipment.

E. Mat: Fibrous material consisting of randomly oriented chopped or swirled filaments loosely held together with a binder.

F. Chopped glass: Fibrous material consisting of randomly oriented chopped filaments applied directly to a mold surface or laminated under construction by a chopper gun.

G. Fiber prominence (jackstraw): The distinct visibility of individual glass strands causing a loss of translucency of the laminate.

1.04 DESIGN REQUIREMENTS

A. Design fiberglass reinforced plastic tanks, scrubbers, and other vessels following the procedures and methods, utilizing the equations and formulas, and incorporating safety factors and allowable design stresses and strains set forth in ASME RTP-1. Base the design of duct and other fiberglass reinforced plastic equipment not covered by ASME RTP-1 on the engineering rationale, applicable formulas, and safety factors set forth in ASME RTP-1.

B. Perform calculations necessary to ensure long-term, low risk service of the fiberglass reinforced plastic equipment with minimum reasonable maintenance requirements.
   1. Long-term, low risk service is defined as a service life of 20 years without major structural failure or leakage.
   2. The design shall ensure proper functioning of the equipment at the stated operating conditions.
   3. The design shall include as a minimum, engineering calculations, materials selection and documented physical and mechanical properties, and detailed drawings required for fabrication and assembly of the equipment.

C. Design in accordance with applicable national, regional, and local design and building codes.
   1. Wind and seismic forces shall be determined in accordance with the building code as specified in Section 01410 - Regulatory Requirements.

D. Resistance to overturning shall not include the weight of the liquid contained in the equipment.

E. Consider the interaction of the installed system including but not limited to thermal expansion of duct, tanks, and vessels and the effects of external loading from piping, fans, pumps, platforms, and other attached items.

F. Allow for the most severe combination of conditions which may include, but not be limited to, the following:
   1. Internal or external pressure.
   2. Static head of contents (working and test conditions).
   3. Mass of structure and contents.
   4. Design temperature including upset conditions.
   5. Superimposed loads, such as seismic and wind forces.
   6. Bending moments due to eccentric loads.
   7. Localized loads acting at supports, lugs, and other attachments.
   8. Shock loads.
   9. Loads due to heating or cooling and thermal gradients.
   10. Loads applied during transport or erection.
   11. Loads imposed by personnel during erection and operations.
   12. Fatigue.

G. Use safety factors and allowable strains specified in ASME RTP-1 unless otherwise specified. Do not use safety factors and allowable strains less than the following:
   1. Allowable hoop and axial strain shall be 0.001 inch per inch for filament wound tanks.
   2. A safety factor of 10 for hand lay-up components in tension, flexure, or other loading conditions where elastic stability is not in question.
   3. A safety factor of 5 for external loading (vacuum) or local buckling due to seismic or wind loading.

H. Safety factors for upset conditions or infrequent loading situations may be less than the above values for the specific condition if acceptable to the Engineer.

I. There will typically be other aspects which should be considered. Identify and consider their effects, identify design limitations, and submit this information.

J. Provide test reports or other documentation for laminate properties used in the design. Laminates shall be similar in construction, layer sequence, resin type, and cure to those used to determine tested properties. Properties shall be adjusted to reflect reductions at operating temperatures. Test reports shall be provided for:
   1. Grating: Indicate grating strength and deflection.
   2. Physical properties of test cover panels.
   3. Tanks showing conformance with specified strength requirements.

K. The corrosion liner shall be a minimum of 100 mils in thickness, unless otherwise specified, and documentation shall be provided verifying veil type, liner thickness, and resin cure.
   1. Consider 50 mils of the corrosion liner as sacrificial and do not include it in determining structural wall thickness.
   2. Use structural wall thickness not less than 0.375 inches for tanks and vessels and 0.1875 inches for ductwork.
   3. Submit minimum structural thicknesses of other types of fiberglass reinforced plastic fabrications.

L. Laminate types may include hand layup, helical winding, and hoop/chop construction methods.
   1. In laminates with helix angles greater than 80 degrees and in hoop/chop laminates, orientate approximately 10 percent of the structural wall thickness at 0 degrees (longitudinal direction).
   2. Apply this reinforcement in at least 2 layers of weft unidirectional fabric and equally spaced within the structural wall.

M. For tanks and scrubbers; nozzles, determine manways and shell reinforcements according to the tables and formulas in ASME RTP-1.

N. Anchor tanks and vessels using lugs and a continuous filament wound band or an integral filament wound load ledge with external stainless steel anchor clips.
   1. The anchor clips shall be bolted to the concrete foundation; use non-shrink grout to level anchor clips.
   2. The design shall resolve the sum of the moments and the sum of the force equal to 0.

O. Design internal beams and support attachments using a maximum of 200 pounds per square inch shear stress for secondary bonds. Also apply this to design of external lugs required for ladders, platforms, and other attached items.

1.05 SUBMITTALS

A. Shop drawings and calculations:
   1. Submit general arrangement and fabrication drawings, calculations, and elements of the design.
   2. Include submittal information which describes specifically how the equipment is to be built and details necessary to ascertain that products meet specified requirements. Provide in the form of drawings, standards, specifications, or other shop instructions, but may also be partially contained in quality control records. The submittal shall include, but not be limited to:
      a. Fabrication drawings.
      b. General arrangement drawings signed by an Engineer registered in the state where the project is located, showing complete structural, fasteners, and erection procedures for a complete assembly.
      c. Quality control programs.
      d. Verification that the manufacturer has been engaged in fabrication of similar fiberglass reinforced plastic equipment for a minimum of 5 years.
      e. Statement of compliance with contract design requirements, codes, and standards.
      f. Recommendation for each resin selection from resin manufacturer.
      g. Type and amounts of fillers.
      h. Nominal corrosion liner description.
      i. Reinforcement types and glass content range for hand lay-up laminates.
      j. For filament wound laminates:
         1) Helix angle.
         2) Glass content range.
         3) Strand yield.
         4) Strand per inch in the winding band.
         5) Ply thickness.
         6) Amount of chop or unidirectional roving interspersed with winding, if any, and location within laminate.
      k. For other components:
         1) Construction type.
         2) Laminate thicknesses.
         3) Ply sequences.
         4) Glass content range.
      l. For secondary overlays (both interior and exterior):
         1) Laminate thicknesses.
         2) Ply sequences and widths.
      m. Construction details: Construction details for assembly and other special configurations, including:
         1) Tank bottom/top attachments with knuckle configuration and overlays and thicknesses.
         2) Tank support and anchor lugs, including attachment details.
         3) Tank nozzles and installation, including cutout reinforcement, gusseting, and similar items.
         4) Tank lateral or other support fabrication details, including platform attachment clips and/or shoulders.

5) Scrubber configuration and fabrication details of internal support system and other specialty items.
6) Cover panel joints, anchorage detail, and details of doors and inspection ports and their attachment or incorporation within the cover.

n. Miscellaneous equipment required.
o. Test reports and certification of compliance with physical property requirements.
p. Color samples.
q. Manufacturer's installation instructions.
r. ASME RTP-1 certification.

B. Operation and Maintenance Data.

C. Warranty.

1.06 QUALITY ASSURANCE

A. Manufacturer qualifications: Fiberglass reinforced plastic manufacturer with experienced personnel, physical facilities, and management capacity sufficient to produce custom-made glass fiber and resin products of quality and size specified for minimum 5 years with satisfactory performance record.

B. Quality assurance plan: Fabricator shall be responsible for implementation of a comprehensive quality assurance plan. The quality assurance plan describes procedures with the following minimum requirements:
1. Fabricator shall designate personnel to inspect equipment while in process and after completion to ensure compliance to every aspect of the section and fabrication drawings.
a. Inspection shall include, as a minimum, checks for visual defects, laminate thickness and sequence, glass content, Barcol hardness, dimensional tolerances, adherence to construction details, surface preparation, and environmental conditions.
b. Fabricator's inspector shall complete a report of the findings including method of measurement for each separate assembly.
2. Prior to use of resins in fabrication, fabricator shall extract samples of resins and retain them for use by the Engineer. Sample size shall be 100 cubic centimeters minimum:
a. Take 1 sample for each manufacturer's batch number if resin is received in the form it will be used.
b. If the fabricator alters the resin after receipt, such as through the addition of styrene, promoters, or other additives, take samples from each drum or portion thereof mixed with additives.
c. Fabricator shall provide documentation for each sample including resin type, manufacturer, batch and lot number, drum number, complete listing of additives with amounts added, and description and manufacturer of each additive.
3. Fabricator shall inspect glass reinforcement prior to use in fabrication.
a. Do not use glass that does not meet the manufacturer's acceptance standards.
b. Do not use glass material that is wet or has been wet.

c. For each type of glass and lot number used, fabricator shall record the manufacturer, product description, binder type, product code, production date, and lot number.
d. For mat, woven roving, unidirectional roving, and cloth, also include in records actual measured weight per square yard of material.

4. Fabricator shall retain nozzle cutouts and other excess laminate, clearly marking each piece to identify its original location. These laminate samples become the property of the Owner.
5. For areas where valid laminate samples are not available, take sample plugs at the Engineer's request.
   a. Repair subsequent holes in a manner acceptable to the Engineer.
6. Fabricator shall verify glass content on available samples in accordance with ASTM D2584. Complete this test and submit the results complete for each major component where samples are available.
7. Prior to final shipment of the equipment, fabricator shall submit to the Engineer a complete quality control report, consisting of copies of records maintained for compliance with this Section.

PART 2 PRODUCTS

2.01 RESIN AND REINFORCEMENT MATERIALS

A. General physical properties: In accordance with applicable specifications PS15-69, ASTM C582, ASTM D3299, ASTM D4097, and ASME RTP-1 with verification of properties. Physical properties may include tensile, flexural, and compression modulus of elasticity and ultimate strengths, limiting strains, Poisson ratios, coefficients of expansion, and other directional properties as required for the design of the equipment.

B. Resin:
1. Fabricate equipment using the corrosion-resistant resin(s) specified in the fiberglass reinforced plastic equipment specifications. The fabricator is required to obtain independent endorsement of each resin selection from the resin manufacturer. Unless otherwise specified, use the resin throughout laminates.
2. The type of catalyst recommended varies between resin manufacturers. Submit resin/catalyst before fabrication begins to verify compliance to the resin manufacturer's recommended procedures.
3. Employ no fillers, additives, or pigments in the resin.
   a. A thixotropic agent for viscosity control may be used in the proportion and type recommended by the resin manufacturer.
   b. Use no thixotropic agent in the corrosion liner or on surfaces to be in contact with the corrosive environment.
4. Make resin putty using the same resin as was used in the original fabrication and shall contain milled glass fibers.
   a. The use of silica flour, grinding dust, or other fillers is not allowed.
5. When specified, add antimony trioxide or antimony pentoxide to the resin in the amount necessary to achieve the required fire retardancy rating in the structural wall only. Follow resin manufacturer's recommendations.
   a. Unless otherwise specified, the corrosion liner shall not contain this additive.

C. Reinforcement:
   1. Show the type and sequence of reinforcements to be used on the fabrication drawings.
   2. Use as commercial grade corrosion-resistant borosilicate glass fiber reinforcement, unless otherwise specified.
   3. Use glass fiber reinforcing having a surface finish and binder that is specifically recommended by the glass manufacturer for the particular resin system to be used.
   4. Use Type C (chemical grade) glass, 10 mils (0.01 inches) thickness, or polyester surfacing veil, such as Nexus surfacing veils.
   5. Use Type E (electrical grade) glass, 1-1/2 ounces or 3/4-ounce per square foot, with nominal fiber length of 1.25, within 0.75 inches mat.
   6. Continuous glass roving used in chopper guns for spray up shall be Type E chopper roving.
   7. Woven roving shall be 24 ounces per square yard Type E glass and have a 5-by-4 plain weave.
   8. Continuous roving used in filament wound structures shall be Type E glass winder roving with a yield of 200 yards or more per pound.
   9. Use Type E glass unidirectional fabric. Weft unidirectional fabric shall be 15.7 ounces per square yard.
   10. When specified, use Type ECR glass reinforcements supplied in similar fabric styles to those specified above.

2.02 FABRICATION

A. Molds:
   1. Construct molds of a suitable material to produce a smooth and glossy corrosion liner surface on the fiberglass reinforced plastic equipment.
   2. Covering of mandrels with cardboard must be accepted by the Engineer prior to start of fabrication.

B. Laminates:
   1. Determine specified glass content in accordance with ASTM D2584.
   2. Consider laminate thicknesses shown on the fabrication drawings as construction minimums. Verify that minimum thicknesses are obtained using the laminate sequences specified. When only total laminate thicknesses are specified or indicated on the Drawings, the minimum allowable structural laminate thickness shall be the total laminate thickness less the specified corrosion liner thickness.
   3. Interruptions in laminating sequence shall follow the application of a ply of mat and be succeeded by a ply of mat.
   4. The interruption shall not exceed 24 hours, and the in-process surface must retain acetone sensitivity until laminating is resumed. Lack of compliance with these aspects or indication that contamination of the surface has occurred shall require that surface preparation be accomplished before resuming.
   5. Chopped strand glass applied by chopper gun is allowed in lieu of mat layers in the structural laminates only.
      a. Chopper gun application of the corrosion liner is not allowed.
   6. Coat non-mold surfaces with resin containing wax additive in the amount necessary to allow full cure of the surface. In the case of exterior surfaces, this wax coat shall also contain an ultraviolet stabilizer in the type and amount recommended by the resin manufacturer.

7. The exterior surface of equipment shall be resin-rich and reinforced with 1 layer C glass surfacing veil, unless otherwise specified.
8. When specified, the exterior coat shall be an opaque pigmented surface coat, applied only after Engineer's inspection. Color shall be selected by the Engineer.

C. Corrosion liner laminates:
   1. The inner surface of laminates shall be resin-rich and reinforced with surfacing veil of the type and number of layers as shown on the fabrication drawings.
   2. The interior layer of the corrosion liner shall consist of 1-1/2 ounces per square foot mat in the number of layers specified on the fabrication drawings. An exotherm interruption is specifically prohibited within the corrosion liner.
   3. Chopped glass applied by chopper gun is not allowed in the corrosion liner.
   4. Plies of the inner surface and interior layer are to gel completely before proceeding with the structural laminates.
   5. Completed corrosion liner as described above shall contain not less than 20 percent nor more than 30 percent glass by weight.
      a. Use no thixotropic material in the resin for the liner, nor in the fabrication of fiberglass reinforced plastic components intended for internal service.
      b. The completed liner shall be the minimum thickness specified or indicated on the Drawings.
   6. Do not use a separately cured unreinforced gel coat.

D. Hand lay-up structural laminates:
   1. The corrosion liner laminate shall be followed by hand lay-up structural laminates of varying reinforcement sequences as indicated on the fabrication drawings.
   2. For hand lay-up structural laminates, reinforcement shall consist of mat and woven roving in the sequence specified on the fabrication drawings.
   3. Woven roving shall have a ply of mat on each side. Two adjacent plies of woven roving are not permitted.
   4. Laminates containing primarily 1-1/2 ounces per square foot mat layers in conjunction with woven roving shall contain not less than 35 percent or more than 45 percent glass (by weight).
   5. Laminates containing primarily 3/4-ounce per square foot mat layers in conjunction with woven roving are considered to be high strength laminates and shall contain not less than 45 percent or more than 55 percent glass by weight.

E. Filament wound structural laminates:
   1. The corrosion liner laminate shall be followed by filament wound structural laminates as indicated on the fabrication drawings.
   2. For filament wound structural laminates, reinforcement shall consist of continuous strand fiberglass roving applied with a minimum of interruptions until the specified minimum thickness is attained.
      a. This laminate shall contain 55 to 70 percent glass by weight as indicated on the fabrication drawings.
   3. Each complete cycle of filament winding shall form a closed pattern of winding bands which completely covers the surface with 2 bi-directional layers.
      a. Each layer shall be a maximum of 1 roving in thickness.
      b. Uniformly space the filaments across the winding band without bunching or gaping.

4. Specify the helix angle of winding on the approved fabrication drawings, as measured from the centerline of revolution of the equipment shell.
5. Tolerance on helix angle is plus or minus 2 degrees, unless otherwise specified.
6. The fabrication drawings may require that layers of unidirectional roving be interspersed within the continuous filament winding.
7. Apply the unidirectional roving with the glass strand aligned in the axial direction, to within plus or minus 5 degrees.
8. If layers of mat or chopped glass are needed to ensure proper bonding of unidirectional roving, or within the filament winding to accommodate the Fabricator's manufacturing methods, consider the layers' extra material that will result in a thickness greater than specified. The amount of filament winding and unidirectional roving specified must still be applied.

F. Joining laminates:
1. Fiberglass reinforced plastic joining laminates are subject to applicable requirements specified in other sections for laminates.
2. Reinforce fiberglass reinforced plastic joints with an overlay of glass reinforcement and resin which extends equally within plus or minus 1/2 inch on each side of the joint. Use minimum thickness, ply sequence, and ply widths of fiberglass reinforced plastic joints as indicated on fabrication drawings.
3. Restrain parts to be joined to prevent movement until completion and cure of the joint overlay.
4. Fit-up parts and verify that tolerances and assembly requirements are satisfied. Completely fill the void between component parts with resin putty, taking care not to extrude an excessive amount of putty into the interior.

G. Environment:
1. The fabrication process and materials at the point of fabrication are to be maintained within a range of 60 to 95 degrees Fahrenheit. This temperature must also be at least 5 degrees greater than wet bulb temperature, as measured with a sling psychrometer.
2. Store materials in a dry area and within the temperature and humidity limits recommended by the manufacturers.

H. Flanges:
1. Make flanges by hand lay-up construction with nozzle neck and flange made integrally in 1 piece and fabricated in accordance with the dimensions indicated on the fabrication drawings. Extend layers of reinforcement in the nozzle neck and hub uninterrupted into the flange.
2. Build-up additional hub thickness using alternating layers of 1-1/2 ounces per square foot mat and 24 ounces per square yard woven roving.
3. Build-up additional thickness in the flange using "ring" cutouts of mat, evenly distributed throughout the flange thickness.
4. Press molded or filament wound flanges are not allowed.
5. Overall machine facing of the back of flanges is not permitted.
    a. To obtain proper seating, spotface bolt holes for SAE size washers.
    b. Resin coat bolt holes and other cut surfaces so that no fibers are exposed.
    c. Spotfacing shall not produce a flange thickness less than indicated in the fabrication drawings.

6. Bolt holes in flanges shall straddle principal centerlines of the Equipment. Tolerance in bolt hole locations and in diameter of bolt circle shall be plus 1/16 inch.
7. Depressions or projections in flange face shall be no greater than 1/32 inch.

I. Allowable visual defects:
1. Visual defects in areas of the equipment shall not exceed the maximum allowable levels of visual defects set forth in Table A, unless acceptable to Engineer.
2. Visual defects in accordance with ASTM D2563.
3. Presence of visual defects in excess of the allowable levels of Table A shall be grounds for rejection of the equipment. Listed quantities apply to small, localized areas and shall not be averaged over larger areas.
4. For the purpose of Table A, use of the following definitions apply:
   a. INNER surface - Interior process surface, thickness of surfacing veil(s), and interface between veils and mat layers. Includes surfacing veils on internal joints.
   b. Interior mat layers - Layers of mat following the inner surface, and interface between liner and structural wall. Includes mat layers on internal joints.
   c. Structural wall - Layers of filament winding or alternating layers of mat and woven roving following the corrosion liner, and layers of mat and woven roving in internal overlays.
   d. Exterior surface - The exterior surface of the laminate and the thickness of the surfacing veil.
   e. Dimensions listed in Table A refer to the largest dimension measured for defects.

TABLE A
MAXIMUM ALLOWABLE LEVELS OF VISUAL DEFECTS

Condition/ Defect	Inner Surface	Interior Mat Layers	Structural Wall	Exterior Surface
Chip	None	None	None	
Crack	None	None	None	
Crazing	None	None	None	
Delamination	None	None	See Air Bubble	
Dry Spot	None	See Air Bubble	See Air Bubble	
Foreign Inclusion	None	Maximum Diameter 1/32"	See Air Bubble	
Fracture	None	None	None	None
Air Bubble/ Void	Less than 1/64" Ø unlimited. 1/64" to 1/16" Ø 2 / sq. in. Maximum Diameter 1/16"	Less than 1/32" Ø unlimited. 1/32" to 1/8" Ø 5 / sq. in. Maximum Diameter 1/8"	Less than 3/16" Ø unlimited. 3/16" to 1/4" Ø 2 / sq. in. Maximum Diameter 1/4"	
Blister	See Air Bubble	See Air Bubble	See Air Bubble	

TABLE A MAXIMUM ALLOWABLE LEVELS OF VISUAL DEFECTS				
Condition/ Defect	**Inner Surface**	**Interior Mat Layers**	**Structural Wall**	**Exterior Surface**
Burned	None	None	None	
Pit (Pinhole)	Less than 1/32" Ø 50/square feet 1/32" to 1/16" Ø 10/square feet Maximum Diameter 1/16" Maximum Depth 1/32"	N/A	N/A	
Resin Pocket	None	Maximum 1 square inch per occurrence.	Maximum 1 square inch per occurrence.	
Wrinkle	Allowable if laminate is glass reinforced. No sharp edges allowed.	Allowable if laminate is glass reinforced and full mat layer thickness and total thick- ness are maintained.	Allowable if laminate is glass reinforced and full mat layer thickness and total thick- ness are maintained.	
Scratch	None	N/A	N/A	
Fiber Prominence	None	Maximum 10 fibers visible per square inch	Maximum 20 fibers visible per square inch	

2.03 SOURCE QUALITY CONTROL

A. Inspection:
   1. Owner's inspection: Permit the Engineer access to the equipment during fabrication and upon completion for the purpose of verifying compliance to the Contract Documents. The inspection is not intended to replace the Fabricator's own quality control procedures.
   2. In no respect does inspection of equipment by Engineer relieve the Fabricator of compliance with the Contract Documents.
      a. A final inspection will be performed by the Engineer.
   3. The Fabricator shall notify the Engineer at the completion of particular milestones during fabrication. The milestones are as follows:
      a. View tooling prior to fabrication.
      b. Beginning application of corrosion liner for each part, extraction of each part prior to beginning assembly.
      c. Upon completion of each separate assembly, Engineer reserves the right to include additional milestones.
   4. Allow Engineer to photograph the equipment while in process and/or upon completion.
   5. Engineer may use magnification or other special viewing or measurement devices during inspection.
   6. Evidence of poor workmanship or lack of compliance with aspects of the Contract Documents will be grounds for rejection of the equipment.

7. Subsequent repair of rejected equipment may, at the Engineer's option, be undertaken in an attempt to bring the equipment to an acceptable state.
    a. Repair procedures must be accepted by the Engineer prior to implementation.

2.04 TESTING

A. The Engineer may employ destructive testing, such as ultimate tensile or flexure strength tests or glass content ignition tests, on available samples or use other non-destructive test methods, such as acoustic emission or ultrasonic polygauge thickness measurement, on the completed equipment for verification of compliance to the contract documents.

B. Testing performed by the Engineer will be accomplished through use of applicable ASTM test methods when appropriate.

C. Hardness tests will be made for acceptance by the Engineer on the liner surface using the Barcol impressor, Model GYZJ 934 1, calibrated at 2 points in accordance with ASTM D2583.
    1. Ten readings will be taken in a localized area, deleting the 2 highest and 2 lowest, and averaging the remaining 6.
    2. Minimum acceptable Barcol hardness will be a reading of 30 unless otherwise specified.

D. An acetone sensitivity test will also be performed by the Engineer as an acceptance criteria. Evidence of a sticky or tacky surface following rubbing with an acetone-saturated cloth will be grounds for rejection of the equipment.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 06611

FIBERGLASS REINFORCED PLASTIC FABRICATIONS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Fiberglass reinforced plastic fabrications including:
   1. Weirs.
   2. Stop plates.

1.02 REFERENCES

A. American Water Works Association (AWWA):
   1. F 102 - Matched-Die-Molded, Fiberglass-Reinforced Plastic Weir Plates, Scum Baffles, and Mounting Brackets.

B. ASTM International (ASTM):
   1. D635 - Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position.
   2. D638 - Standard Test Method for Tensile Properties of Plastics.
   3. D790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
   4. D2583 - Standard Test Method for Indentation of Hardness of Rigid Plastics by Means of a Barcol Impressor.
   5. E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

C. United States, Department of Agriculture (USDA).

D. United States, Department of the Interior:
   1. Bureau of Reclamation (USBR):
      a. ISO 9826 - Water Measurement Manual, Measurement of Liquid Flow in Open Channel.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Parshall flume liner: Provide temporary bracing for liner to ensure maintenance of dimensions during shipment. Maintain bracing in place for installation.

PART 2 PRODUCTS

2.01 WEIR PLATES

A. General:
   1. In accordance with AWWA F 102, and as specified in this Section.

B. Materials:
   1. Laminate construction: Glass fiber-reinforced, chemical-resistant polyester resin.
      a. Glass content of laminate: Minimum 20 percent by weight.
      b. Resin fillers: Minimum 40 percent.
   2. Physical properties of laminate: Equal to or exceeding the tensile, flexural, impact, hardness, and water absorption properties specified in AWWA F 102.
   3. Performance criteria:
      a. Chemical resistance: Classification: AWWA F 102 Type II (chemical-resistant resin, filler and fabrications
   4. Color: Manufacturer's standard aqua/turquoise.

C. Fabrications:
   1. Fabricated to the shapes, dimensions, and details indicated on the Drawings and specified**,** and using processes as specified in this Section.
   2. Dimensions:
      a. Conform to tolerances in accordance with AWWA F 102, unless otherwise indicated.
      b. Final laminate thickness: Plus or minus 10 percent of nominal thickness.
   3. Fabricate weir plates with oversize holes to allow vertical adjustment.
   4. Seal cut edges of non-standard lengths, and edges of drilled and countersunk holes in fiberglass reinforced plastic fabrications with resin.
   5. Furnish fiberglass reinforced plastic lapped plate splices at joints.

D. Rectangular "flat crested" weirs:
   1. Fabrication:
      a. Molded to produce uniform, smooth surfaces.
      b. Tolerances: In accordance with AWWA F 102.
   2. Manufacturers: One of the following or equal:
      a. Glass Steel, Inc.
      b. MFG Water Treatment Products.
      c. NEFCO, Inc.
      d. Warminster Fiberglass.

E. Accessories:
   1. Washers: Of same material as weirs, with surfaces smooth, free of voids, and without dry spots and crazes.
   2. Assembly hardware: Concrete anchors as specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.

2.02 STOP PLATES

A. General:
   1. See Stop Plate Schedule in Contract Drawings for quantities and sizes.
   2. Chemical exposure: compatible with typical chemicals found in raw and secondary municipal wastewater.

B. Manufacturers: One of the following or equal:
   1. Glass Steel, Inc.
   2. Plasti-Fab Inc.
   3. Warminster Fiberglass.

C. Materials:
   1. Minimum corrosion liner: Manufacturer's standard for the service environment specified.
   2. Ultraviolet stabilizer: Added to the exterior surface coat of fabrications in the type and amount recommended by the resin manufacturer for the in-service UV exposure.
   3. Resin: polyester.
   4. Color: Owner to select from supplier's standard color pallet.
   5. Handles: as specified in Stop Plate schedule in Contract Drawings.
   6. Guide Frame material: vinyl ester
   7. Guide Frame mount: as specified in Stop Plate schedule in Contract Drawings.
   8. Seals: as specified in Stop Plate schedule in Contract Drawings.

D. Fabrication:
   1. Stop plates: Hand lay-up components to specified shape and dimensions.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that conditions are satisfactory for installation of products as specified in Section 01600 - Product Requirements.

3.02 ERECTION AND INSTALLATION, GENERAL

A. Install products where indicated on the Drawings in accordance with manufacturer's printed instructions.

3.03 WEIRS

A. Carefully install weirs, aligning and leveling to the elevations indicated on the Drawings.

B. Installation tolerances:
   1. V-notch weirs. In the completed installation:
      a. The variation in elevation between any 2 notches of the weir plate in a tank shall not exceed 1/8 inch.
      b. In a round tank, the variation from elevation between any one quadrant of the weir and that of any other quadrant shall not exceed 1/16 inch.

END OF SECTION

SECTION 07190

WATER REPELLENTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Water repellent for concrete masonry.

1.02 DEFINITIONS

A. Water repellent: Resistance to penetration of water from rainfall.

1.03 REFERENCES

A. International Union of Testing and Research Laboratories for Materials and Structures (RILEM):
   1. RILEM Test Method No. 11.4, Measurement Of Water Absorption Under Low Pressure.

1.04 SYSTEM DESCRIPTION

A. Performance requirements: Surfaces with water repellent shall be uniform in color with unaltered texture.

1.05 SUBMITTALS

A. Product Data.

B. Samples: Water repellent applied on 8-inch by 8-inch substrates to receive water repellent, marked with application date and application rate.

C. Manufacturer's Application Instructions.

1.06 QUALITY ASSURANCE

A. Manufacturer qualifications: Manufacturer of water repellents for minimum 5 years with satisfactory performance record.

B. Applicator qualifications: Trained, approved, and accepted by water repellent manufacturer.

C. Spray personnel qualifications: Minimum 2 years of experience spraying exotic coatings.

D. Regulatory requirements: Comply with volatile organic compound regulations.

E. Mock-ups:
   1. Apply water repellent on 8-foot by 8-foot mock-up walls. Use same equipment and procedures that will be used in applying material on walls.

2. Test mock-up for water penetration 30 days after applying water repellent in accordance with field quality control.
3. When accepted by the Engineer, mock-up walls will be standard for walls.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to site in manufacturer's original containers with seals unbroken and labeled with manufacturer's batch number.

B. Store materials in original, unopened containers in compliance with manufacturer's printed instructions.

1.08 ENVIRONMENTAL REQUIREMENTS

A. Apply water repellent under temperature and relative humidity conditions before, during, and after application in accordance with manufacturer's instructions.

B. Allow surfaces to dry for minimum 5 days after rains.

1.09 PROJECT CONDITIONS

A. Make proper material allowance based upon substrate material and surface configuration when determining quantities of material.

1.10 WARRANTY

A. Warrant to furnish and apply water repellent on walls that experience water penetration because of failure of water repellent for minimum 5 years.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Water repellent sealer:
1. One of the following or equal:
a. Rainguard Products.
b. ProSoCo, Inc.

2.02 MATERIALS

A. Water repellent sealer for concrete and concrete masonry: Silane/Siloxane; Volatile Organic Compound compliant; free of silicone oils, paraffin wax, or urethanes.
1. Manufacturers: The following or equal:
a. Rainguard, BLOK-LOK.

2.03 EQUIPMENT

A. Spray equipment: High-volume, low-pressure, airless, with maximum 60 pounds per square inch pressure:
1. Pump: Non-atomizing, able to flow material on walls at minimum 1 to 1-1/2 gallons per minute.

2. Orifice size for concrete, slump block, exposed concrete aggregate, and cement plaster: 0.060 to 0.110 inches.
3. Orifice size for brick, clay brick tile, brick veneer, stone, and wood: 0.060 inches.

PART 3 EXECUTION

3.01 EXAMINATION

A. Carefully inspect installed construction. Verify that construction is ready for repellent application.

B. Require manufacturer's representative to verify that water repellent may be installed.

3.02 PREPARATION

A. Allow concrete or masonry walls to cure at least 30 days before applying water repellent.

B. Clean wall surfaces of soil, mud, efflorescence, or other detrimental materials.

C. Tuck-point or caulk cracks, other than hairline cracks.

D. Route out defective mortar joints, point with mortar and tool.

E. Moisture content: Apply water repellent sealer when moisture content of substrate is 15 percent or less.

3.03 APPLICATION ON CONCRETE MASONRY

A. Apply water repellent in accordance with manufacturer's printed instructions.

B. Apply flood coat using low-pressure spray equipment.

C. Start at top of wall and work down using overlapping horizontal passes.

D. Hold spray head 8 to 10 inches from surface so saturation coat runs freely down wall 6 to 10 inches below point of application on most substrates.

E. Spray by traveling horizontally to ensure uniform coverage.

F. Overlap each following pass by centering spray head on bottom line of the previous pass.

G. Trigger gun off at end of each pass to avoid applying excessive amount of material. Do not over apply.

H. Avoid application in hot or windy weather as premature drying can cause whitish residue on walls.

3.04 FIELD QUALITY CONTROL

A. 20 days after application, test water repellent on CMU surfaces using RILEM Test Method No. 11.4:
   1. Contractor shall perform a 20-minute RILEM baseline test on dry untreated CMU units of each type to receive water repellent. Test results (water loss in milliliter) shall be compared to CMU units in walls after water repellent application.
   2. On water repellant coated CMU, a RILEM tube test resulting in 5 milliliter or less after 20 minutes is necessary to qualify for 5-year warranty.

B. Notify the Engineer and manufacturer at least 72 hours in advance of test.

C. Where tested wall areas fail to pass RILEM tube test, apply additional coat of water repellent on entire wall from corner to corner.

D. Test all locations where directed by the Engineer.

3.05 CLEANING

A. Concrete masonry: Clean drips, runs, and overspray residue while still wet, using detergent and water. Clean application and spray equipment with detergent and water immediately following use.

B. Clean application and spray equipment according to the manufacturer's recommendations.

C. Remove excess materials, equipment, and debris incidental to water repellent application upon completion.

3.06 PROTECTION

A. During application, protect water repellent treated and adjacent surfaces from damage.

B. Protect glass, aluminum, and other surfaces from overspray.

C. Protect concrete sidewalks from runoff. Soak with water immediately prior to application on adjacent walls.

D. Repair damaged areas promptly.

END OF SECTION

SECTION 07212

WALL INSULATION SYSTEM

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Rigid insulation materials and furring system.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

1.03 SUBMITTALS

A. Product data.

B. Manufacturer's installation instructions.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products in accordance with manufacturer's recommendations.

B. Store materials on Project site in dry area protected from weather and sunlight.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Rigid insulation:
   1. The following or equal:
      a. Dow Chemical Co.

B. Furring wall framing:
   1. The following or equal:
      a. Dietrich Metal Framing.

2.02 MATERIALS

A. Rigid insulation (Walls):
   1. Dow Styrofoam, 2.4-inch thick, R-11.4 min, 24-inch by 96-inch boards.

B. Rigid insulation (Foundation and Under slab):
   1. Dow Styrofoam, 2-inch thick, R-10 minimum.

C. Furring wall framing:
   1. Dietrich Furring Channel, 7/8-inch by 25-gauge galvanized steel.

D. Fasteners: Powder actuated fasteners, or other anchors as necessary to penetrate substrate, and of appropriate length for insulation thickness.

PART 3 EXECUTION

3.01 PREPARATION

A. Clean substrate of loose material.

B. Verify waterproofing behind properly sized electrical outlet boxes.

3.02 INSTALLATION

A. Install insulation in accordance with manufacturer's recommendations.

B. Cut and fit as necessary to accommodate doors, windows, and electrical conduit.

C. Begin installation of board at one corner. Tightly butt board joints to form uninterrupted surface.

D. Position furring channels at edges of surface, at centers of vertical board joints, and at 24 inches on center vertically.

E. Position additional furring channels around openings and as necessary to provide firm attachment for gypsum board or FRP panels.

F. Drive fasteners through furring channels and boards into firm substrate at maximum 6 inches from channel ends and at minimum 16 inches on center.

END OF SECTION

SECTION 07220

ROOF AND DECK INSULATION

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Roof and deck insulation and associated accessories.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   2. D41- Standard Specification for Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing.
   3. D312 - Standard Specification for Asphalt Used in Roofing.

B. National Roofing Contractors Association (NRCA).

C. Underwriters Laboratories, Inc. (UL).

1.03 SYSTEM DESCRIPTION

A. Roof insulation system: As follows with UL Class A and FM Class 1A fire classification and meeting FM 1-90 wind up-lift requirements.
   1. Roof R-Value shall be R-30 ci minimum as indicated on Drawing GA01.
   2. Where tapered rigid foam insulation is indicated on the Drawings, insulation shall be as follows:
      a. Multiple layer insulation, comprised of layers of flat and tapered rigid foam roof insulation, built up to provide a taper, sloped to drains, of 1/4 inch per foot minimum.
      b. Minimum insulation thickness at roof drains shall be 2.4 inches.
      c. Provide drainage pattern as indicated on the Drawings.

1.04 SUBMITTALS

A. Product data.

B. Samples. Include 6-inch square samples of each type and thickness of insulation required.

C. State thickness and R-value of insulation to be provided at each building.

D. Manufacturer's installation instructions: Include the following:
   1. Indicate special environmental conditions required for installation.
   2. Indicate adhesive recommendations.
   3. Indicate fastener recommendations and attachment pattern.
   4. Indicate installation techniques.

E. Certificates:
   1. Certify that products meet or exceed specified requirements.
   2. Certify that insulation is approved by manufacturer for use with specified roofing materials.

F. Manufacturer's field reports.

G. Warranty.

1.05 QUALITY ASSURANCE

A. Manufacturer qualifications: Manufacturer of proposed product for minimum 5 years with satisfactory performance record.

B. Installer qualifications:
   1. Manufacturer-approved installer of products similar to specified products on minimum 5 projects of similar scope as Project with satisfactory performance record.
   2. Committed to complying with manufacturer's specifications and NRCA recommendations.
   3. Committed to assuming undivided responsibility for roof insulation, roofing membrane and sheet metal flashing, and trim associated with roofing.

C. Product compatibility: Provide roofing manufacturer approved roof insulation.

D. Pre-installation conference: Conduct as specified in Section 01312 - Project Meetings.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products in accordance with manufacturer's instructions.

B. Label asphalt containers with certification of full compliance with requirements of ASTM D312, Table 1, and indicating equiviscous temperature, finished flowing temperature, and flash point.

C. Store roof system materials on pallets or dunnage at least 4 inches above ground and suitably covered to protect from weather.

1.07 SEQUENCING AND SCHEDULING

A. Apply no more insulation than can be completely covered with roofing membrane on the same day.

B. When installation of insulation and roof membrane cannot be completed within same day, install temporary water cutoffs at end of day's work and remove cutoffs prior to resumption of work.

1.08 WARRANTY

A. Furnished by roof membrane manufacturer, as specified.

PART 2 PRODUCTS

2.01 MATERIALS

A. Vapor retarder: ASTM D 2178, Type IV; asphalt impregnated glass fiber sheet with nominal tensile strength 30 percent higher than required by ASTM D 2178 for Type IV felts.
   1. Manufacturers: One of the following or equal;
      a. John Manville, Inc., Denver, CO, GlasPly Premier.
      b. Atlas Roofing Corporation, Atlanta, GA, equivalent product.

B. Tapered foam roof insulation:
   1. Closed cell polyisocyanurate foam core bonded to universal fiberglass reinforced facers.
   2. Utilizing environmentally compliant blowing agent.
   3. Manufacturers: One of the following or equal:
      a. Johns Manville, Inc., Tapered ENRGY 3.
      b. Atlas Roofing Corp., Tapered ACFoam II.

C. Mineral board as recommended by roofing manufacturer: Factory fabricated, 1/2-inch thick, glass mat faced, noncombustible, moisture resistant, silicone treated, gypsum core panel.
   1. Manufacturers: The following or equal:
      a. Georgia-Pacific, Dens-Deck Roof Board.

D. Roof crickets and saddles: Tapered Perlite Roof Insulation or as otherwise recommended by roofing manufacturer to meet warranty requirements.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that deck is properly graded to outlets.

B. Verify that deck surfaces are clean, dry, and where required, coated with primer.

3.02 INSTALLATION OVER CONCRETE OR OTHER NON-NAILABLE DECKS

A. Install roof insulation in accordance with manufacturer's specifications.

B. Secure wood nailers to roof deck adjoining eaves, at roof curbs for attachment of flashing and counterflashing, and at other locations indicated on the Drawings.
   1. Nailers shall be built up of pressure treated wood to match the thickness of the insulation.

C. Prime concrete decks at rate of 1 gallon of primer per square of roofing. Lay first layer of roof insulation with long joints continuous and short joint staggered. Set firmly into full width mopping of hot asphalt at approximately 33 pounds per square.

D. Apply second layer of roof insulation with both long and short joints offset from joints of first layer. Firmly set in full width mopping of hot asphalt applied at approximately 33 pounds per square.

E. Install cant strips at curbs, parapets, and intersections of roofs and vertical walls when recommended by membrane manufacturer. Place cant on top of insulation and set in solid mopping of asphalt.

F. Roof crickets:
   1. Install as required to achieve drainage pattern indicated on the Drawings, and as otherwise required to obtain roof warranty. Set in full mopping of hot asphalt. Feathered edges of crickets and tapered insulation shall be formed of perlite or fiber board.
   2. Mop 12-inch wide felt strip into solid asphalt at valley formed by installation of roof crickets to provide additional membrane reinforcement.

G. Before application of roofing, turn over and solidly mop projecting felt to insulation at vertical surfaces and edges.

H. Do not leave insulation exposed to weather.

3.03 FIELD QUALITY CONTROL

A. Roof insulation which becomes wet or damaged shall be removed and replaced with solid, dry insulation, unless installer provides written acceptance of the damaged insulation from the roofing manufacturer, whose warranty shall cover the system.

B. Inspections: Roof membrane manufacturer, whose warranty shall cover complete roof assembly, shall provide supervision and inspection necessary to secure warranty.

END OF SECTION

SECTION 07554

FULLY-ADHERED POLYVINYL CHLORIDE ROOFING

PART 1 GENERAL

1.01 SUMMARY

A. Roofing System: This specifies the following adhered roofing system:
   1. Solvent Based Adhesive.

1.02 REFERENCES

A. Current Edition of: Identified reference requirements as put forth by the project specification.
   1. International Building Code (IBC).
   2. American Society of Testing Materials (ASTM).
   3. National Roofing Contractors Association (NRCA).
   4. Single Ply Roofing Institute (SPRI).
   5. Sika Corporation Roofing Applicator Handbook.
   6. Technical Bulletins.

1.03 SUBMITTALS

A. Literature: Copies of current relevant information pertaining to the primary components to be used in the roof system including but not limited to:
   1. Specifications.
   2. Roofing's Warranty.
   3. Applicator's Warranty.
   4. Product Data Sheets.
   5. Material Safety Data Sheets.
   6. UL listings/approvals.

B. Samples for Verification: Representative samples of primary components to be used in the roof system.

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work, including:
   1. Base flashings and membrane terminations.
   2. Tapered insulation, including slopes.
   3. Roof plan showing orientation of roof deck, orientation of roofing membrane, patterns for insulation attachment, and membrane fastening spacing.
   4. Fastening patterns for corner, perimeter, and field-of-roof locations.

1.04 QUALITY ASSURANCE

A. Roofing Qualifications:
   1. Demonstrated performance history of producing PVC roof membranes no less, in duration of years, than the warranty duration specified.
   2. Manufactured by membrane supplier and not private labeled.

B. Installer Qualifications:
   1. A qualified firm that is authorized by the approved manufacturer - Roofing to install all work pertaining to product manufacturer's roof system and that is eligible to receive manufacturer's warranty.

C. Preinstallation Roofing Conference: Conduct conference at Project site.
   1. Roofing representative, Owner, Architect, Owner's Insurer, Testing and Inspecting Agency representative, Roofing Installer, Deck Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
   2. Review methods and procedures related to roofing installation, including manufacturer's most current requirements.
   3. Review base flashings, special roofing details and transitions, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
   4. Review governing regulations and requirements for insurance and certificates.
   5. Review temporary protection requirements for roofing system during and after installation.
   6. Deviations from the project specifications or the approved shop drawings are not permitted without prior written approval by manufacturer - Roofing, the owner, the owner’s representative, and the designer.

D. Fire Design:
   1. Underwriters Laboratories, Inc. (Class A Assembly).

E. Wind Design:
   1. System shall meet minimum requirements in accordance of ASCE 7 per code jurisdiction.

F. Special Design:
   1. ANSI-SPRI ES-1.
   2. Energy Star.

1.05 DELIVERY, HANDLING, AND STORAGE

A. Deliver roofing materials to project site in original containers with seals unbroken and labeled with product manufacturer's name or product brand name.

B. Comply with most current product data sheet requirements when handling, storing, protecting, or installing roofing materials. Including but not limited to avoiding physical damage, deterioration by sunlight, excessive moisture, or other potentially damaging conditions.

C. Store liquid materials in their original undamaged containers in a clean, dry, protected location; away from direct sunlight; within the temperature range noted on the product data sheet.

D. Handle and store roofing materials and equipment in a manner to avoid permanent deflection of deck.

1.06 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's most current requirements and warranty requirements.

B. Material Compatibility: Roofing materials shall be compatible with one another and adjacent materials under conditions of service and application required and confirmed by roofing manufacturer.

1.07 WARRANTY

A. Roofing Warranty: Sika warrants to the owner the specified warranty for the specified warranty period as long as the roofing is installed according to Technical instructions by an Authorized Roofing Applicator. The warranty must be non-prorated and must not exclude coverage due to ponding water. Warranty shall be a non-dollar limit.
   1. Warranty: System.
   2. Warranty Period: 20 years from date of substantial completion.

B. Applicator's Warranty: Signed by installing applicator, covering the work of a System Warranty, including all components of roofing system installation such as membrane roofing, base flashing, roof insulation, fasteners, cover boards, vapor retarders, and walkway products, for the following warranty period:
   1. Warranty Period: 5 years from date of substantial completion.

PART 2 PRODUCTS

2.01 PERFORMANCE / DESIGN CRITERIA

A. ASTM D4434: Type II.

B. NSF/ANSI Standard 347: Platinum.

C. Guarantee membrane thickness meets or exceeds specified thickness when tested according to ASTM D751.

2.02 ROOFING MATERIALS

A. PVC Sheet: the following or equal:

   1. Thermoplastic membrane, fiberglass scrim reinforcement, with lacquer coating and factory applied 9 ounce.

B. PVC Sheet Thickness: The following or equal:
   1. Sarnafil G410, 80 mil (2.0 mm) for roof deck.
   2. Sarnafil G410, 60 mil (1.5 mm) for interior face of parapet walls, and curbs.

C. PVC Sheet Exposed Face Color: the following or equal:
   1. EnergySmart White, initial solar reflectance of 0.83, emittance of 0.90, and solar reflective index (SRI) of 104.

D. Membrane Attachment Component: The following or equal:
   1. Sarnacol 2170 (solvent based adhesive).

E. Roof Board and Insulation Attachment Components: The following or equal:
   1. Sarnacol AD Board Adhesive (urethane based adhesive).

F. Roof Board: The following or equal:
   1. Securock Gypsum-Fiber.

G. Deck Primer: The following or equal:
   1. Sarnavap Primer.

H. Flashing Materials:
   1. Wall/Curb Flashing: The following or equal:
      a. Detail Membrane.
   2. Misc. Flashing Accessories: The following or equal as recommended by manufacturer:
      a. Sarnacircles.
      b. Sarnacorners Inside.
      c. Sarnacorners Outside.
      d. Sarnastack Universal.
      e. Sarnastack Split.
      f. Open Post Flashing.
      g. Sarnareglet.
      h. Sarnacol 2170 adhesive.
      i. G410 Coverstrip.

I. Miscellaneous Materials: The following or equal as recommended by manufacturer:
   1. Accessories:
      a. Aluminum Tape.
      b. Seam Cleaner.
      c. Sarnastop.
   2. Sealants and Pitch Pocket Fillers:
      a. Sikaflex-1a.
      b. Sarnafiller.
      c. Multi-Purpose Tape.
   3. Temporary Overnight Tie-ins (must be removed prior to start of next day's roofing):
      a. Shall be in compliance with manufacturer's recommendation.

J. Walkway Protection:
   1. Crossgrip XTRA.

PART 3 EXECUTION

3.01 EXAMINATION

A. Applicator shall verify that the work done under related sections meets the following conditions:
   1. Roof drains and scuppers have been installed properly, or reconditioned, or replaced.

2. Roof curbs, nailers, equipment supports, vents and other roof penetrations are properly secured and prepared to receive new roofing materials.
3. All surfaces are smooth and free of dirt, debris and incompatible materials.
4. For concrete deck, verify that concrete substrate is dry and free of moisture. Verify that concrete curing compounds that will impair adhesion of roofing components to roof deck have been removed.
5. All roof surfaces shall be free of water, ice and snow.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's most current requirements. Remove sharp projections.

B. Prevent materials from entering and clogging roof drains and flashings and from spilling or migrating onto surfaces of other construction. Remove roof drain plugs when no work is taking place or when rain is forecast.

3.03 ROOFING INSTALLATION, GENERAL

A. Install roofing system according to product manufacturer's most current requirements including but not limited to roofing applicator handbook, product data sheets, specifications, and or relevant technical bulletins.

B. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at end of workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.

3.04 INSULATION / ROOF BOARD INSTALLATION

A. Coordinate installing roofing system components so insulation or roof boards are not exposed to precipitation or other sources of moisture.

B. Comply with product manufacturer's most current requirements for installing insulation or roof boards.

C. Install tapered insulation to conform to slopes indicated.

D. Install insulation to achieve required thickness. Use at least 2 layers of insulation when the total insulation thickness exceeds 2.7 inches. Stagger joints in both directions at least 12 inches between layers.
   1. Where installing composite and non-composite insulation in two or more layers, install non-composite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.

E. Trim insulation where necessary at roof drains so completed surface is smooth and does not restrict flow of water.

F. Drains shall be properly sumped to allow membrane to sit flat without stretching or wrinkling.

G. Fill gaps exceeding 1/4 inch with insulation. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.

H. Installation Method:
   1. Urethane Adhered: Install layer/s of insulation or roof board and secure by adhering to substrate by using Sarnacol Urethane Board Adhesive at the spacing rate and application method according to Sika and Owner's Representative/Designer.

3.05 ROOFING MEMBRANE INSTALLATION

A. The surface of the insulation or substrate shall be inspected prior to installation of the Sarnafil roof membrane. The substrate shall be clean, dry, free from debris and smooth with no surface roughness or contamination. Broken, delaminated, wet or damaged insulation boards shall be removed and replaced.

B. Accurately align roofing, and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.

C. Apply roofing with side laps shingled with slope of roof deck where possible.

D. Make sure seam areas are free of debris, dirt, and dust, overlap membrane sheets, and hot-air weld side and end laps of roofing and sheet flashings according to manufacturer's most current requirements to ensure a watertight seam installation.
   1. Verify in-field weld strength of seams a minimum of twice daily, repair seam sample areas.
   2. Test lap edges with probe to verify seam weld continuity.
   3. If any tears or voids in lapped seams are found repair using appropriate approved technique.

E. Adhered System:
   1. Solvent Based Adhesive:
      a. Roller apply Sarnacol 2170 adhesive to the substrate with solvent-resistant rollers. Only the substrate area which can be completely covered with membrane in the same day's operations shall be coated with adhesive. Allow adhesive to dry completely.
      b. Coat the substrate again with adhesive and allow to dry slightly to produce strings when touched with a dry finger, unroll membrane onto the 2nd coated substrate. Do not allow second application of adhesive on the substrate to dry completely. The bonded sheet shall be pressed firmly in place with a minimum 100 pound steel membrane roller.

3.06 BASE / FIELD FLASHING INSTALLATION

A. Install all membrane and preformed flashings according to roofing system manufacturer's most current requirements.

B. Install membrane base flashing by applying bonding adhesive to substrate and underside of membrane flashing at required rate. Do not apply to seam area of flashing.

C. Flash field penetrations and inside/outside corners with appropriate prefab flashing components or by approved custom in-field fabrication technique.

D. Firmly roll membrane flashing into the adhesive. Hot-air weld side and end laps to ensure a watertight seam installation.

E. Terminate and seal top of membrane flashings and mechanically anchor to substrate by approved Sika Corporation - Roofing detail.

F. Spread continuous sealant bead leaving no gaps over deck drain flange at roof drains, and securely seal roofing in place with clamping ring.

3.07 WALKWAY INSTALLATION

A. Crossgrip XTRA: Install walkway product in locations indicated, loose-lay on deck sheet, and connect butt ends together.

3.08 FIELD QUALITY CONTROL

A. Arrange for roofing system manufacturer's technical personnel to inspect roofing installation upon completion.

B. Repair or remove and replace components of roofing system that do not comply with specified requirements.

C. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.

D. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.

3.09 PROTECTION

A. Protect roofing system from damage and wear during construction period. Inspect roofing for damage if used during construction

END OF SECTION

SECTION 07700

ROOF SPECIALTIES AND ACCESSORIES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Manufactured roof specialties and accessories, including the following:
   1. Metal coping.
   2. Reglet and counterflashing systems.

1.02 SUBMITTALS

A. Product data: Include finish and color options.

B. Shop drawings. Include equipment curbs and supports details.

C. Certifications: Certify that curbs are capable of supporting the specified equipment as specified in Section 01612 - Seismic Design Criteria.

D. Samples: Include finish and color samples.

E. Manufacturer's Installation Instructions.

F. Warranties.

1.03 QUALITY ASSURANCE

A. Manufacturer qualifications: Manufacturer of proposed product for minimum 5 years with satisfactory performance record.

B. Installer qualifications: Installer of products similar to specified products on minimum 5 projects of similar scope as Project with satisfactory performance record.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products in accordance with manufacturer's recommendations.

1.05 WARRANTY

A. Provide manufacturers' standard warranties that warranty against defects for longer than 1 year.

PART 2 PRODUCTS

2.01 METAL COPINGS

A. Manufacturers: One of following or equal:
   1. Peterson Aluminum Corp., Pac-Lok.
   2. MM Systems Corp., Snap-Lok.
   3. W. P. Hickman Co., Permasnap.

B. Characteristics:
   1. Capable of direct attachment to top of masonry walls.
   2. Capable of counterflashing roofing.
   3. Edge securement shall comply with Chapter 16 of the 2015 International Building Code and tested in compliance.

C. Copings:
   1. Material: Aluminum, minimum 0.063 inch thick.
   2. Width: To suit wall thickness.
   3. Length: 144 inches.
   4. Face Heights: Sufficient to conceal nailers or roof decking.
   5. Corners: Mitered and welded with minimum 24-inch legs.
   6. Finish: Kynar® 500, resin-base color coating. Color as selected from manufacturer's standard color line.

D. Splice plates: Same materials, width, face heights, and finish as coping, 6 inches long.

E. Seal strips: Extruded Butyl with protective paper.

F. Anchor plate: Galvanized steel. Same width, face height as coping, approximately 12 inches long.

G. Fasteners and anchors: Manufacturer's recommendation.

2.02 REGLET AND COUNTERFLASHING SYSTEMS

A. Manufacturers: One of the following or equal:
   1. Fry Corp.
   2. Cheney Flashing Co.

B. Metal reglet and counterflashing system:
   1. Material: Aluminum, minimum 0.025-inch thick.
   2. Reglet: Type for embedding in masonry with 4-inch wide top flange.
   3. Counterflashing: Formed with snap lock flange to engage reglet receive and to provide spring action at bottom edge against roofing base flashing.
   4. Hold down clips: Type 302 stainless steel, with fasteners.
   5. Sealant: As specified in Section 07900 - Joint Sealants.

C. Retainer system for flexible counterflashing:
   1. Retainer: Type for embedding in masonry.
   2. Locking gasket: Vinyl rope capable of locking into reglet and firmly holding flashing.
   3. Sealant: As specified in Section 07900 - Joint Sealants.

D. Reglet system for non-proprietary counterflashing:
   1. Reglet: Original with spacer channel and vinyl rope.
   2. Sealant: As specified in Section 07900 - Joint Sealants.

E. Lengths: Longest possible.

F. Joints: With alignment splines.

G. Corners: Prefabricated, watertight.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install roof accessories and specialties accordance with manufacturers' instructions.

3.02 INSTALLATION OF METAL COPINGS

A. Accurately align and install metal copings with uniformly smooth vertical faces.

B. Attach anchor plate to top of wall at 72 inches on center.

C. Install splice plates on anchor plates at splice joints of coping. Install seal strips on top of plate and down face approximately 1/2 inch. Apply slight pressure on sealant to incur adherence to clean, dry splice plate. Remove protective paper from sealant.

D. Fully engage hook on front face of coping with front leg of anchor plates, pivot coping into position pressing firmly at rear over each anchor plate until hook on rear face of coping snaps into place.

E. Leave 1/4-inch joint between abutting ends at splice plates.

3.03 INSTALLATION OF METAL REGLET AND COUNTERFLASHING SYSTEM

A. Verify that reglets have been installed properly with minimum 3-inch overlaps.

B. Apply sealant on back of surface mounted reglets. Fasten reglets to wall with minimum 3-inch overlaps.

C. Install hold down clips at minimum 30 inches on center. Insert counterflashings in reglets. Ensure spring action of counterflashing over roofing base flashings. Turn hold down clips over counterflashings.

D. Apply sealant on tops of surface mounted reglets in accordance with Section 07900 - Joint Sealants.

END OF SECTION

SECTION 07900

JOINT SEALANTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Acrylic-Latex sealant.
   2. Precast concrete joint sealant.
   3. Silicone sealant.
   4. Synthetic rubber sealing compound.
   5. Synthetic sponge rubber filler.
   6. Related materials.

1.02 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO):
   1. M198 - Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.

B. ASTM International (ASTM):
   1. C920 - Standard Specification for Elastomeric Joint Sealants.
   2. C990 - Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.
   3. C1330 - Standard Specification for Cylindrical Sealant Backing for Use with Cold Liquid-Applied Sealants.
   4. C1521 - Standard Practice for Evaluating Adhesion of Installed Weatherproofing Sealant Joints.
   5. D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension.
   6. D624 - Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomer.

1.03 SUBMITTALS

A. Product data.

B. Samples, include color selections.

C. Manufacturer's Installation Instructions.

D. Warranty.

1.04 QUALITY ASSURANCE

A. Manufacturer qualifications: Manufacturer of proposed product for minimum 5 years with satisfactory performance record.

B. Installer qualifications: Manufacturer approved installer of products similar to specified products on minimum 5 projects of similar scope as Project with satisfactory performance record.

1.05 PROJECT/SITE CONDITIONS

A. Environmental requirements: Do not apply sealant on wet or frosty surfaces or when surface temperature is higher than 100 degrees Fahrenheit or lower than recommended by the manufacturer.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products in accordance with manufacturer's recommendations.

B. Code date packages. Do not use material older than manufacturer’s published shelf life. Store materials at temperatures lower than 80 degrees Fahrenheit. Condition materials in accordance with manufacturer’s instructions prior to installation.

1.07 SEQUENCING AND SCHEDULING

A. Caulk joints prior to painting.

1.08 WARRANTY

A. Warrant to correct defective products for minimum 1 year in accordance with manufacturer's standard warranty.

PART 2 PRODUCTS

2.01 SEALANTS

A. General:
   1. Provide colors matching materials being sealed.
   2. Where compound is not exposed to view in finished work, provide manufacturer's color which has best performance.
   3. Nonsagging sealant for vertical and overhead horizontal joints.
   4. Sealants for horizontal joints: Self-leveling pedestrian/traffic grade.
   5. Joint cleaner, primer, bond breaker: As recommended by sealant manufacturer.
   6. Sealant backer rod and/or compressible filler made from closed cell polyethylene, polyethylene jacketed polyurethane foam, or other flexible, nonabsorbent, non-bituminous material recommended by sealant manufacturer to:
      a. Control joint depth.
      b. Break bond of sealant at bottom of joint.
      c. Provide proper shape of sealant bead.
      d. Serve as expansion joint filler.

2.02 ACRYLIC-LATEX SEALANT

A. Permanently flexible, nonstaining, and nonbleeding latex modified acrylic sealant compound, colors as selected by Engineer from manufacturer's standard options:
   1. Manufacturers: One of the following or equal:
      a. Tremco, Tremflex 834.
      b. Pecora Corp., Number AC-20.
      c. Sonneborn, Sonolac.

2.03 PRECAST CONCRETE JOINT SEALANT

A. Preformed, cold-applied, ready-to-use, flexible joint sealant in accordance with ASTM C990 and AASHTO M 198:
   1. Manufacturers: One of the following or equal.
      a. Henry Corp., Ram-Nek.
      b. Concrete Sealants Division, ConSeal.

2.04 SILICONE SEALANT

A. ASTM C920, Type S, Grade NS, Class 25, single component silicone sealant:
   1. Manufacturers: One of the following or equal:
      a. Tremco, Proglaze.
      b. Pecora Corp., Number 864.
      c. Dow Corning, Number 795.
      d. General Electric, Number 1200 Series.

2.05 SYNTHETIC RUBBER SEALING COMPOUND

A. Manufacturer: One of the following or equal:
   1. Sika Corporation, Sikaflex 2c NS or SL
   2. Pacific Polymers, Elastothane 227R.

B. Material: In accordance with ASTM C920 Type M, Grade P (pourable), Class 25 and Type M, Grade NS (non-sag), Class 25; multi-part polyurethane; able to cure at room temperature to firm, highly resilient polymer; able to perform satisfactory when continuously submerged in water or sewage and exposed to direct sunlight in dry condition; with the following properties determined at 75 degrees Fahrenheit and 50 percent relative humidity:
   1. Base: Polyurethane rubber.
   2. Application time: Minimum 2 hours.
   3. Cure time: Maximum 3 days.
   4. Tack free time: Maximum 24 hours.
   5. Ultimate hardness: Non-sag 25, Pourable/SL 40, within 5 Shore A.
   6. Tensile strength: Non-sag 95 pounds per square inch minimum and self-leveling minimum 170 pounds per square inch when tested in accordance with ASTM D412.
   7. Ultimate elongation: Minimum 340 percent when tested in accordance with ASTM D412.
   8. Tear resistance: Non-sag 45 pounds per inch minimum and self-leveling minimum 85 pounds per inch when tested in accordance with ASTM D624, Die C.
   9. Service temperature range: Minus 25 degrees to 158 degrees Fahrenheit.

C. Color: Gray to match concrete, unless indicated on the Drawings.

2.06 SYNTHETIC SPONGE RUBBER FILLER

A. Closed-cell expanded sponge rubber manufactured from synthetic polymer neoprene base, or resilient polyethylene foam backer rod. In accordance with ASTM C1330, Type C:
   1. Manufacturers: The following or equal:
      a. Presstite, No. 750.3 Ropax Rod Stock.

B. Characteristics:
   1. Suitable for application intended.
   2. Strength: As necessary for supporting sealing compound during application.
   3. Resiliency: Resistance to environmental conditions of installation.
   4. Bonding: No bonding to the sealing compound.
   5. Structure: Cellular, prevents absorption of water.
   6. Compatibility with other materials in joint and acceptance by manufacturer of sealing compound.
   7. Size: Minimum 25 percent greater than nominal joint width.

2.07 RELATED MATERIALS

A. Primer: Nonstaining type, recommended by sealant manufacturer to suit application.

B. Joint cleaner: Noncorrosive, nonstaining, compatible with joint forming materials and as recommended by sealant manufacturer.

C. Bond breaker tape: Pressure-sensitive tape recommended by sealant manufacturer to suit application.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify acceptability of joint dimensions, physical, and environmental conditions.

B. Verify that surfaces are dry, clean, and free of dirt, grease, curing compound, and other residue which might interfere with adhesion of sealants.

3.02 PREPARATION

A. Allow concrete to cure thoroughly before caulking.

B. Synthetic sponge rubber filler:
   1. Prepare surfaces designated to receive filler in accordance with manufacturer's installation instructions.
   2. Do not stretch filler beyond its normal length during installation.

C. Caulking:
   1. Verify that surfaces are dry, clean, and free of dirt, grease, curing compounds, and other residue that might interfere with adhesion of sealant.

2. Concrete, masonry, wood, and steel surfaces: Clean and prime in accordance with manufacturer's instructions prior to caulking.

D. Synthetic rubber sealing compound:
   1. Ensure surfaces to which synthetic rubber must bond are dry and free of dust, dirt, and other foreign residue.
   2. Heavy sandblasted caulking groove to sound surface, and prime with manufacturer's recommended primer for particular surface.

E. For sidewalks, pavements, and similar joints sealed with elastomeric sealants and subject to traffic and other abrasion and indentation exposures, fill joints to depth equal to 75 percent of joint width, but neither more than 5/8 inches deep nor less than 3/8 inches deep.

F. For normal moving building joints sealed with elastomeric sealants not subject to traffic, fill joints to depth equal to 50 percent of joint width, but neither more than 1/2 inch deep nor less than 1/4 inch deep.

G. For joints sealed with acrylic-latex sealants, fill joints to depth in range of 75 percent to 125 percent of joint width.

H. Use joint filler to achieve required joint depths, to allow sealants to perform properly.

I. Prepare surfaces and install synthetic sponge rubber filler in accordance with manufacturer's recommendations.

J. Do not stretch filler beyond normal length during installation.

K. Apply bond breaker when recommended by joint sealer manufacturer.

3.03 INSTALLATION

A. Synthetic sponge rubber filler: Install filler in accordance with manufacturer's installation instructions.

B. Caulking, joints, and sealing:
   1. Construct expansion, contraction, and construction joints as indicated on the Drawings.
   2. Install pipe and conduit in structures as indicated on the Drawings.
   3. Caulk doors, windows, louvers, and other items installed in or over concrete openings inside and out.
   4. Use synthetic rubber sealing compound for caulking where indicated on the Drawings or as specified, except for masonry construction and where specified otherwise.
   5. Complete caulking prior to painting.
   6. Verify that concrete is thoroughly cured prior to caulking.
   7. When filler compressible material is used, use untreated type.
   8. Apply caulking with pneumatic caulking gun.
   9. Use nozzles of proper shape and size for application intended.
   10. Maintain continuous bond between caulking and sides of joint to eliminate gaps, bubbles, or voids and fill joint in continuous operation without layering of compound.

11. Employ experienced applicators to caulk joints and seams in neat workmanlike manner.
12. To hasten curing of compound when used on wide joints subject to movement, apply heat with infrared lamps or other convenient means.
13. Apply synthetic rubber sealing compound with pneumatic caulking tool or other acceptable method.

3.04 CLEANING

A. Clean surfaces adjacent to sealant as work progresses.

B. Remove excess uncured sealant by soaking and scrubbing with sealant cleaning solvent.

C. Remove excess cured sealant by sanding with Number 80 grit sandpaper.

D. Leave finished work in neat, clean condition.

3.05 SCHEDULE

A. Acrylic latex:
   1. Use where indicated on the Drawings.
   2. Interior joints with movement less than 7.5 percent and not subject to wet conditions.

B. Silicone:
   1. Use where indicated on the Drawings.
   2. Joints and recesses formed where window, door, louver and vent frames, and sill adjoin masonry, concrete, stucco, or metal surfaces.
   3. Door threshold bedding.
   4. Moist or wet locations, including joints around plumbing fixtures.
   5. Stainless steel doors and frames, including joints between applied stops and frames, and around anchor bolts.
   6. Plenum joints.

C. Synthetic rubber sealing compound, non-sag Type II:
   1. Use where indicated on the Drawings.
   2. Water-bearing and earth-bearing concrete structures.
   3. Joints in masonry, concrete vertical surfaces, and metal-faced panels in vertical surfaces.
   4. Joints between sheet metal flashing and trim.
   5. Joints between sheet metal flashing and trim, and vertical wall surfaces.
   6. Small voids between materials requiring filling for weathertight performance in vertical surfaces.
   7. Perimeters of frames of doors, windows, louvers, and other openings where bonding is critical to airtight performance.
   8. Expansion and control joints in masonry vertical surfaces.

D. Synthetic rubber sealing compound, self-leveling Type I:
   1. Use where indicated on the Drawings.
   2. Expansion and control joints in masonry, concrete horizontal surfaces, and metal panels in horizontal surfaces.

3. Small voids between materials requiring filling for weathertight performance in horizontal surfaces.
4. Pavement joints.
5. Perimeters of frames of doors, windows, louvers, and other openings in horizontal surfaces where bonding is critical to airtight performance.

3.06 FIELD QUALITY CONTROL

A. Adhesion testing:
   1. Perform adhesion tests in accordance with ASTM C1521 per the following criteria:
      a. Water bearing structures: 1 test per every 1,000 LF of joint sealed.
      b. Exterior precast concrete wall panels: 1 test per every 2,000 LF of joint sealed.
      c. Chemical containment areas: 1 test per every 1,000 LF of joint sealed.
      d. Building expansion joints: 1 test per every 500 LF of joint sealed.
      e. All other type of joints except butt glazing joints: 1 test per every 3,000 LF of joint sealed.
      f. Manufacturer's authorized factory representative provide written recommendations for remedial measures on failing tests.

END OF SECTION

SECTION 08110

HOLLOW METAL DOORS AND FRAMES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Steel Non-Fire Resistive Rated:
   1. Doors.
   2. Door frames.

1.02 REFERENCES

A. American National Standards Institute (ANSI):
   1. A250.6 - Hardware on Steel Doors (Reinforcement Application).
   2. A250.8 - Recommended Specification for Standard Steel Doors and Frames.

B. ASTM International (ASTM):
   1. A653 - Standard Specification for Sheet Steel, Zinc Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   2. A924 - Standard Specification for General Requirements for Steel Sheet, Metallic- Coated by the Hot-Dip Process.
   3. A1008 - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
   4. A1011 - Standard Specification for Steel, Sheet and Strip, Hot Rolled, Carbon, Structural, High Strength Low Alloy, High Strength Low Alloy with Improved Formability, and Ultra High Strength.
   5. E152 - Standard Methods of Fire Tests of Door Assemblies.
   6. E413 - Classification for Rating Sound Insulation.
   7. E1408 - Standard Test Method for Laboratory Measurement of the Sound Transmission Loss of Door Panels and Door Systems.
   8. E2074 - Standard Test Method for Fire Tests of Door Assemblies, Including Positive Pressure Testing of Side-Hinged and Pivoted Swinging Door Assemblies.

C. National Association of Architectural Metal Manufacturers (NAAMM)/Hollow Metal Manufacturers Association (HMMA):
   1. HMMA 861 - Guide Specifications For Commercial Hollow Metal Doors and Frames.

D. Steel Door Institute (SDI):
   1. SDI-111 - A Steel Doors and Frame Details.
   2. SDI-117 - Manufacturing Tolerances Standard Steel Doors and Frames.

1.03 SUBMITTALS

A. Product data.

B. Shop drawings: Show the following with references to the Engineer's door marks and hardware groups:
   1. Location of door and frame types.
   2. Details of fabrication, including core construction, glass lights, louvers, weatherstripping, and factory finish for each door.
   3. Cutouts and reinforcements for hardware.
   4. Methods of installation and anchorage to adjacent construction.

C. Manufacturer's instructions: Submit manufacturer's installation instructions.

1.04 QUALITY ASSURANCE

A. Testing agency qualifications: Approved by ultimate enforcing authority for the Project; regularly engaged in inspection of materials and workmanship at factory.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Before delivery, identify type and size of each door and frame in such a way that markings will not damage finish.

B. Preassemble doorframes in shop and deliver to Project site with spreader bar at sill or tie them in pairs to form box.

C. Protect doors and frames with resilient packaging sealed with heat shrunk plastic. Break seal on-site to permit ventilation.

D. Protect doors and frames during shipment and storage to prevent warping, bending, and corrosion.

1.06 SEQUENCING AND SCHEDULING

A. Ensure timely delivery of reviewed hardware schedule and hardware templates such that no delay occurs in the work of the Contract.

PART 2 PRODUCTS

2.01 MATERIALS

A. Sheet steel: ASTM A1008, commercial quality, level, cold rolled steel, or ASTM A1011, hot rolled, pickled and oil rolled steel. Galvanize by hot-dip process with zinc-coating in accordance with ASTM A924 or with ASTM A653 and the coating designation A60.

B. Clips, bolts, screws, and rivets: sized as recommended by manufacturer.

C. Primer: Rust- inhibitive epoxy primer compatible with high-solids epoxy finish coating system as specified in Section 09960 - High-Performance Coatings.

D. Touch-up materials: Primer as recommended by manufacturer.

E. Door hardware: As specified in Section 08710 - Door Hardware.

F. Grout: As specified in Section 04220 - Concrete Unit Masonry.

2.02 DOOR AND FRAME TYPES

A. Interior doors: ANSI 250.8, Grade III, Model 3 or NAAMM HMMA 810 Type A and NAAMM HMMA 861, flush steel rib-stiffened, minimum 18 gauge face sheets.

B. Exterior doors: ANSI 250.8, Grade III, Model 3, or NAAMM HMMA 810 Type A and NAAMM HMMA 861, flush steel rib-stiffened, minimum 16 gauge face sheets.

C. Interior frames: ANSI 250.8 or NAAMM HMMA 861, fully welded frames, minimum 16 gauge, sizes and shapes as indicated on the Drawings.

D. Exterior frames: ANSI 250.8 or NAAMM HMMA 861, fully welded frames HMMA 861, except minimum 14 gauge sizes and shapes as indicated on the Drawings.

2.03 COMPONENTS

A. Door cores:
   1. Stiffeners: Vertical steel ribs formed from minimum 22-gauge plain sheet steel, spaced at maximum 6 inches apart and securely attached to face sheets by spot welds at maximum 5 inches on center.
   2. Core fillers: Insulation, minimum 0.60 pound density noncombustible type, installed in spaces between stiffeners for full height of door; labeled door core material shall conform to requirements of labeling authority.

2.04 FABRICATION OF FRAMES

A. Galvanize all frames installed in exterior openings.

B. Frames: Sheet steel, integral type, welded continuous to full depth of frames with minimum 5/8-inch deep stops, unless otherwise indicated on the Drawings.

C. Hardware reinforcement: Minimum 7 gauge at hinges; 12 gauge at strikes, bolts, closers, and other applied hardware.

D. Jamb Anchors: As required for adjacent wall construction, minimum 3 per jamb, unless otherwise indicated on the Drawings.

E. Floor anchors: Fixed type, except where adjustable anchors are indicated on the Drawings, 1 per jamb, with minimum 2 holes for anchorage. Where floor fill occurs, terminate bottom of frames at indicated finished floor level and support by adjustable extension clips resting on and anchored to structural slabs.

F. Anchors at masonry: Adjustable strap and stirrup, minimum 16 gauge corrugated or perforated steel at maximum of 30 inches on center and extending minimum 8 inches into masonry.

G. Masonry angle stiffeners: Factory welded into heads of frames for installation in openings more than 48 inches wide.

2.05 FABRICATION OF DOORS

A. Galvanize all doors installed in exterior openings.

B. Reinforce face sheets with steel rib stiffeners, spaced at maximum 6 inches apart, and securely attached to face sheets by spot welds at maximum 5 inches on center.

C. Fill voids between face sheets and stiffeners with fiberglass insulation having a minimum density of 0.8 pounds per cubic foot.

D. Edges: Full weld without visible joints. Bevel striking edge 1/8 inch in 2 inches.

E. Tops and bottoms of doors: Close with continuous recess steel channel of minimum 16 gauge, extending full width of door and spot welded to both faces.

F. Tops and bottoms of exterior doors: Flush closing channels welded to make tops and bottoms waterproof with weep holes for escape of moisture.

G. Hinge reinforcement: 7 gauge.

H. Lock, closer, and flush bolt reinforcement: 12 gauge.

I. Astragals:
   1. Install on active leaf of double doors in accordance with UL listing requirements for fire resistive ratings as indicated on the Drawings, and for exterior pairs of doors.
   2. Do not install on doors swinging in pairs with rating of 90 minutes or less in means of egress where both leaves are required to provide building code required exiting widths.
   3. Do not provide astragal cutouts for hardware operations.

J. Astragal clearances for non-fire resistive rated doors: Same as fire resistive rated doors, unless otherwise indicated on the Drawings.

2.06 HARDWARE PREPARATION

A. Cutout, drill, and reinforce frames and doors for hardware in accordance with hardware templates.

B. Install plaster guards or mortar boxes in back of hardware cutouts in and welded to frames.

C. Prepare fire resistive rated doors for hardware in accordance with requirements of labeling authority.

D. Do not weld hinges to doorframes.

E. Silencers:
   1. Drill single leaf doorframe jamb stops for minimum 3 silencers.
   2. Drill double-leaf doorframe head stops for minimum 2 silencers.
   3. Do not drill doorframes for silencers when weatherstripping is to be installed.

2.07 FINISHING

A. Thoroughly clean surfaces of oil, grease, and other impurities; touch-up abraded galvanizing; and chemically etch.

B. Fill irregularities and sand smooth finish surface. Apply 1 coat of manufacturer's standard rust inhibitive baked-on primer.

C. Finish painting: High solids epoxy polyurethane system:
   1. Exterior and interior doors and frames: As specified in Section 09960 - High-Performance Coatings.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine reviewed hardware schedules and verify proper coordination of hardware and doors and frames.

B. Examine opening locations and verify the following:
   1. Correctness of dimensions, backing, or support conditions.
   2. Absence of defects that would adversely affect frame or door installation.

3.02 INSTALLATION

A. Install doors and frames in accordance with approved shop drawings and manufacturer's instructions.

B. Frames:
   1. Set accurately in position, plumb, align, and attach securely to structure.
   2. Set in place before construction of adjacent masonry or framed walls.
   3. Anchor frames to previously placed concrete.
   4. Set frames before removing spreader bars.
   5. Fully grout frames in masonry as the Work progresses.
   6. Grout frames at concrete through keyways provided at head and jambs.

C. Doors: Install at correct openings, ensure smooth swing and proper closure with frame.

D. Door hardware: Install in accordance with Section 08710 - Door Hardware.

E. Separate or isolate dissimilar metals with neoprene gaskets, sleeves, and washers, or with coatings acceptable to the Engineer.

3.03 TOLERANCES

A. Manufacturing and installation tolerances: As indicated on the Drawings or in conformance to SDI 117 as minimum.

3.04 ADJUSTING AND CLEANING

A. Prime coat touch-up: Immediately after installation, sand smooth and touch-up rust areas, and other areas where primer has been damaged, with prime touch-up paint.

B. Make adjustments as required for correct, proper, and free function and smooth operation without binding of hardware or doors and frames.

C. Protect doors and frames from damage to surface or profile.

END OF SECTION

SECTION 08320

FLOOR ACCESS DOORS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Non-fire-rated floor access doors.

1.02 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO).

B. Occupational Safety and Health Administration (OSHA):
   1. 29 CFR 1910 - Occupational Safety and Health Standards.

1.03 SUBMITTALS

A. Product data.

B. Shop drawings: Show the following:
   1. Floor access door installation recommendations.
   2. Locations of floor access doors.
   3. Door size and configuration.
   4. Live load capacity.
   5. Materials of construction and finishes provided.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Identify type and size of each floor access door in way not to damage finish prior to delivery.

B. Deliver products only after proper facilities are available.

C. Deliver and store packaged products in original containers with seals unbroken and labels intact until time of use.

D. Handle carefully to prevent damage and store on clean concrete surface or raised platform in safe, dry area.
   1. Do not dump onto ground.

E. Protect floor access doors during shipment and storage to prevent warping, bending, and corrosion.

1.05 WARRANTY

A. Provide manufacturer’s warranty against defects in material and workmanship for a period of 5 years.

1.06 MAINTENANCE

A. Deliver 2 keys for each cylinder lock to Owner.

PART 2 PRODUCTS

2.01 LIGHT-DUTY FLOOR ACCESS DOORS

A. Manufacturers: One of the following or equal:
   1. The Bilco Co., Floor Doors Model K or KD (double leaf).
   2. Babcock Davis Associates, Inc., Model BFDNA-SAL or BFDNA-DAL (double leaf).

B. Style: Single leaf or double leaf as indicated on the Drawings, stainless steel, capable of withstanding minimum live load of 150 pounds per square foot, and designed to open to 90 degrees and lock automatically in that position.

C. Door leaf: 1/4-inch aluminum diamond-pattern plate reinforced with stainless steel stiffeners as required for specified live load.

D. Frame: 1/4-inch extruded stainless steel with built-in neoprene cushion and with strap anchors bolted to exterior.

E. Hardware:
   1. Hinges: Cast steel hinges bolted to underside door leaf that pivot on torsion bars that counterbalance door for ease of operation.
   2. Lock: Snap lock with removable handle mounted on door leaf.
   3. Grip handle: Provide vinyl grip handle designed to release cover for closing.
   4. Operating mechanism: Automatic hold-open arm.

2.02 MEDIUM-DUTY FLOOR ACCESS DOORS

A. Manufacturers: One of the following or equal:
   1. The Bilco Co., Model J or JD (double leaf).
   2. Babcock Davis Associates, Inc., Model BFDDP-SAL or BFDDP-DAL (double leaf).

B. Style: Single leaf or double leaf as indicated on the Drawings, stainless steel, capable of withstanding minimum live load of 300 pounds per square foot, channel frame, with drainage couplings.

C. Door leaf: Minimum 1/4 inch, diamond-pattern plate reinforced with stiffeners as required to meet specified live load.

D. Frame: 1/4-inch channel with anchor flange around perimeter.

E. Hardware:
   1. Hinges: Each leaf equipped with a minimum of 2 heavy forged-brass hinges with stainless steel pins.
   2. Lock: Snap lock with removable handle mounted on door leaf.
   3. Grip handle: Provide vinyl grip handle designed to release cover for closing.

4. Operating mechanism: Spring operators designed for ease of operation and automatic hold-open arm with release handle.
5. Drainage assembly: Provide 1-1/2-inch drainage coupling located in corner of the channel frame.

2.03 HEAVY-DUTY OFF-STREET FLOOR ACCESS DOORS

A. Manufacturers: One of the following or equal:
   1. The Bilco Co., Model JH-20 or JDH-20 (double leaf).
   2. Babcock Davis Associates, Inc., Model BFDDH-SAL or BFDDH-DAL (double leaf).

B. Style: Single leaf or double leaf as indicated on the Drawings, aluminum, capable of withstanding minimum AASHTO H-20 wheel load with a maximum deflection of 1/150 of the span, live load channel frame, with drainage couplings.

C. Door leaf: Minimum 1/4 inch, diamond-pattern plate reinforced with stiffeners as required to meet specified live load.

D. Frame: 1/4-inch channel with anchor flange around perimeter.

E. Hardware:
   1. Hinges: Each leaf equipped with a minimum of 2 heavy forged-brass hinges with stainless steel pins.
   2. Lock: Snap lock with removable handle mounted on door leaf.
   3. Grip handle: Provide vinyl grip handle designed to release cover for closing.
   4. Operating mechanism: Spring operators designed for ease of operation and automatic hold-open arm with release handle.
   5. Drainage assembly: Provide 1-1/2-inch drainage coupling located in corner of the channel frame.

2.04 FINISHES

A. Floor access door finishes:
   1. Aluminum: Manufacturer's standard mill finish.
   2. Aluminum in contact with dissimilar metals and concrete: Manufacturer's standard bituminous coating.
   3. Steel: Manufacturer's standard red oxide primer.

B. Hardware finishes:
   1. Provide optional Type 316 stainless steel hardware throughout, including parts of the latch and lifting mechanism assemblies, hold-open arms, and all brackets, hinges, pins, and fasteners.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine construction to receive floor access door and verify correctness of dimensions and other supporting or adjoining conditions.

3.02 PREPARATION

A. Coordinate details with other work supporting, adjoining, or requiring floor access doors.

B. Verify dimensions and profiles for each opening.

C. Verify that location will serve portion of work to which access is required.
   1. Where proposed functional location conflicts with other work, notify the Engineer before installation.

D. Apply coating to aluminum surfaces that will be in contact with dissimilar metals or concrete when there is none.

3.03 INSTALLATION

A. Install floor access doors in accordance with manufacturer's instructions.

B. Ensure correct types and adequate sizes at proper locations.

C. Securely attach frames to supporting work and ensure doors, frames, and hardware operate smoothly and are free from warp, twist, and distortion.

D. Attach drain pipe to coupling provided.
   1. Drainage shall be routed as indicated on the Drawings.

3.04 ADJUSTING

A. Adjust doors, frames, and hardware to operate smoothly, freely, and properly without binding.

3.05 CLEANING

A. Thoroughly clean surfaces of grease, oil, or other impurities; touch up abraded prime coat where applicable.

END OF SECTION

SECTION 08332

OVERHEAD COILING DOORS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Non-fire rated insulated overhead coiling doors.

1.02 REFERENCES

A. National Electrical Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1000 V Maximum).

B. ASTM International:
   1. A123 - Standard specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   2. A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.
   3. A666 - Standard specification for Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
   4. A924 - Standard Specification for General Requirements of Steel Sheet, Metallic-Coated by the Hot-Dip Process (Referenced by ASTM A653).

1.03 DEFINITIONS

A. NEMA:
   1. Type 4 enclosure in accordance with NEMA 250.

1.04 SYSTEM DESCRIPTION

A. Design requirements:
   1. Compatibility with space and service requirements:
      a. Doors and equipment items provided shall be compatible with space limitations specified and indicated on the Drawings.
      b. Make modifications to doors and equipment items necessary to conform with space limitations or with utility services specified for rough-in.
      c. Provide items complete including all necessary ancillary equipment as may be required for complete and trouble-free operation.
   2. Maintenance requirements: For ease of maintenance, provide overhead coiling doors complying with following requirements:
      a. Provide each door assembly as complete unit produced or supplied by a single manufacturer, including frames, sections, brackets, operating mechanisms, hardware, except hardware items specified in Section 08710 - Door Hardware, and all necessary accessories for installation of complete in openings indicated.
      b. Unless otherwise specified, all doors of particular type throughout the entire project shall be as manufactured or supplied by a single manufacturer.

1.05 SUBMITTALS

A. Product data:
   1. General: Submit data completely describing products, including rough-in diagrams.
   2. Electrical operators: Submit complete manufacturer's data for all components for electric door operators. Show motor size and characteristics. Show manufacturer's verification that motor has been adequately sized for each size and type of door required. Submit electrical schematic diagrams.

B. Shop drawings:
   1. Drawings showing complete installation details, required clearances, relation to building structure, complete electrical rough-in requirements required for installation of motor operators for doors and for connection of such doors to fire alarm system, referenced to the door mark number.
   2. Show location and size of access doors required to perform maintenance on doors and auxiliary equipment.

C. Samples: Submit samples of finishes for finish selection.

D. Quality control submittals:
   1. Manufacturer's instructions:
      a. Installation instructions for each type and size of door, including manufacturer's data, operating instructions, and maintenance data.
      b. Furnish installer copy of diagrams and installation instructions.

E. Contract closeout submittals:
   1. Project record documents:
      a. Operation and maintenance data: Provide manufacturer's operation and maintenance data for each different type of door specified, complete with manufacturer's list of recommended spare parts and their prices, electrical schematic diagrams, and name and address of nearest maintenance organization approved by door manufacturer.
      b. Warranty: Provide manufacturer's standard warranty.

1.06 QUALITY ASSURANCE

A. Regulatory requirements:
   1. Wind loading as specified in Section 01614 - Wind Design Criteria.
   2. Seismic requirements for door anchorage and support systems as specified in Section 01612 - Seismic Design Criteria.
   3. Provide electrical materials in NEMA Type enclosures as specified.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Packing, shipping, and storage: Protect doors during shipment and storage to prevent warping, bending, and corrosion.

B. Deliver materials only after proper facilities are available: Provide clean dry surfaces or platform as required and protect from deterioration and foreign matter.

1.08 PROJECT CONDITIONS

A. Field measurements: Field verify all opening dimensions and clearances prior to fabricating doors. Fitting doors to openings is the responsibility of the Contractor.

1.09 SEQUENCING AND SCHEDULING

A. Inserts and anchorages: Furnish inserts and anchoring devices which must be set into concrete or built into masonry. Provide setting drawings, templates, and directions for installation of anchorage devices. Coordinate delivery with other work to avoid delay to the Contract.

PART 2 PRODUCTS

2.01 MANUFACTURED UNITS

A. Manufacturers: One of the following or equal:
   1. Overhead Door Corp.
   2. Wayne-Dalton Corp.
   3. The Cookson Co., Inc.

B. Steel overhead coiling door:
   1. Mounting: Face of wall.
   2. Operation: As indicated on the Drawings.
   3. Curtain:
      a. Exterior slats: Manufacturer’s standard, minimum 20-gauge steel galvanized in accordance with ASTM A653, interlocking flat-faced slats with ends of alternate slats fitted with metal end locks to hold curtain in alignment.
      b. Bottom bar: Steel galvanized in accordance with ASTM A123, fitted with 2 equal-sized steel angles minimum 1/8-inch thick, with lift handle and slide bolt at either end and provided with a flexible PVC bulb type astragal to ensure a consistent seal along the floor. Extrusion designed to interlock with door curtain.
      c. Weatherstripping:
         1) Bottom bar: Manufacturer's standard, provided with a flexible PVC bulb type astragal to ensure a consistent seal along the floor. Extrusion designed to interlock with door curtain.
         2) Door jambs: Manufacturer's standard vinyl extrusion seals, manufacturer's standard.
         3) Hood: Manufacturer's standard vinyl air baffle.
   4. Guides: Steel galvanized in accordance with ASTM A123, formed of roll formed steel channels and angles or structural angles of sufficient depth to provide a groove of adequate depth on each jamb to hold curtain firmly in guides under design wind pressure.
   5. Brackets: Steel galvanized in accordance with ASTM A123, steel plate with permanently sealed ball bearings designed to enclose ends of coil and provide support for counterbalance pipe at each end.
   6. Barrel and counterbalance mechanism: Steel pipe of sufficient size to carry door load with maximum deflection of 0.03 inch per foot of opening width and counterbalanced by helical springs, oil tempered torsion type designed with

minimum safety factor of 1.25 percent, and having cast iron barrel plugs that anchor springs to tension shaft and pipe.

7. Hood: Manufacturer's standard, minimum 24-gauge steel galvanized in accordance with ASTM A653, designed to enclose curtain coil and counterbalance mechanism.

C. Insulation:
   1. Interior slats: Material to match exterior slats as specified in previous article, interlocking flat-faced slats, manufacturer's standard size with ends of alternate slats fitted with metal end locks to hold curtain in alignment.
   2. Insulation: CFC-free Polyethylene foam yielding a minimum R-value of 6.20.

D. Door operators:
   1. Motor operator: Unless otherwise indicated on the Drawings, provide a heavy-duty type motor operator.
      a. High starting torque type motor having sufficient power to operate the load at an average speed of 1 foot per second.
      b. Totally enclosed, fan cooled, continuous-duty motor, sized to suit door size (1 horsepower minimum), with Class B insulation.
      c. 480 volt, 3-phase operation.
      d. Controlled by momentary contact 3-button station marked OPEN, CLOSE, and STOP. As indicated on the Drawings.
      e. Provide automatic screw-type limit switch to break circuit at termination of travel.
      f. Provide gear reducer consisting of high efficiency worm gearing running in an oil bath and a spring set, solenoid-operated brake designed to hold the load when power is off.
      g. Provide emergency hand chain operator which does not affect the time of the limit switch, to operate the load in case of power failure.
      h. Operator to have reversing NEMA Size 1 starter having mechanical and electrical interlocks, properly sized 24-volt control transformer, and other controls necessary for proper operation, completely assembled and wired to a terminal strip to facilitate field wiring of the power source, pushbutton stations, and/or other remote devices.
      i. Unless otherwise indicated on the Drawings, all electrical material supplied shall be in NEMA Type 4 enclosures.
      j. Provide electronic safety edge to reverse direction of door if obstruction is encountered.
      k. Where no safety edge is specified, 2-button constant pressure type pushbutton stations marked OPEN and CLOSE shall be provided in lieu of 3-button station previously indicated.

2.02 ACCESSORIES

A. Fasteners: Sizes and types as recommend by reviewed door manufacturer.

2.03 FINISHES

A. Slats, hood and bottom bar:
   1. Galvanized steel: Manufacturer's standard rust inhibitive prime coat and with powder coat finish as selected by Owner from manufacturer's standard colors.

B. Guides and bracket plates:
   1. Galvanized steel: manufacturer's standard rust inhibitive prime coat in a flat black finish.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of conditions: Examine openings to receive overhead coiling doors and verify:
   1. Dimensions and correctness of backing or support conditions.
   2. Absence of defects that would adversely affect installation.

B. Do not start the work until unsatisfactory conditions are corrected.

3.02 PREPARATION

A. Verify dimensions and design for each opening.

B. Coordinate details with other work supporting or adjoining coiling doors.

C. Furnish fastening devices as required to mount doors properly.

3.03 INSTALLATION

A. Install doors in strict accordance with manufacturer's installation instructions, unless specifically otherwise indicated on the Drawings.

B. Install assemblies plumb, square, and level at their proper elevations and in their proper planes.

C. Securely anchor assemblies to interior face of openings, in manner that provides full opening clearance, perfectly aligned and adjusted for smooth operation.

D. Interface with other products: Separate or isolate dissimilar metals with neoprene gaskets, sleeves, or washers, or with an acceptable coating.

3.04 ADJUSTING

A. Verify that door assemblies are securely anchored to structure, guides are perfectly aligned, and doors are adjusted for smooth operation.

B. Upon completion of installation, ensure doors are free from warp, twist, or distortion and are lubricated and properly adjusted to operate freely.

3.05 CLEANING

A. Thoroughly clean surfaces of grease, oil, and other impurities.

B. Replace any damaged or otherwise disfigured doors with new prior to final acceptance.

3.06 DEMONSTRATION

A. Provide Owner's maintenance employees with minimum of 8 hours of maintenance instruction.

3.07 PROTECTION

A. Protect installed doors from damage until final acceptance.

END OF SECTION

SECTION 08520

ALUMINUM WINDOWS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Fixed aluminum windows with hardware.

1.02 REFERENCES

A. Aluminum Association (AA):
   1. 45 - Designation System for Aluminum Finishes.
   2. 92 - Care of Aluminum.

B. American Architectural Manufacturer's Association (AAMA):
   1. 101 - North American Fenestration Standard/Specification for Windows, Doors, and skylights.

C. ASTM International (ASTM):
   1. B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
   2. C509 - Standard Specification for Elastomeric Cellular Preformed Gasket and Sealing Material.
   3. C864 - Standard Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers.
   4. E283 - Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows Curtain Walls and Doors Under Specified Pressure Differences Across the Specimen.
   5. E330 - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights, and Curtain Walls by Uniform Static Air Pressure Difference.
   6. E331 - Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference.
   7. F588 - Standard Test Methods for Measuring the Forced Entry Resistance of Window Assemblies, Excluding Glazing Impact.

1.03 PERFORMANCE REQUIREMENTS

A. Comply with testing and performance requirements of AAMA and AAMA 101.

B. Air infiltration: Maximum 0.37 cubic feet per minute per foot of operable sash crack length or 0.15 cubic feet per minute per square foot of fixed window area at 6.24 pounds per square foot inward test pressure when tested in accordance with ASTM E283.

C. Water resistance test: No water infiltration when tested at static air pressure difference of 6.00 pound feet per square foot for fixed and ventilator lights in accordance with ASTM E331.

D. Uniform load deflection: Maximum 1/175 of span when tested in accordance with ASTM E330 at static air pressure of 60 pound feet per square foot with ventilators closed and locked and pressure applied first on one side then on other side.

E. Uniform load structural performance: No glass breakage, permanent damage to fasteners, hardware parts, support arms, or actuating mechanism, and damage that would cause the unit to be inoperable when tested in accordance with ASTM E330 at static air pressure difference of 6.24 pounds per square foot with pressure applied first on one side and then other side.

F. Window component structural performance: In compliance with performance requirements indicated by and when tested in accordance with AAMA.

G. Forced entry resistance: Minimum Performance Level 10 when tested in accordance with ASTM F588.

1.04 SUBMITTALS

A. Product data.

B. Shop drawings: Include dimensioned elevations of window openings and sash sizes, complete framing details, glass and glazing details, hardware, and anchorage details to adjacent structure.

C. Samples: Minimum 12 inches in length, illustrating, factory-applied aluminum finishes.

D. Manufacturer's Installation Instructions.

1.05 QUALITY ASSURANCE

A. Regulatory requirements: Design windows to comply with following requirements:
   1. Seismic requirements: As specified in Section 01612 - Seismic Design Criteria.
   2. Wind loading: As specified in Section 01614 - Wind Design Criteria.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Identification: Prior to shipping identify each window with type location of each window, using Engineer's window mark, in manner as not to damage surface.

B. Packing: Provide wrapping or strippable coating to protect prefinished aluminum surfaces.

C. Delivery: Delivery materials only after proper facilities are available.

D. Shipping, storage, and protection: Ship and store materials in manner that prevents damage such as warping, bending, stains, discolorations, scratches, abrasions, or soiling.

1.07 PROJECT CONDITIONS

A. Protect aluminum from damage using protective sleeves, polyethylene sheets, removable coatings, or other suitable means.

B. Remove protective devices only when required to perform work or in absence of damage-producing conditions prior to final acceptance.

PART 2 PRODUCTS

2.01 ALUMINUM WINDOWS

A. AAMA 101, Class F-DW-HC-HC40:
   1. Manufactures: One of the following or equal:
      a. Kawneer Co., Sealair Model 8225T Isolock.
      b. Hope Architectural Products, Model 210T Series.

B. Extrusions: 6063-T5 alloy and temper in accordance with ASTM B221 Alloy G.S. 10A-T5.

C. Glass: Insulating glass, as specified in Section 08800 - Glazing.

D. Glazing: Compatible with aluminum, sealants, and sealing materials and compatible with gasketing material:
   1. Exterior windows: Dry glazed closed cell elastomeric material in accordance with ASTM C509, manufacturer's standard size and shape.
   2. Interior windows: ASTM C864, aluminum glazing bead, snap-in type and compression wedge of dense elastomer.

2.02 FABRICATION

A. Window framing and vent members: One part framing members with 3/8-inch thermal barrier, 2-1/4-inch overall depth, minimum 0.125-inch thick extrusions.

B. Thermal barrier: 2-part, chemically cured, high-density polyurethane.

C. Ventilator corner attachment: Permanently leakproof; mitered, clipped, epoxied, and staked; or mitered, clipped, and sigma arc welded.

D. Frame corners and meeting rail intersection attachments: Permanently leakproof; coped and tenoned, and forged; or mortised and tenoned, and sigma arc welded.

E. Weep slots: Capable of positive drainage to exterior and protected by snap-in-weep covers or integral drips.

F. Glazing beads: 0.050-inch thick.

G. Glazing rabbets: Minimum 13/16-inch deep by width required for glass.

H. Glazing method: Inside.

I. Finishes:
   1. Exposed aluminum: Anodize exposed aluminum surfaces uniformly in accordance with AA 45, Architectural Class 1 Anodic Coating AA-M12C22A42/44, without gripper marks, dark bronze color.

2.03 RELATED MATERIALS

A. Exposed fasteners: Type 305 stainless steel, manufacturer's standard.

B. Concealed fasteners: Manufacturer's standard steel with provisions to isolate dissimilar metals, or aluminum:
   1. Steel in contact with aluminum: Cadmium plated or Type 305 stainless steel.
   2. Steel not in contact with aluminum: Structural or mild steel hot-dip galvanized after fabrication and touched-up when welded.

C. Coatings for isolating dissimilar metals: Manufacturer's standard bituminous paint.

D. Coatings for isolating aluminum from concrete, metal, wood, or other absorptive material: Manufacturer's standard zinc chromate metal primer.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify wall openings and adjoining work are ready to receive aluminum windows.

B. Examine receiving frames and reviewed hardware schedules to verify coordination with doors.

3.02 INSTALLATION

A. Install aluminum windows in accordance with manufacturer's instructions.

B. Set plumb, square, level, and in exact alignment with other work.

C. Anchor frames to structure securely.

D. Align assemblies plumb and level, free of warp or twist. Maintain assemblies dimensional tolerances, aligning with adjacent work.

E. Install watertight flashings.

F. Lead collected moisture or water to outside as directly as possible.

G. Seal joints between framing and building structure in manner to provide watertight installation as specified in Section 07900 - Joint Sealants.

H. Separate or isolate dissimilar metals and materials with coatings:
   1. Apply minimum 2 coats to obtain minimum thickness of 5 mils to isolate dissimilar metals.
   2. Apply minimum 2 coats to obtain minimum thickness of 3 mils to isolate aluminum from concrete, metal, wood or other absorptive material.

I. Install screens and frames at operable units.

3.03 ADJUSTING

A. After completion of glazing and finish painting, adjust windows and window hardware as required for smooth operation and correct function, and lubricate hardware and moving parts as required.

B. Adjust operable units for smooth, free, and easy operation without binding.

3.04 CLEANING

A. Remove protective material from prefinished aluminum surfaces.

B. Clean in accordance with recommendations of AA 92 and reviewed manufacturer's cleaning instructions using only materials approved by aluminum manufacturer. Where doubt exists, make spot tests.

C. Remove soil or other sources of discoloration.

END OF SECTION

SECTION 08710

DOOR HARDWARE

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Door hardware.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
   2. E283 - Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.

B. Builders Hardware Manufacturers Association (BHMA):
   1. A156.7 - Template Hinge Dimensions.
   2. A156.18 - Materials and Finishes.

C. Underwriters Laboratories, Inc.

1.03 SUBMITTALS

A. Product data.

B. Hardware schedule: Include references to Engineer's hardware group number, door type designations, locations, other pertinent data, and manufacturer names or suitable abbreviation opposite items scheduled.

C. Keying Schedule: Include list giving key code and numbers of doors which can be opened by each key.

D. Samples: Include for each different type and manufacturer for review of finish.

E. Construction key distribution list: Submit upon Owner's request.

F. Templates:
   1. Furnish hardware templates to fabricators of doors, frames, and other work to be factory-prepared for hardware.
   2. Check shop drawings of other work to confirm that adequate hardware backing is available.

G. Project record documents: Include corrected hardware schedule.

1.04 REGULATORY REQUIREMENTS

A. Provide hardware for fire-resistive rated openings that complies with UL and listed by UL.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver hardware where directed in unopened packages with items packed separately, complete and ready for installation with necessary fittings, trim, fasteners, and accessories.

B. Provide packages bearing the manufacturers' labels with each item or group of items identified according to the accepted hardware schedule.

1.06 MAINTENANCE

A. Require lockset manufacturers to deliver permanent removable cylinder cores and keys and minimum 2 extractor keys to Owner directly.

1.07 SCHEDULING AND SEQUENCING

A. Upon receipt of accepted hardware schedule, coordinate accepted hardware schedule, templates, reinforcing units, and template instructions to door and frame sections.

B. Restrict distribution of construction keys to superintendents and foremen. Maintain record of persons who have received keys on construction distribution list.

PART 2 PRODUCTS

2.01 FASTENERS

A. Types:
   1. To concrete, marble, or masonry: Machine screws and flush shells.
   2. On gypsum board or plaster: Screws of sufficient length to provide solid connection to framing or backing behind gypsum board or plaster.
   3. To mineral and hollow core doors: Hex bolts.
   4. Of exit devices to doors: Thru-bolts, unless otherwise specified.

B. Screws, exposed: Phillips-head type, full-threaded screws, not combination type.

C. Sizes: Suitable for heavy use.

D. Finish: Stainless steel, unless otherwise required to match material and hardware finish.

2.02 HINGES

A. Manufacturers: One of the following or equal:
   1. Stanley.
   2. Hager.
   3. McKinney.

4. Ives.

B. Material:
   1. Interior doors in corrosive environments: Stainless steel.
   2. Interior doors in operation areas: Brass.
   3. Exterior doors: Stainless steel.

C. Knuckles, number of: Minimum 5.

D. Ball bearings: Concealed with interior self-lubricating bushings.

E. Type for doors with closers: Ball bearing.

F. Material for fire-resistive rated doors: Steel.

G. Pins for interior doors: Non-rising.

H. Pins for exterior doors: Non-removable.

I. Template hinges: BHMA A156.7.

J. Tips: Flat button.

K. Height: As follows, unless otherwise specified:
   1. Doors 1-3/8-inch thick: 3-1/2 inches.
   2. Doors 1-3/4-inch thick and up to 41 inches wide: 4-1/2 inches.
   3. Doors 1-3/4-inch thick and from 41 to 48 inches wide: 4-1/2 inches, extra heavy.
   4. Doors 2 inches thick or over 48 inches wide: 5 inches, extra heavy.

L. Widths: Sufficient to clear trim projection when door swings 180 degrees, unless otherwise specified.

M. Number per door leaf: As follows, unless otherwise specified:
   1. 3 hinges on door to 7 feet, 6 inches in height.
   2. 1 additional hinge for each additional 2 feet, 6 inches of height or fraction thereof.

2.03 LOCKSETS

A. Manufacturers typical: One of the following or equal:
   1. Schlage ND Series Rhodes design with removable core cylinders.
   2. Sargent, Division of Essex Industries, Inc., Model 10-Line with removable core cylinders, and Model L levers and roses.

B. Manufacturers for corrosive environments: Suitable for marine use or other severe climate conditions, having only stainless steel or bronze parts. One of the following or equal:
   1. Schlage L Series with removable core cylinders, and 06A lever and rose.
   2. Sargent, Division of Essex Industries, Inc., Model 8200 with removable core cylinders, and Model L levers, and Model LN roses.

C. Cylinders:
   1. Number of pins: Minimum 6.
   2. Cases: Steel, cylindrical.
   3. Interior parts: Non-corrosive with non-plastic, non-die-cast, non-aluminum mechanisms.
   4. Accessibility to key-in-knob type cylinders: Not requiring removal of lockset from door.
   5. Plugs: Extruded brass bar material fully round without flattened areas.
   6. Cores: Removable.

D. Strikes:
   1. Material: Same as lock trim.
   2. Lock and latch boxes: Wrought.
   3. Lips: Extended, able to protect trim from marring by latch bolt.
   4. Cutouts at metal frames: In accordance with ANSI, unless otherwise specified.

E. Levers: Type that returns to within 1/2 inch of door.

F. Backset: 2-3/4 inches.

G. Trim materials: As follows, unless otherwise specified:
   1. Typical: Stainless steel.
   2. Corrosive environments: Stainless steel.

2.04 CONSTRUCTION KEYING

A. Type: Removable core system.

2.05 PERMANENT KEYING AND KEYS

A. Number of keys:
   1. Grand master keys: 4.
   2. Keyed alike: 8 keys for each keyed alike group furnished.
   3. Keyed different: 2.

B. Identification:
   1. Emboss face of each cylinder plug and key with minimum 3-digit visual key control system.
   2. Emboss DO NOT DUPLICATE on keys.

2.06 CLOSERS

A. Manufacturers:
   1. Features:
      a. Heavy-duty.
      b. Non-handed and non-sized.
      c. Adjustable spring power from size 1 through 4.
      d. Hold open feature where specified.
      e. Manufacturer's special rust inhibitive epoxy primer on every part.
   2. One of the following or equal:
      a. Sargent, 351 Series.
      b. LCN, Super Smoothee Model 4041 Series.
      c. Norton Door Controls, Multi-Size Door Closers Model 7500BF Series.

B. Type: Full rack and pinion type with steel spring and non-gumming, non-freezing hydraulic fluid.

C. Controls: Separate set for regulating sweep speed, latch speed, backcheck and backcheck positioning, or where schedules, spring power.

D. Sizes: As recommended by accepted manufacturer.

E. Covers: Metal, capable of receiving finishes to match adjacent hardware finishes, unless otherwise specified.

F. Narrow frame provisions: Drop plates.

G. Effort to operate: As follows:
   1. Exterior: Maximum 8-1/2 pounds.
   2. Interior: Maximum 5 pounds.

H. Adjust closers in accordance with manufacturer's directions for size of door.

2.07 EXIT DEVICES

A. Lever design:
   1. Manufacturers: The following or equal:
      a. Von Duprin, Lever Model 06.

B. Rim device, non-fire resistive rated:
   1. Manufacturers: One of the following or equal:
      a. Von Duprin Inc., Model Series 98.
      b. Sargent Essex Ind., Model Series 8800.

C. Rim device, fire-resistive rated:
   1. Manufacturers: One of the following or equal:
      a. Von Duprin Inc., Model Series 98-F.
      b. Sargent Essex Ind., Model Series 12-8800.

D. Material: As scheduled.

E. Corrosive environment provisions: Zinc dichromate coated internal parts.

2.08 MISCELLANEOUS DOOR HARDWARE

A. Mechanical holders: Foot-operated plunger with instant release by touch of toe and integral spring to keep constant shoe pressure against floor; brass.
   1. Manufacturers: The following or equal:
      a. Glynn-Johnson.

B. Automatic flush bolts: Mortise, bar with stop-mounted coordinator and strikes; materials as scheduled.
   1. Manufacturers: One of the following or equal:
      a. Glynn-Johnson.
      b. Hager Hinge Co.

C. Kick plates: As scheduled, 0.050-inch thick, beveled edges, 10 inches high, 1-1/2 inches narrower than single doors, 1 inch narrower than leaf of door pairs.
   1. Manufacturers: One of the following or equal:
      a. Ives.
      b. Trimco.

D. Gasketing systems: As scheduled, self-adhesive silicone seal, continuous at head and jambs, rated for fire and smoke in accordance with ASTM E283, sound rated in accordance with ASTM E90.
   1. Manufacturers: One of the following or equal:
      a. Pemko Mfg. Co.
      b. National Guard Products Inc.
      c. Reese.

E. Weatherstripping for exterior doors and smoke, light, and sound seals for interior doors.

F. Thresholds: As scheduled, extruded aluminum, maximum 1/2-inch high, maximum slope of 1 foot in 2 feet.
   1. Manufacturers: One of the following or equal:
      a. National Guard Products Inc.
      b. Pemko Mfg. Co.

G. Dustproof strike: As scheduled.
   1. Manufacturers: One of the following or equal:
      a. Ives.
      b. Trimco.

H. Door bottoms: As scheduled, extruded aluminum with vinyl insert, surface mounted, length equal to door width minus 2 inches, automatic, recessed in bottom of door.
   1. Manufacturers: One of the following or equal:
      a. Pemko.
      b. Reese.

I. Astragals: As specified in Sections 08110 - Hollow Metal Doors and Frames.

J. Silencers: As scheduled, pneumatic gray rubber.
   1. Manufacturers: One of the following or equal:
      a. Trimco.
      b. Ives.
      c. Rockwood.

2.09 FINISHES

A. Brass and bronze: BHMA A156.18 626 (US26D), satin chrome.

B. Steel: BHMA A156.18 652 (US26D), satin chrome.

C. Stainless steel: BHMA A156.18 630 (US32D), satin stainless steel.

D. Aluminum: BHMA A156.18 628 (US28).

E. Plastic closer covers: Spray paint to match typical door hardware finish.

F. Metal closer covers: Plate covers to match typical door hardware finish.

G. Electromagnetic hold open devices: Manufacturer's standard brushed zinc finish.

PART 3 EXECUTION

3.01 EXAMINATION

A. Inspect doors and door frames for damage or defects and examine hardware for compatibility with receiving conditions and suitable to intended use.

B. Verify that required wall backing has been installed.

3.02 INSTALLATION

A. Install finish hardware in accordance with manufacturer's templates and instructions.

B. Accurately and properly fit hardware.

C. Securely fasten fixed parts for smooth, trouble-free, non-binding operation.

D. Fit faces of mortise parts snug and flush.

E. Ensure that operating parts move freely and smoothly without binding, sticking, or excessive clearance.

F. Protection:
   1. Protect door hardware from damage or marring of finish during construction, use strippable coatings, removable tapes, or other acceptable means.
   2. Ensure door hardware displays no evidence of finish paint after final building cleanup.

G. Latch guard and dead bolts: Install so that bolts automatically engage in keeper, whether activated by closer or by manual pressure.

H. Closers:
   1. Mount on opposite sides of corridors or vestibules, except at exterior doors.
   2. Mount for 180-degree swing wherever possible.
   3. Mount with drop plates at narrow top rail doors.
   4. Adjust to operate noiselessly and evenly.
   5. Have closer manufacturer regulate closers prior to final acceptance of project.

I. Kick plates: Screw on push side of doors, unless otherwise indicated on the Drawings.

J. Gasketing: Mount to provide complete contact between door and frame, finished floor, or both; and weathertight enclosure.

K. Thresholds:
   1. Install immediately before inspection for Substantial Completion or protect from heavy traffic damage during construction.
   2. Cope to fit door frame profile and drill to suit required flush bolts and panic bolts.
   3. Unless indicated on the Drawings to be set in grout, set in double bead of sealant, tightly fit at jambs, and make waterproof.
   4. Fasten to concrete slab with 5/16-inch stainless steel flat head countersunk machine screws and concrete anchors at 8-inch centers.

L. Silencers: Insert into predrilled holes in frames.

3.03 CONSTRUCTION KEYING

A. Insert construction cores in cylinders of exterior doors, and doors requiring security and access for workman, unless otherwise directed by the Engineer.

3.04 ADJUSTING

A. Examine hardware in place for complete and proper installation. Lubricate bearing surfaces for proper function.

B. Replace, rework or otherwise correct defective door hardware, including incorrect hand or function.

3.05 CLEANING

A. Remove protective materials and devices and thoroughly clean exposed surfaces of hardware.

B. Check for surface damage prior to final cleaning for acceptance of project.

3.06 HARDWARE SCHEDULE

A. While the Hardware Schedule is intended to cover all doors and other moveable parts of the building and establish a type and standard of quality, it shall be the specific duty and responsibility of the finish hardware supplier to examine the Drawings and Specifications and furnish proper hardware for all openings.

3.07 HARDWARE GROUPS

A. Grit Handling Facility (Area 21):
   1. HW-1: Door 101-1.
      3 EA Hinge BB1191 4 1/2 X 4 1/2 US26D HA.
      1 EA Lockset ND40S 626 SC.
      1 EA Closer 7500 SN-134689 NO.
      1 SET Weatherstripping 303AS PE.
      1 EA Door Bottom 216AV PE.
      1 EA Threshold 170 A PE.
      1 EA Raindrip 346 C PE.
   2. HW-2: Doors 102-1, 104-2.
      3 EA Hinge BB1191 4 1/2 X 4 1/2 US26D HA.
      1 EA Exit Device 9875L X 996L-M US26D VO.

1 SET Manual Flush Bolt FB51P630 Ives.
1 EA Dust Proof Strike DP 2626 Ives.
1 EA Astragal 357 C600 PE.
1 EA Closer 7500 SN-134689 NO.
1 SET Weatherstripping 303AS PE.
1 EA Door Bottom 216AV PE.
1 EA Threshold 170 A PE.
1 EA Raindrip 346 C PE.

3. HW-3: Doors 103-1, 103-5, 104-1, 202-1, ST1-1.
   3 EA Hinge BB1191 4 1/2 X 4 1/2 US26D HA.
   1 EA Exit Device 9875L X 996L-M US26D VO.
   1 EA Closer 7500 SN-134689 NO.
   1 SET Weatherstripping 303AS PE.
   1 EA Door Bottom 216AV PE.
   1 EA Threshold 170 A PE.
   1 EA Raindrip 346 C PE.
4. HW-4: Doors 201-1, ST1-2, ST1-3.
   3 EA Hinge BB1191 4 1/2 X 4 1/2 US26D HA.
   1 EA Exit Device 9875L X 996L-M US26D VO.
   1 EA Closer 7500 SN-134689 NO.
   1 SET Silencers1229A Grey TR.

END OF SECTION

SECTION 08800

GLAZING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Glass and glazing.

1.02 REFERENCES

A. American National Standards Institute (ANSI):
   1. Z97.1 - Safety Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test.

B. ASTM International (ASTM):
   1. C1036 - Standard Specification for Flat Glass.
   2. C1048 - Standard Specification for Heat-Treated Flat Glass - Kind HS, Kind FT Coated and Uncoated Glass.
   3. E773 - Standard Test Method for Accelerated Weathering of Sealed Insulating Glass Units.

C. Glass Association of North America (GANA):
   1. GANA Glazing Manual.

D. Insulating Glass Certification Council (IGCC):
   1. Certified Products Directory.

E. U.S. Consumer Product Safety Commission (CPSC):
   1. 16 CFR 1201 - Safety Standard for Architectural Glazing Materials.

1.03 DEFINITIONS

A. Full height windows: Windows meeting the following conditions:
   1. Lowest edge is less than 18 inches above floor.
   2. Area is greater than 9 square feet.
   3. Walking surface is on both sides either of which is within 36 inches of window.
   4. Window has no minimum 1-1/2-inch railing or mullion at from 24 to 36 inches above floor.

1.04 SUBMITTALS

A. Product data.

B. Shop drawings: Locations of glass types and typical glazing details.

C. Samples: As follows:
   1. Glazing sealants, 2-inch long beads, for color selection.
   2. Glass, 1 square foot of each type specified.

D. Certificates of compliance: Certification that tempered glass in accordance with ANSI Z97.1 and CPSC 16 CFR 1201.

E. Manufacturer's Installation Instructions.

1.05 REGULATORY REQUIREMENTS

A. As specified in Section 01410 - Regulatory Requirements.

B. Wind loading: As specified in Section 01614 - Wind Design Criteria.

C. Provide glass and glazing that conforms to CPSC 16 CFR, Part 1201, and exit requirements of the building code.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle materials in manner to prevent damage.

B. Deliver and store packaged materials in original containers bearing manufacturer's name.

C. Deliver glass affixed with manufacturer's labels showing strength, grade, thickness, type and quality of glass, and for insulating glass, IGCC certification label.

D. Remove labels after installation, inspection, and final acceptance.

1.07 PROJECT CONDITIONS

A. Perform glazing when ambient air temperature is 40 degrees Fahrenheit or above.

1.08 WARRANTY

A. Warrant to replace insulating glass units that exhibit interpane dusting or misting within 10 years with new in accordance with manufacturer's standard warranty.

PART 2 PRODUCTS

2.01 GLASS

A. Clear monolithic: ASTM C1036, Type I, Class 1, Quality q3; minimum 1/4-inch thick.
   1. Manufacturers: One of the following or equal:
      a. PPG Industries, Inc.
      b. Guardian Industries Corp., Sunguard, Clear.

B. Tinted monolithic: ASTM C1036, Type I, Class 2, Quality q3; tinted light bronze; minimum 1/4-inch thick:
   1. Manufacturers: One of the following or equal:
      a. PPG Industries, Inc., Solarbronze.
      b. Guardian Industries Corp., Sunguard, bronze.

C. Tempered: ASTM C1048, Kind FT, Condition A, Type I, Class 1 or Class 2 as scheduled below, Quality q3; tempered without visible tong marks when installed; minimum 1/4-inch thick:
   1. Manufacturers: One of the following or equal:
      a. PPG Industries, Inc., Herculite.
      b. Guardian Industries Corp., equivalent product.

D. Insulating glass units: IGCC Rating Level CBA when tested in accordance with ASTM E773 and E774; hermetically sealed units consisting of minimum 1/4-inch thick, tinted exterior light, minimum 1/4-inch thick, clear interior light, and 1/2-inch wide air space, dehydrated with blended molecular sieve and silica gel desiccant, with metal spacer channel with bent corners and welded splice on 1 vertical side, and polyisobutylene primary and silicone secondary seals.
   1. Manufacturers: One of The following or equal:
      a. PPG Industries, Inc., Twindow.
      b. Guardian Industries Corp., equivalent product.

2.02 GLAZING MATERIALS

A. Setting blocks: Neoprene, 80 to 90 durometer.

B. Spacer blocks: 30 to 40 durometer, thickness equal or greater than insulated window thickness by minimum 6 inches long.

C. Pressure tape: Butyl rubber tape:
   1. Manufacturers: One of the following or equal:
      a. Tremco Mfg. Co., Tremco 440 Tape.
      b. 3-M Co., Weatherban 5422.

D. Sealant: Silicone:
   1. Manufacturers: One of the following or equal:
      a. General Electric Co., Silicone Construction Sealant Series SCS-1200.
      b. Dow Corning Corp., 999-A, Silicone Building and Glazing Sealant.

E. Glazing gaskets and other materials for exterior openings:
   1. As specified in Section 08520 - Aluminum Windows.

2.03 SOURCE QUALITY CONTROL

A. Allowable bow and warp tolerances: As measured with glass resting on edge upon two 1 inch wide supports:
   1. Typical: Maximum 1/8 inch in 48 inches.
   2. Tempered glass: Maximum allowed in accordance with ASTM C1048.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine openings to receive glass for defects that would affect glass and glazing work.

B. Verify removal of rivets, screws, bolts, welding fillets, or other projections from clearances in glazing rabbets.

3.02 PREPARATION

A. Examine frames receiving glass and ensure surfaces are clean and dry.

B. Remove dust and oil from glass by wiping clean immediately before installation.

C. Verify that sealants are compatible with glazing materials.

3.03 INSTALLATION OF MONOLITHIC GLASS

A. In accordance with GANA Glazing Manual, manufacturer's instructions, and accepted shop drawings by the Engineer.

B. Glaze doors in closed position after hanging and adjustment.

C. Accurately size and cut glass clean for each glazing condition:
   1. Do not nip edges.

D. Cut and set glass to full fit and play consistent with expansion and contraction requirements and at exterior for absolute security under maximum high velocity wind and vacuum stresses.

E. Maintain edge clearance at least equal to glass thickness from perimeter of glass to inside of rabbet.

F. Maintain 1/8-inch clearance between faces of glass and adjacent stop or bead.

G. Maintain minimum bite of 3/8 inch.

H. Set glass as required to ensure against optical distortion.

3.04 INSTALLATION OF INSULATED GLASS UNITS

A. In accordance with GANA Glazing Manual, manufacturer's instructions, and accepted shop drawings by the Engineer.

B. Use wet and dry glazing method.

C. Cut glazing tape to length and set against permanent stops to project 1/16 inch above sight line.

D. Place setting blocks at quarter points and no closer than 6 inches from corners.

E. Rest glazing on setting blocks and push against tape for full contact at perimeter of unit.

F. Place glazing gasket.

G. Install removable stop with concealed leg notched to accommodate setting blocks.

H. Align top of gasket with stops.

3.05 INSTALLATION OF GASKETS

A. Gaskets: Install in accordance with manufacturer's instructions.

B. Glazing of interior metal frames: Use pressure or foamed tape and sealant as indicated as required to eliminate rattle and reduce sound transmission.

3.06 SEALANT APPLICATION

A. As specified in Section 07900 - Joint Sealants, unless specifically noted otherwise.

B. Ensure protective coatings have been removed from aluminum surfaces.

C. Where setting blocks and spacer shims are required to be set in sealant, butter with sealant, place into position, and allow to set prior to installation of glass.

D. Neatly tool sealant or compound joints to compress material and improve adhesion. Repair or replace pockets exposed by tooling.

3.07 INSTALLATION OF MIRRORS

A. Comply with glass manufacturer's glazing recommendations.

B. Verify that wall surface is primed and sealed, smooth and firm, thoroughly dry. Support mirrors on setting blocks.

C. Set mirror in mastic spots or strips as recommended by mirror manufacturer. Apply mastic so it covers approximately 25 percent of mirror and so mastic does not impede ventilation.

D. Seal bottom edge and abutting materials joints.

3.08 CLEANING

A. After inspection by Engineer, remove labels and marks from glass in accordance with manufacturer's published recommendations.

B. Clean glass and surrounding surfaces from spatter and blemishes resulting from glazing operations.

C. Clean and polish glass inside and outside.

D. Clean glass with a soft, clean, grit-free cloth and mild soap, detergent, or slightly acidic cleaning solution:
   1. Immediately rinse with clean water and remove excess rinse water with a clean squeegee.
   2. Do not use an abrasive cleaner.

E. Remove grease and miscellaneous glazing materials with commercial solvent. Follow with normal wash and rinse.
   1. Be careful not to damage joint sealers.

3.09 GLASS AND LOCATION SCHEDULE

A. Exterior locations: Glass as follows, unless otherwise scheduled or indicated on the Drawings:
   1. Typical: Insulating, tinted.
   2. Non-fire-rated doors: Tinted and tempered.
   3. Fire-rated doors: Wired.
   4. Fire-rated windows: Wired.
   5. Entrance doors: Tempered and tinted.
   6. Windows within 48 inches of doors: Insulating, tinted, and tempered.
   7. Full height windows: Insulating, tinted, and tempered.
   8. Spandrels: Spandrel, tinted.

B. Interior locations: Glass as follows, unless otherwise scheduled or indicated on the Drawings:
   1. Typical: Clear, non-tempered.
   2. Non-fire-rated doors: Clear and tempered.
   3. Fire-rated doors: Wired.
   4. Fire-rated windows: Wired.
   5. Windows within 48 inches of doors: Clear and tempered.
   6. Full-height windows: Clear and tempered.

C. Public toilet mirrors: Mirrors, sizes as indicated on the Drawings.

END OF SECTION